SUSTAINABLE DEVELOPMENT AND THE FUTURE OF CONSTRUCTION

A COMPARISON OF VISIONS FROM VAROUS COUNTRIES

CIB Report

ISBN 90-6363-011-5

Publication 225

W82

FUTURES STUDIES IN CONSTRUCTION

PREFACE

This international CIB W82 Project aimed to answer the following question: *"What will be the consequences of sustainable development on the construction industry by the years 2010?"*

This study was focused on investigating the relationship and clearly defining the links between the principles of sustainable development and the construction sector.

It was launched in 1995 and was carried out with the collaboration of experts coming from countries in Western and Eastern Europe, North America, South Africa and Asia, with the objective to produce this CIB Publication in time for the CIB Gävle Congress.

This publication comprises fourteen national reports and an international synthesis, which give a comparison between visions from various countries on what comprises the notion of "sustainable construction".

There are many issues presented in this publication, all of which illustrate the constraints, policies, influences, recommendations and best practice that help describe sustainable construction. It is therefore of interest for all the actors of the sector (designers, industry, constructors, researchers, users, authorities...) to get a global view on the concept and to evaluate how their action can contribute to this challenge.

This publication should also be used as a source document for future studies and in particular for the development of a CIB Agenda 21 for Sustainable Construction following the CIB Gävle Congress.

Finally, this work must be seen as a living study and is open to an updating process. Input from additional countries, not already involved, is encouraged.

Wim Bakens
CIB Secretary General

EXECUTIVE SUMMARY

This international CIB W82 Project aimed to answer the following question:

"What will be the consequences of sustainable development on the construction industry by the years 2010?"

The study focused on investigating the relationship, and clearly defining the links, between the principles of sustainable development and the construction sector.

The (Kibert) definition for sustainable construction: "*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*" was taken as a starting point in 1995 when the project was launched. The objective was to interpret and describe its meaning in different participating countries and, if appropriate, to give it a better definition from their national point of view.

The project has involved the collaboration of experts from countries in Western and Eastern Europe, North America, South Africa and Asia, with the objective of producing this CIB Publication in time for the CIB Gävle Congress. The publication resulting from this project comprises fourteen national reports and an international synthesis, which give a comparison between visions from various countries on what comprises the notion of "sustainable construction".

The publication comprises:

Project Overview
Definitions of Sustainable Construction
Answers to Five Questions
Strategic Recommendations
Examples of Better Practice
Conclusion
The Country Reports
Belgium
Finland
France
Hungary
Ireland
Italy
Japan
Malaysia
Netherlands
Romania
South Africa
Spain
United Kingdom
United States of America

Definitions of Sustainable Construction

The word *sustainable* (suggesting the idea of constant, permanent or continuous) is translated to some languages as *durable*. The concept of "durable construction" may change the vision on the intended objectives, laying stress on resistance in time.

Sustainable construction has different approaches and different priorities in various countries. Some of them identify economic, social and cultural aspects as part of their sustainable construction framework, but it is raised as a major issue only in a few countries.

The main emphasis in national definitions lies on ecological impacts to the environment (biodiversity, tolerance of the nature and resources). The problems of poverty and underdevelopment or social equity are sometimes ignored in the definitions of sustainable construction and in addition to economic prerequisites or social questions, numerous other variables and their importance range from country to country.

Such features as density and demography of population, national economy and standard of living, geography and natural hazards, availability of land and water, energy production and supply, the structure of the building sector or the quality of the existing building stock etc. have also an influence and interpretation in national definitions.

The Five Questions

The content of this synthesis is based on answers given to the five questions that formed the main body of the national reports.

1. What kind of buildings will we built in 2010 and how will we adapt existing buildings?
2. How will we design and construct them?
    - What does this entail for **initiating, designing, constructing, maintaining, operating and demolishing** buildings?
3. What kind of materials, services and components will we use then?
    - What does this entail for manufacturers of building products and systems?
4. What kind of skills and standards will be required?
    - What does this entail for **human resources and skills** needed in the construction industry?
5. What kind of cities and settlements will we have in 2010?
    - What does this entail for **city planners** and the built environment?

Strategic Recommendations

The challenge the construction sector is facing today is not only to find the best balance between the various contemporary constraints of the act of building (technical, architectural, social or economic constraints) but also to endeavour to favour "decisions without regret" at every moment in the life cycle of a building, and especially in the construction phase. This chapter summarises the main recommendations given in the national reports towards:

- Building owners and clients should have a very important role in disseminating sustainable construction since they represent the demand of the building sector.
- Initiatives which involve planning, industry and constructors through adapted regulations, standards or fiscal measures and incentives.
- Education and training which should be largely used to have sustainable development concepts well known and accepted by all people.
- Developing a common language.
- Designers adopting a more integrated approach to design.
- Manufacturers of building products assessing the life cycle considerations as the basis of product development.
- Building users should see the environmental issues as one aspect of productivity.
- Building maintenance organisations should see environmental consciousness as a factor of competitiveness.
- The development of adapted tools to help in decision making.
- The improvement of the building process itself

Finally, a general recommendation which is stated is to take action at once to act preventively and to prepare the building sector to changes which are needed in the building process.

Examples of Better Practice

This section presents extracts of the case studies which are presented in the national reports. The full case studies provide an insight into the many approaches people have taken to putting the theory of sustainable construction into practice. It is hoped that these examples will help shape and define our own vision of sustainable construction and encourage the wider application of sustainable construction practices.

In total there are 59 examples presented in this section as follows:

Urban Planning - which includes examples of community planning.
Product development and design - including new uses of traditional materials.
Manufacturing and construction - looking also at new partnerships for construction.
Operation - including integrating new technologies for greater efficiency.
Deconstruction - looking at the long term use of the building.

Final Conclusion

There are many issues presented in this publication all of which illustrate the constraints, policies, influences, recommendations and best practice which help describe sustainable construction. It is therefore of interest for all the actors of the sector (designers, industry, constructors, users, authorities,...) to get a global view on the concept and to evaluate how their action can contribute to this challenge.

Current practices are widely different depending on how well the concept of sustainable building is developed in the various countries. There is also a marked difference between the developed market economies, transition economies and developing economies. The more mature economies pay more attention to the creation of a sustainable building stock either by new developments or by upgrading their existing building stock. In the transition economies the emphasis is on new developments (reduction of housing shortage), by learning from Western experience, and making improvements to their transport networks. In the developing economies social equity is much higher on the agenda than environmental concerns. Social and economic sustainability (e.g. job creation) is given much more thought.

The industry will have to adapt to these new and emerging construction markets which have environmental and social dimensions. Construction businesses will be expected to integrate into, and consider more fully, the issues valued by others at national, regional and community level where the driving forces will be a mixture of political, social and market forces, requiring products which respond to genuine need and concerns.

Finally, this work must be seen as a living study and is open to an updating process. Input from additional countries, not already involved, is strongly encouraged.

CONTENTS

FULL NATIONAL REPORTS

Sustainable Development and the Future of Construction
A comparison of visions from various countries

0. ABSTRACT

This international CIB W82 Project aimed to answer the following question: *"What will be the consequences of sustainable development on the construction industry by the years 2010?"*

This future study was focused on investigating the relationship and clearly defining the links between the principles of sustainable development and the construction sector.

The methodology allowed:
- to present the specificity and orientations of fourteen countries,
- to display clear visions of what the construction sector could be in fifteen/twenty years in the framework of sustainable development in these countries,
- to show proposed ways to reach this goal,
- and to gather the information through an international synthesis stressing the main elements from the various countries.

The study consisted of two main steps:
- a first step was dedicated to national efforts in order to get results at national level, which involved concertation with industry and national representative organisations;
- a second step was dedicated to the international synthesis and the validation and dissemination of the results.

The study led to:
- the identification of the issues, constraints and currently followed policies in the field of sustainable construction in various countries;
- the identification of the changes and adaptations foreseen for the construction sector in these countries through answers given by experts on five questions dealing with:
    - i) the kind of buildings which will be built and how existing buildings will be adapted,
    - ii) the ways of designing and constructing,
    - iii) the kind of materials, services and components,
    - iv) the kind of skills and standards which will be required,
    - v) the kind of cities and settlements which will be developed;
- the analyses of the consequences for the phases of the construction process;
- the definition of recommendations to the main driving actors of the sector;
- an illustration of best practices through some case studies, design methods, buildings or building products.

1. PROJECT OVERVIEW

1.1 Introduction

This international CIB Project was launched at the W82 Amsterdam meeting (spring 1995). In accordance with the scope of this Commission dealing with "Future Studies in Construction" - to supply, analyse and interpret the external (exogenous) factors affecting the development and future of the construction field, and, to produce, formulate and evaluate its future alternative - the Project aimed at answering the following question:

"What will be the consequences of sustainable development on the construction industry by the years 2010?"

"Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". According to this definition from the World Commission on Environment and Development (1987), it is clear that the various activities of the construction sector have to be regarded and analysed when considering sustainable development. As a matter of fact, on one side, the built environment constitutes one of the main supports (infrastructures, buildings,) of economic development, and, on the other side, its construction has significant impacts on resources (land, materials, energy, water, human/social capital) and on the living and working environment. Hence the construction industry has a lot of direct and indirect links with the various aspects of sustainable development.

The First International Conference on Sustainable Construction held in Tampa in 1994 [1] introduced the following definition of sustainable construction "the creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles" (Kibert and alii).

This very broad definition must be seen only as a starting point to build a more concrete definition of the concept of sustainable construction and begin to describe the stakes and issues of sustainable development that relate to the construction sector. More research is required to investigate the relationship between sustainable development and the future of construction. As an example among others proposed today, a conceivable sustainable construction road map is given in Figure 1.

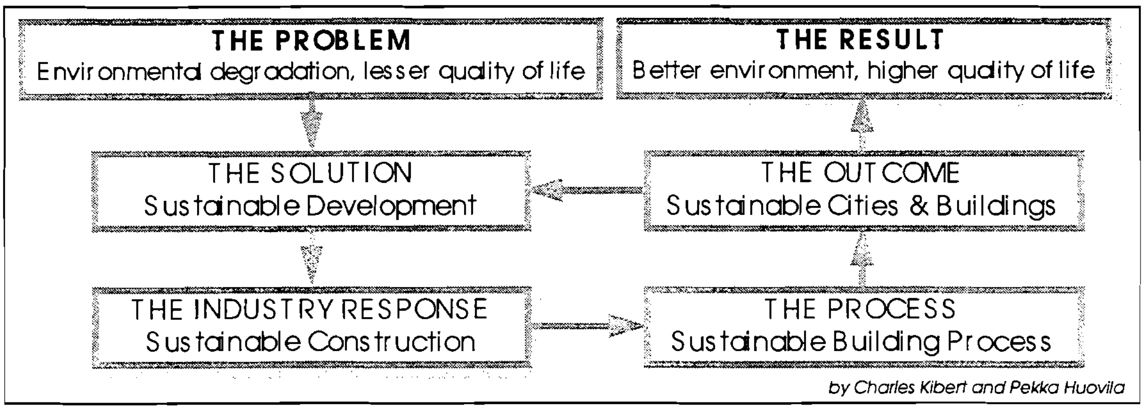

Figure 1: A Conceivable Sustainable Construction Road Map

1.2 Methodology

The Project was focused on the clear definition of the links between the construction sector and the principles of sustainable development. It followed a methodology which had several main characteristics: i) it was an international study allowing to present and to take account of the specificity and orientations of various countries; ii) it was a future study aimed at defining a clear vision of what the construction sector could be in fifteen/twenty years in the framework of sustainable development and how this goal could be reached; iii) it was carried out by experts coming from organisations deeply involved in the topic at national level.

The Project was divided into several tasks (Figure 2) grouped in four phases.

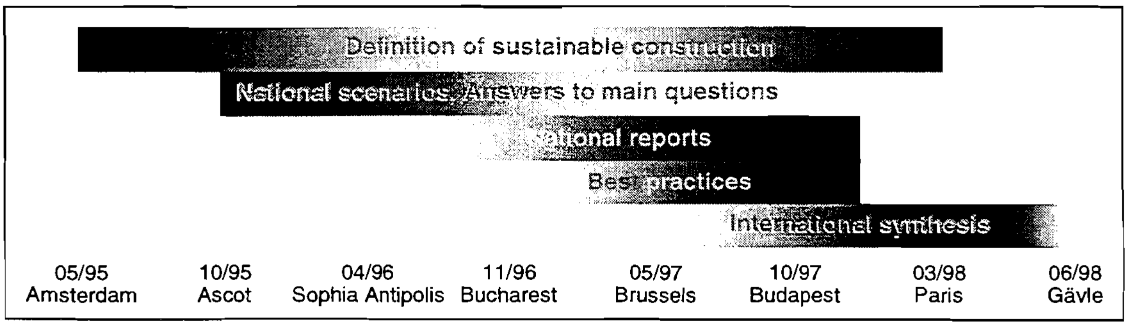

Figure 2: Main Tasks of the Project

Three different co-ordinators were nominated for the first three phases of the project as presented in the next sections: Sandy Halliday, for BSRIA, accepted to lead phase 1, Pekka Huovila, from VTT, led phase 2, and Caspar Richter, from SBR, led phase 3. Luc Bourdeau co-ordinated the last phase dealing with the international synthesis.

About eighteen countries were involved in some or all of these phases and fourteen were able to produce a full National Report (Figure 3).

Countries	Organisations	National Project Leaders
Belgium (BE)	CSTC	Frans Henderieckx
Finland (FI)	VTT	Pekka Huovila
France (FR)	CSTB	Luc Bourdeau
Hungary (HU)	ETE	Gyorgy Kunszt
Ireland (IE)		C.J. Walsh
Italy (IT)	Florence	Roberto Bologna
Japan (JP)	Univ. of Tokyo	Tomonari Yashiro
Malaysia (MY)	Ministry of Housing	Dang Anom Md. Zin
Netherlands (NL)	TNO	Roel Lanting
Romania (RO)	Urbanproiect	Jana Suler
South Africa (ZA)	CSIR	Chrisna du Plessis
Spain (ES)	UPC	Pere Alavedra
United Kingdom (GB)	BSRIA	Tom Smerdon
United States (US)	GaTech	Godfried Augenbroe

Figure 3: Full National Reports Produced in the Project

Greece (GR) through Aristotle University of Thessaloniki (Dimitris Bikas and Sotiris Milonas) joined the project later and produced a partial contribution which was integrated in the various chapters of the synthesis.

1.3 Phase 1: Definitions of the concept of Sustainable Construction

Phase 1 of the Project sought to identify what each participating country or region understands by "Sustainable Development" and "Sustainable Construction".

The participants of the meeting in October 1995 were asked to present papers which gather national initiatives on Sustainable Construction and to try to discuss about a definition of sustainable construction [2, 3]. It was proposed to start from the definition provided by Kibert and alii.

The intention of the Meeting was to generate an interactive debate consistent with the holistic nature of the subject. In total thirteen papers from ten countries (Canada, Finland, France, Hungary, Netherlands, New Zealand, Palestine, Rumania, United Kingdom and United States) were received and discussed on a wide range of topics.

The meeting consisted of a series of informal interactive sessions to identify common themes and concerns. The papers were extremely diverse but common threads were identified.

Several definitions of "sustainable construction" were offered which reflected the regional diversity and different priorities in the participating countries. The constraints, specific issues and future scenarios specific to every country turned out to have a strong influence on the concept of sustainable construction described in each country as well as the level of priority given to the various issues.

One chapter of the synthesis is dedicated to these aspects.

1.4 Phase 2: Answers to 5 main questions and consequences

The questions to be answered in Phase 2 were the following:

- What kind of buildings will be built in 2010, and how will we adapt existing buildings?
- How will we design and construct them?
- What kind of materials, services and components will be used there?
- What kind of skills and standards will be required?
- What kind of cities and settlements will we have then?

There was no common methodology given to participants on how to find answers to these questions. That was left open to be freely defined in each country: e.g. scenario for sustainable construction, analysis and documentation of expert interviews and brainstorming sessions. National studies consisting of answers to the five questions together with a more precise (i.e. more concrete) definition of sustainable construction from participating countries were asked to be presented in the 4/96 Meeting [4].

It was also decided that the precise content of the coming Phase 3 would be described in this meeting. The intention of i) integrating the activities of other relevant CIB Working commissions and Task Groups and ii) including the presentation of some success stories were already introduced.

Phase 2 was started with Belgium, Finland, France and the Netherlands. The number of participating countries increased soon to ten after Hungary, Italy, Japan, Rumania, United Kingdom and United States decided to join the project.

Taking into account the variety of definitions of the concept which resulted from Phase 1, it was at that stage found to be too early to agree on one common definition for Sustainable Construction. Therefore each country was given the liberty of using the Kibert definition or its own definition for sustainable construction to develop answers to the 5 main questions.

One chapter of the synthesis deals with this phase of the Project.

1.5 Phase 3: National Reports

From the initial results of Phase 2 of the Project rose a need for a common methodology to be applied in Phase 3 enabling a later international synthesis of the national reports.

A methodology was proposed in mid-96, which was based on a multi-dimensional analysis of the problem. Three dimensions were firstly introduced:

- ecological principles (six principles are defined in the construction field in order to meet the three basic goals of Sustainable Development: to eliminate resource depletion, to eliminate environmental degradation, and to create a healthy interior and exterior environment);

- resources (four resources are concerned: land, energy, water and materials);
- life-cycle phases of the construction process (five phases are defined: develop and plan, design, manufacture and construct, operate, deconstruct).

After discussions, it was preferred by most of the countries to use a two-dimensional structure such as presented on Figure 4.

Resources / Process	LAND	ENERGY	WATER	MATERIALS
Urban planning Product development & Design Manufacturing & Construction Operation Deconstruction				

Figure 4: Structure for Presenting Consequences in National Reports

The idea was that for each point of this two- or three-dimensional space, it is possible to think about the consequences for the construction industry and therefore to give elements of the answer to the five questions defined earlier.

A general important remark which came from several participating members was that the definition of Sustainable Development and therefore the definition of the ecological goals and principles which were proposed did not fit necessarily the concept in all of the countries. As a matter of fact, it appeared, from the previous contributions on Phases 1 and 2, that the concept from some countries can be much broader than the "ecological" concept proposed here [5, 6, 7].

On the other hand, this methodological approach offers an interesting support for thinking about consequences to the construction industry. It enables a grasp of the overall idea and to debate over the appropriateness of activities meant to contribute to Sustainable Development. It also provides a good instrument to make a synthesis of the national reports.

Therefore, it was agreed to use this methodological approach for Phase 3 of the Project. To solve the problem linked to the general important remark mentioned above, it was agreed to give the possibility to every country to add to each dimension as many topics as needed.

In order to follow a way towards sustainable construction, it was decided to present main national strategic recommendations that could be addressed to the various actors of the construction sector in each country.

One chapter of the synthesis is dedicated to these recommendations.

Finally, it was also agreed that the project participants would present in their National Report best practices of Sustainable Construction from their countries.

One chapter of the synthesis deals with these good practice examples.

1.6 Phase 4: International Synthesis

The last Phase of the Project was an international synthesis of the results (Figure 5). This work started in summer 97 and was based on National Reports. The objective of this synthesis was not to try to derive so far a common universal vision of sustainable construction, but to try to present in a systematic considered way the visions coming from various countries and the associated recommendations addressed to the actors of the construction sector.

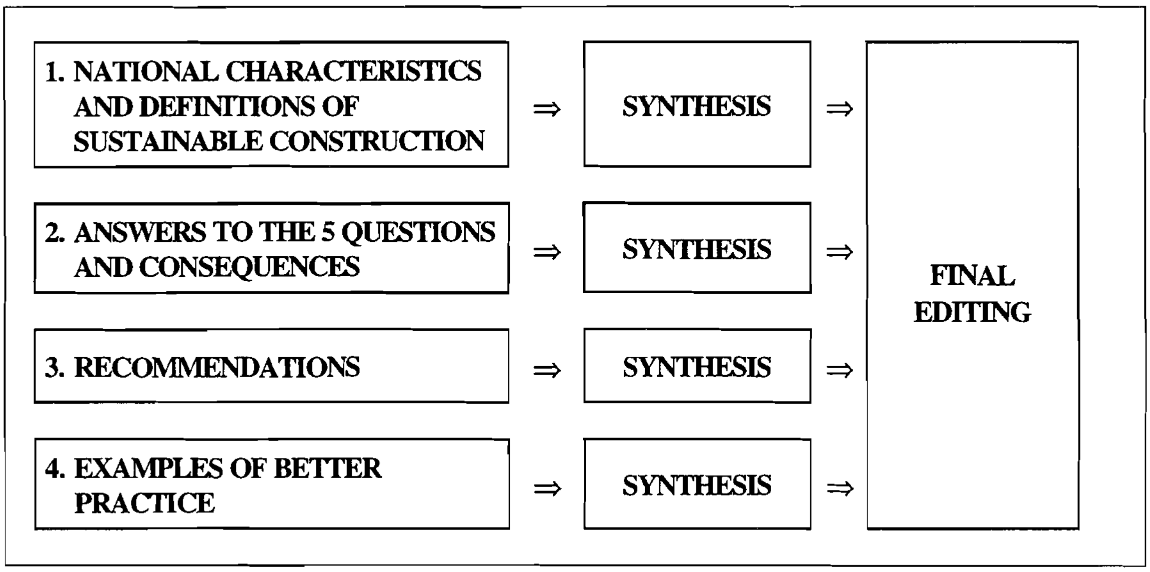

Figure 5: Methodology for the International Synthesis

The final results of the project give an international view of long term contributions from a Sustainable Construction industry for Sustainable Development. Clusters of national differences, due to special issues and national constraints, give more specific views of the different sectors. There are clusters of recommendations, provided in the National Reports, for government, management of construction and industry and for research and development as well as best practices for sustainable design and construction.

Consultation with people outside of the project was also organised at international level. Two papers were presented in Conferences in Tampere in August 1997 [8] and in Paris in June 97 [9]. A workshop was also organised in the framework of this Paris conference and the results presented at the end of the Conference. A paper was also published in the CIB Bulletin [10].

Consultation with CIB people not involved in the project was organised through a workshop held in Paris in March 98, at which contributions were made by experts from other CIB Commissions and from developing countries.

1.7 Conclusion

Sustainable construction should be an important component of achieving sustainable development. However, no clear consensus on the exact meaning of such a concept seems to be agreed today.

At the moment, the Project, presented in conferences and journals [8, 9, 10], led to a set of fourteen national reports and an international synthesis, gathered in this CIB Publication, which contain:

- the identification of the issues, constraints and currently followed policies in the involved countries in the field of sustainable construction;
- the identification of the foreseen changes and adaptations for the construction sector in these countries through answers given by experts on five main questions;
- the analyses of the consequences of sustainable development for the phases of the construction process;
- the identification of main strategic recommendations to be given in these countries to the main driving actors of the construction sector;
- an illustration of best practices through some case studies, design methods, buildings or building products.

The main goal of the present international synthesis was to extract main issues from the national reports, to detect the common ones and to stress the main differences (in scenarios, consequences, recommendations to actors...).

The next step should be to reach a more consensus vision through a global common model (with of course eventually items specific to regions or countries) and to set up indicators and policies to translate this vision into reality.

1.8 Organisation and financing of the Project

The national reports included in this publication and the other national contributions taken into account in the international synthesis were carried out by national research teams that organised their work according to the general framework agreed by the CIB W82 working commission but also according to national circumstances. These teams had their own way of working and also had to arrange their own financing.

The composition of each national team that produced a national report under the responsibility of the co-ordinators listed in Figure 3 can be found in each national report included in this Publication. Most of the national reports were also published or are going to be published in the country in question.

An editing team composed of Luc Bourdeau (CSTB), Pekka Huovila (VTT), Roel Lanting (TNO) and Alan Gilham (BRE) carried out the international synthesis. Chapter 2 was placed under the co-ordination of Pekka Huovila, Chapter 3 under the co-ordination of Roel Lanting, Chapter 4 under the co-ordination of Luc Bourdeau and Chapter 5 under the co-ordination of Alan Gilham, who also assured an English language reviewing.

Luc Bourdeau assured the final editing and the general co-ordination.

1.9 References

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8. Huovila, P., Richter, C. (1997) *Life Cycle Building Design in 2010* in *Proceedings of the 11th International Conference on Engineering Design ICED 97,* August 19-21, 1997, Tampere.

9. Bourdeau, L., Halliday, S., Huovila, P., Richter, C. (6/1997) *Sustainable Development and the Future of Construction* in *Proceedings of the Second International Conference on Buildings and the Environment,* June 9-12, 1997, Paris.

10 Bourdeau, L., Huovila, P. (1997) *A CIB W82 Project on "Sustainable Development and the Future of Construction"* in *CIB Information,* October/November - Nr. 4/97, Rotterdam.

2. NATIONAL CHARACTERISTICS AND DEFINITIONS OF SUSTAINABLE CONSTRUCTION

2.1 Introduction

This chapter presents what is understood by sustainable construction in different countries that have participated in this project. Belgian (BE), Finnish (FI), French (FR), Greek (GR), Hungarian (HU), Irish (IE), Italian (IT), Japanese (JP), Malaysian (MY), Dutch (NL), Romanian (RO), South African (ZA), Spanish (ES), British (GB) and American (US) contributions towards sustainable construction definition are presented after describing their national constraints, specific issues and future issues in order to give the context to these definitions. Problems and common elements in the definitions are finally summarised. This synthesis is based on the source documents, the national reports, and no further information has been sought to compensate possible shortages in some details.

Sustainable development has several definitions, such as:

- *"development that meets the needs of the present without compromising that ability of future generations to meet their own needs"* (the BRUNDTLAND Report WCED, 1987);
- *"improving the quality of human life while living within the carrying capacity of supporting ecosystems"* (Caring for the Earth, IUCN/UNEP 1991);
- *"development that delivers basic environmental, social and economic services to all residences of a community without threatening the viability of natural, built and social systems upon which the delivery of those systems depends"* (International Council for Local Environmental Initiatives, ICLEI 1996);
- *"determined to promote economic and social progress for their peoples, taking into account the principle of sustainable development and within the context of the accomplishment of the internal market and of reinforced cohesion and environmental protection, and to implement policies ensuring that advances in economic integration are accompanied by parallel progress in other fields"* (Amsterdam Treaty, 1997).

Sustainable construction is seen as a way for the building industry to respond to achieve sustainable development. All national authors in this project were given the (Kibert) definition for sustainable construction: "*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*" as a starting point. The task was to interpret and to describe its meaning in their own country and, if appropriate, to give it a better definition from their national point of view. The objective of the international project was then to try to formulate and, if possible, to agree on one common definition for sustainable construction.

2.2 National characteristics and definitions

2.2.1 Belgium

Sustainable construction is not defined in the Belgian national report. The issues of urban development, mobility and infrastructure, quality of dwellings, environmental management planning, soil remediation, energy, construction and demolition waste, RTD initiatives, and information and training issues are treated under the title "Sustainable Construction in Belgium". It is also reminded that the country is divided in three regions (Flanders, Brussels and Wallonia) that are responsible for their own environmental and building policy and legislation.

2.2.2 Finland

Three recent future scenario works (Figure 6) were selected as a starting point: four Dutch national sustainable development scenarios for the year 2030, four French national future scenarios for 2030, and five Finnish global future scenarios for 2005 and on.

Duurzame Ontwikkeling-scenario (The NL 1996) *Span* 2030 *Scope* "Extended economy" forms of capital and their interchangeability	**Bâtiment 2030 / Club Bâtiville** (France 1992) *Span* 2030 *Scope* National & European socio-economic variables	**Finland an the possible worlds / SITRA** (Finland 1995) *Span* 2005 – ? *Scope* Global development "macro level phenomena"
A1 **Strong Together** Global dominance of environmental values	B1 **Laisser-faire** Strong liberalism + economy in crisis	C1 **Master Plan** Multinational cooperation + political stability + sustainable development
A2 **Strong Alone** National dominance of environmental values	B2 **Croissance duale** "Intermediate scenario": liberalism + fordism + modest economic development	C2 **Merciless Business** Dominance of the market and free capital + economic and political instability
A3 **Considered Sustainment** "Intermediate scenario": modest regulation + technological optimism	B3 **Productivisme** Dominance of the EU level + modest regulation + techndogical optimism + strong economy	C3 **Conflicting Cultures** Cultural blocs + national separatism + economy-driven conflicts
A4 **Weak Sustainment** Market dominance, liberalism + technological optimism + strong economy	B4 **Développement durable** Dominating environmental values on the global and the EU level	C4 **Beyond the End** A fast and severe crisis invoked by competition and economic growth + global disorder + new localism and regionalism
		C5 **Competing Power Blocs** International spheres of influence + hegemony of power blocs + power politics

Figure 6: Dutch, French and Finnish Future Scenarios

The chosen working procedure was first to set sustainable future objectives and then start to accomplish them. Therefore the efforts were focused on describing one desired and realistic future, instead of comparing different alternative scenarios. The mission was understood as not to discuss unsustainable futures. A combination of the Dutch Strong Alone and Strong Together, together with the Finnish Master Plan was chosen as a starting point.

The following issues were identified to characterise national features:
- the availability of free space, and air and water of good quality, is not seen as a problem to be solved and is not striving for environment-saving solutions;
- the climatic conditions in the North of Europe are cold, leading towards energy saving thinking and acting as a self-evident matter;
- in general, the education standard is high, and means for co-operation and large-scale responsibility exist;
- although construction is mainly a home market activity, the market requirements in Central Europe act as a driving force to a larger extent than just to the manufacturing industry, that actively exports their building products;
- success factors are, and certainly will be, associated with competition circumstances in Finland and in Europe.

It is reminded that sustainable development is often treated in three areas: ecological and economical, social and cultural. Sustainable construction in this report emphasises ecologically sustainable construction, which means essentially management of bio-diversity, tolerance of nature, and saving resources. The idea is that achievement of ecologically and economically sustainable construction enables socially and culturally sustainable construction.

Sustainable construction, according to the definition, *"in its own processes and products during their service life, aims at minimising the use of energy and emissions that are harmful for environment and health, and produces relevant information to customers for their decision making"*. For building construction this means:
- intensified energy-efficiency and extensive utilisation of renewable energy sources;
- prolonged service life as a target;
- saving of the natural resources and promotion of the use of by-products;
- reducing waste and emissions;
- recycling building materials;
- supporting the use of local resources;
- implementation of quality assurance and environmental management systems.

The intention is to achieve an environmentally responsible industry and building owners together with environmentally conscious consumers.

2.2.3 France

In France the concepts of sustainable development and of "sustainable construction" are quite new. It is only at the end of the 80's that the problem of links between environment and buildings is really raised. However, the problem of energy savings in buildings has been the topic of a lot of development in France since the oil crisis (and even before). Several energy standards were set up in France since the 70's and the last one in 1989 introduced an advanced approach taking into account all energy consumption factors in the dwelling sector.

The main other environmental preoccupation factors in the construction sector so far were the problems of lead and asbestos, the problem of community wastes, the problem of CFC substitutes in building products and equipment (insulation products and cooling systems), the saving of water in flush systems, and the development of the use of recycled materials for road construction.

Sustainable construction is described in a form of 24 criteria in the following treelike outline (aim: design a sustainable building):

Characterise the design phase

- allow a technico-economic optimisation
    - capability to meet functional requirements (*indirect criterion*)
    - capitalistic impact (*indirect criterion*)
- envisage good construction conditions
    - construction logistics (*direct criterion*)
    - working conditions (*indirect criterion*)
    - impact on personal standing and employment (*indirect criterion*)
    - building site pollution (*direct criterion*)
- lead to minimal resources withdrawal
    - impact on raw materials withdrawal (*direct criterion*)
    - impact on energy resources withdrawal (*direct criterion*)

Master the operation phase

- insure maintaining of use functions
    - life duration - robustness (*indirect criterion*)
    - optimised maintenance (*direct criterion*)
    - consumption/wastes (*direct criterion*)
- master management of interfaces
    - cost of access to collective services (*indirect criterion*)
    - people: safety/health (*indirect criterion*)
    - non material services: TV, phone, ... (*indirect criterion*)
- participate and contribute to urban life
    - transport means inter-modality (*indirect criterion*)
    - integration of proximity services (*indirect criterion*)
    - integration of avoided social costs (*indirect criterion*)
    - impact on property value of location (*indirect criterion*)
    - impact of the construction on local environment (*direct criterion*)

Manage/retrofit/demolition phase

- allow retrofit/refurbishment
    - capability to be adapted (indirect criterion)
    - capability to change end use (indirect criterion)
    - capability to improve performances (direct criterion)
- allow deconstruction
    - aptitude to demolition (*direct criterion*)
    - deconstruction - aptitude to waste reprocessing (*direct criterion*)

Three categories of problems are identified behind the notion of Sustainable Construction:

- Physical problems
  arising from the issue of taking account of natural heritage: the management of resources shortage (essentially energy and water), and the management of damage caused to earth (essentially greenhouse effect);
- Biological problems
  following from the issue of not signing mankind's life away;
- Sociological problems
  evolving from the issue of ensuring an inter- and intra-generation solidarity; these problems have socio-political, socio-economic or socio-cultural facets.

2.2.4 Greece

Economic and social constraints can be characterised as:

- illegal immigration and refugees,
- low birth-rate,
- increase of life expectancy, high portion of aged people,
- urbanisation of rural areas.

Energy production and consumption account for 88 % of all greenhouse gas emissions and 92 % of the CO_2 released in the atmosphere. The energy conservation measures essentially involve:

- the reduction of energy requirements, by incorporating "passive systems" in new buildings, by increasing insulation requirements in new constructions and improving the situation in the existing building stock;
- the rational use of all available energy sources, the introduction of natural gas (in such areas as space and water heating) and the extensive use of solar geysers;
- the introduction of new technologies.

There is no official definition for sustainable construction. It is generally stated that the application of the sustainable development principle must satisfy present-day demands without jeopardising the future generations' right to well-being.

2.2.5 Hungary

In practice, the main issue is to achieve and stabilise EU membership for the country.

Economic and social constraints:

- a serious segregation of the society with connected problems of a minority ethnic group, illegal immigration, and refugee groups,
- a very low birth rate and a fairly high portion of aged people,
- a substantial restructuring of the economy and of the society is continuing, in spite of the previous substantial transition, concerning industry, agriculture, and services.

Environmental constraints:
- air pollution by traffic and industry, especially in the capital district,
- water pollution substantially due to foreign contamination,
- soil pollution,
- waste management in general and specifically nuclear waste treatment,
- almost empty villages and connected social problems of the inhabitants,
- an old building stock needing urgent maintenance and repairs; in places becoming slum areas,
- the lack of resources for renovation and reconstruction,
- the portion of imported materials in new construction.

The conceptual problem of sustainable development is clearly stated. The kernel of sustainable development is defined as the avoiding of bad ecological effects of modern economy, industry, and technology. More problematic use of the term refers to other negative phenomena such as poverty. It is therefore suggested that a new expression 'sustainable development and underdevelopment' would be used which includes the tolerability of underdevelopment. The aim of this extension is to better understand the differences of developed and less developed countries.

The given (Kibert) definition is accepted. The human resources and the clearance of miserable urban areas are indispensable.

2.2.6 Ireland

Although it is not yet known what sustainable development means, the wide scope of this concept is seen with complex inter-relationships between different components: environmental protection, human/social development, cultural development, and economic development. Sustainability of the built environment involves:
- establishing limits on the capacity of the natural environment to sustain itself,
- stopping short of those limits, by a controlled factor of safety, in any further future modification or extension to the built environment,
- altering the nature and course of human development, i.e. sustainable development.

The considered view is that sustainable construction represents a quantum leap in the evolution of design philosophy, and that its relentless progress forward is inevitable.

2.2.7 Italy

Italy is going through an economic phase of transition that started in 1992 and is characterised by:
- restrictive policies in public expenditures, set to reduce the great public debt accumulated during the eighties;
- constant effort of the industry to achieve higher productivity rates, as their main strategy in order to participate in the global exchange market.

The following structural features and problems are identified:

- absence of large amounts of natural raw materials; dependence on foreign countries for 80 % of national needs for fossil fuels;
- different growth measure of the advanced northern regions with respect to the southern regions;
- heavy unemployment figures (national average 12 % and over 20 % in southern regions, mostly the youth population);
- negative birth rate;
- drop in the role of the big enterprises and presence of big public enterprises;
- development entrusted to small-medium enterprise's vitality, innovation capability and competitiveness in the international market.

A "considered sustainment" scenario for the future can be synthesised:

- adoption of engagements in defence of the local and global environment, which is not to be more ambitious than the main indications at international level;
- increase in processes of endogenous development and of independent decision-making processes of individual administrations that tend to counter-balance the consequences of the lack of economic political lines explicit in the direction of the endurable development on one side and to bringing forward some changes which will in any case be indispensable on the other.

The meaning of sustainable constructions, and more precisely of sustainable buildings, is defined by the following principles:

- complete interaction with the environment, its natural phases and its resources availability;
- they are designed for efficiency of functioning during the time;
- they are designed for the longevity, the re-use and recycling of their materials;
- they are designed to optimise energy efficiency;
- they avoid the production of wastes and dangerous emissions in the phase of construction and during the life itself of the building;
- they foresee air-conditioning elimination, where possible;
- they avoid the use of electricity for heating and cooling, through passive design;
- for their construction local, recyclable and re-useable resources have been utilised;
- they use renewable materials, like wood.

However, in the definition of the sustainable construction concept, it is appropriate to specify that these principles are necessary, but not sufficient in order that to build in a sustainable way, it is fundamental to base our foundation on a sustainable society where harmony exists inside peoples, between peoples and with the planet.

2.2.8 Japan

Key issues in Japan concerning environmental impacts by construction industry are:

- global warming (over 34 % share in national CO_2-emissions by construction activities);

- depletion of tropical forests (33 % of exported tropical timbers are consumed in Japan);
- ozone depletion (the recycling of ozone depleting materials);
- acid rain (although the relative amount produced by the construction industry is quite small);
- construction wastes (about 21 % of industrial waste in 1990);
- capacity of space (the lack of land area);
- short life buildings (the tendency to demolish buildings after quite a short utilisation period);
- global supply chain (the amount of imported resources which generate environmental problems in other countries).

Basic strategies for integrating policies by the Japanese government for the coming decade may be interpreted as some kind of definition of sustainability. These strategies are:

- cyclic utilisation
  realising a socio-economic system with less environmental impacts by cyclic utilisation;
- harmonisation with nature
  harmonised coexistence with living creatures by conservation and restoration of ecological environments;
- participation
  participation of all organisations to the activities toward 'cyclic utilisation' and 'harmonisation with nature' under equalled role sharing;
- international framework
  promotion of international collaboration.

Additionally, Building Agenda 21, developed by the Architectural Institute of Japan (AIJ), proposed seven principles for future research activities:

- establishment of the methodology to evaluate life cycle impact of building to the environment, as well as creation of measures to constrain impact by using the methodology;
- producing a code of practice of planning together with reconsideration of the present life style from the aspect of energy consumption;
- prolonging the life of buildings in order to prevent rapid resource consumption;
- reducing energy and water consumption in building operation and setting up measures to use renewable resources;
- planning for sustainable land utilisation and for preventing pollution to water, air and land;
- creating measures for a healthy environment;
- promoting technology transfer and information exchange for international co-operation.

2.2.9 Malaysia

The following issues are identified:

- a large proportion of the population lives in urban settlements;
- illegal immigrants create economic and social problems;
- the availability of land, air and good quality is a problem;
- there is a mushrooming of squatter settlements;
- there is a means for co-operation and large scale responsibility towards sustained development still exists;
- unsustainable urban sprawl;
- depletion of forests continues;
- the hot climate needs policy to sustain the energy as most houses have installed air-conditioning units;
- the volume of road vehicles is alarmingly responsible for the emission of CO_2;
- the management of toxic and industrial waste needs to be reviewed;
- environmental protection during the construction process is needed;
- utilisation of imported building technologies and materials.

The definition given by Kibert definition is adopted.

2.2.10 The Netherlands

The present situation is that:

- the Netherlands has the highest population density in Europe (499 inhabitants/km^2);
- as everywhere else in Europe, life expectancy is on the increase and is projected to reach 76 years in 2010 – at that time those over 65 years will form 24,1 % of the population;
- a large proportion of the population (roughly 90 %) lives in urban settlements and some 30 % of them complain about nuisance from noise and odours;
- water management is of extreme importance;
- there are 185 road vehicles per km^2 and road traffic alone is responsible for 22 % of the national CO_2 emission; projections indicate a 70 % increase in road transport kilometres between 1986 and 2010;
- the problem of allocation of space is not restricted to the country itself but also has a global dimension: in other countries the Netherlands effectively takes up five times its own surface for food production, the production of cattle fodder and the import of timber.

The government policy for the immediate future is aimed at:

- energy saving,
- controlled growth of mobility,
- stringent planning of land use,
- efficient use of raw materials and water.

Long-term government policy is based on the identification of three closely linked sustainability variables: energy, mineral resources, and land use and bio diversity.

The scenario proposed for 2010 is a policy target-based approach. It retains the direction and relative dynamism of the economic and political changes observed during the past years, including trends recently recognised (surprise-free scenario). Agenda 2010 for the Netherlands, together with the key issues for the construction industry is as follows:

Sustainability key issues	*Agenda 2010 (goals)*	*Key issues for the construction industry*
General (socio-economic factors)	Incorporate sustainability into decisions; environmental performance standards into building regulations	Decision-support systems, information technology, interdisciplinary co-operation, re-engineering of building process, incentives for innovative technologies
	Incorporate environmental impacts into the tax system or into prices	Life-cycle costing, full cost pricing
	Full acceptance of the sustainability concept	"Social engineering", education
Energy	30 % increase in all energy efficiency (1995 to 2000)	Embodied energy, energy use and supply, urban planning
	Increased energy performance of buildings (23 % in 2000)	Insulation, intelligent building services, alternative energy sources, maintaining healthy indoor environment
	10 % renewable energy (2020)	Optimal use of solar energy and biomass
	35 % reduction in mobility	Physical planning, public transport, energy-efficient transport systems, teleconferencing, teleworking
	Energy taxes	Energy efficient production
Mineral resources	Decreased use of non-renewable raw materials (annual use of 1 % of established reserves)	Lean design, durable products
	Increased use of renewable raw materials (20 %)	Use of biomass
	Closed-loop recycling (90 %)	Infrastructure for recycling/reuse, product stewardship
	Extended service life of buildings; management strategy for existing building stock	Life-cycle flexibility, regeneration of existing stock, sustainable design and site quality
Land-use and biodiversity	Conserve open areas	Use of third dimension, land reclamation, high density building, right use in right place
	Interconnected wildlife areas	Physical planning of infrastructure, reconstruction
	Conservation of ecosystems	Emissions of building products in use, management of river systems, remediation of soil/water pollution
	Water conservation (25 % reduction in household use by 2010)	Efficient use of drinking water, prevention of water pollution

The official definition for sustainable construction is *"a way of building which aims at reducing (negative) health and environmental impacts caused by the construction process or by buildings or by the built-up environment"*.

A more precise definition of sustainable construction is suggested as *"the reduction of the use of natural resources and the conservation of the life support function of the environment by construction processes, buildings and the built-up environment under the premise that the quality of life is maintained"*. The key verbs in the definition: reduce, conserve and maintain can be interpreted as key issues and principles as follows:

criterion	*key issues*	*principles*
Reduce	Use of energy sources Use of mineral resources Use of water resources Use of land	Minimise depletion through: - reuse - recycling - use of renewable resources - efficient use (extended life-span of products, energy and water efficiency, multiple use of land)
Conserve	Natural areas Bio-diversity	Conserve through: - restricted land use, reducing fragmentation - prevention of toxic emissions Restore through: - remediation
Maintain	Healthy indoor environment Quality of built-up environment	Maintain through: - low emission materials, (energy) efficient ventilation, compliance with occupant's needs - provision of amenities, transport, recreation, security - abatement of noise, pollution and odorous Restore/improve through: - renovation, rehabilitation

At the building level, a sustainable building can be defined as a building that:

- consumes a minimum amount of energy and water over its life span;
- makes efficient use of raw materials (environment-friendly materials, renewable materials, enhanced life cycle, demountability);
- generates a minimum amount of waste and pollution over its life span (durability, recyclability);
- uses a minimum amount of land and integrates well with the natural environment;
- meets its user's needs now and in the future (flexibility, adaptability, site quality);
- creates a healthy indoor environment.

2.2.11 Romania

After almost 50 years of a totalitarian regime, the Romanian society is now undergoing a difficult period characterised by structural changes in economics, politics, legal systems, administration and culture. This process, desired by the entire community, has incurred high social costs, which have to be supported by the present generations, in spite of their previous frustrations. Under these circumstances, the process of establishing sustainable development objectives is highly sensitive, as it should not introduce restraints beyond the tolerable limit of the population.

The adjustment of the society to sustainable development principles requires serious cultural shifting. Some components, such as attitudes are characterised by a considerable inertia, where change will take a long time. The phenomenon is even more difficult if the individuals are under the influence of distorted ideologies. Thus, it is difficult to figure what unanimously accepted means could lead to the moderation of the tendency towards "more", when in the highly developed countries this notion represented the idea of prosperity while in the ex-socialist countries it represented a tendency that was to be blamed (against equalitarianism). Also, the stimulation of the notions of re-utilisation and recovery may face resistance in those environments where they used to be considered as a sign of poverty. Finally, moderate consumption, so that resources "should also be available to the next generations" is not easily accepted by those whose minimally necessary needs can be hardly satisfied.

Communication is considered as a prerequisite for creating the initial conditions necessary for the sustainable development process, the more so as the signals relating to the lack of functionality or blockage are more alarming. Such signals are:

- at a decision making level:
    - lack of correlation between the sector strategies and the assessment of their feasibility with reference to the legal frame;
    - lack of consistent activity to ensure feed-back by drawing attention to those situations incompatible with the old regulations or with the rigid implementation conditions in relation to research;
    - poor connections with the final user and difficulties in providing the primary data;
- with reference to professions:
    - insufficient collaboration between specialists (engineers, architects, economists, sociologists...);
- with reference to generations:
    - a certain lack of trust in the capacity of the nowadays adults to create something new after having been educated within an obsolete system, to which a certain arrogance of the "clean" generations is added.

The following definitions are referred from the literature for sustainable environment and sustainable development of constructions:

- 'sustainable environment' means to bequeath the world in such a state as to allow the inhabitants of the future to enjoy a life quality at least similar to the one we built (from Kibert);
- 'sustainable development of constructions' means to consciously conceive a healthy built environment, based on effective use of resources and ecological principles in order to create, administrate, maintain and rebuild the built environment (from CIBW82 Ascot meeting).

The selected resources are land, energy, water and building materials. The established ecological principles are:

- minimise resource consumption,
- maximise resource re-use,

- use renewable or recyclable resources,
- protect the natural environment,
- create a healthy non-toxic environment,
- pursue excellent quality in creating the built environment.

Life quality is unsatisfactory in relation to the national and European standards determining a priority orientation towards achieving European living standards. In fact, at European level, it is already recognised that the developed countries may envisage "the maintenance or improved life quality together with the diminution of resource consumption" as objectives of sustainable development while the less developed countries will focus on "the improvement of life quality without an exaggerated increase of resource consumption" or "the increase of the average material consumption".

2.2.12 South Africa

We are reminded that the concept of sustainability has been practised by indigenous people worldwide for thousands of years. However, few, if any, have managed to couple sustainability with what the western mindset terms "development". Those cultures who have lived the most sustainable lifestyles were often also the ones considered extremely "backward" or "underdeveloped".

The definitions of sustainable development are often vague and ambiguous. Achieving "quality of life" and "quality of the built environment" does not necessarily go in hand with sustainable development as long as "quality of life" is not redefined. In South Africa, social equity is much higher on the agenda than environmental concerns, and therefore more thought is given to the impact of construction on social and economic sustainability.

2.2.13 Spain

Sustainable construction is not defined in the Spanish draft national report. The evaluation criteria with regard to the sustainability concept group the fields of environmental quality, spatial structure, cohesion and social life quality, and local economy.

2.2.14 United Kingdom

The GB report uses the given Kibert definition for the purposes of the study.

2.2.15 United States

National concerns are:
- CFCs emitted by building air conditioners and building material processes;
- a wide diversity of climatic zones, bio-regional sustainability issues, and various building codes in different states, respectively;

- inner cities with steadily deteriorating urban infrastructures;
- unsustainable urban sprawl;
- 'brownfields': abandoned and potentially contaminated industrial and other plants;
- a deregulation tendency which makes control issues difficult;
- mainly local and community-driven sustainability movements.

Constraints are:
- consumption oriented attitudes and low public awareness of sustainability;
- the domination of short term economic indicators;
- a general mistrust towards federal involvement;
- difficulties of imposing energy and pollution taxes;
- difficulties in funding, maintaining and expanding public infrastructure;
- no 'stakeholder' acting on behalf of the building stock and the workers.

Specific issues (by the US Building Futures Council, 1997) are:
- superfund reauthorization and risk sharing,
- cleanup standards,
- brownfields,
- environmental justice,
- environment infrastructure privatisation,
- navigation improvements (the provision of channels for container ships),
- environmental protection during the construction process,
- water minimisation and recycling.

Sustainable construction is not given a new definition in the draft of the US report. It is stated that sustainability calls for a new approach and aiming for a sustainable built environment it requires a paradigm shift [Vanegas, DuBose & Pearce, 1996]. A framework is proposed to take a broader look both in time (full life cycle assessments) and space (the object in its wider system settings), than it is used to do in traditional engineering.

2.3 Conclusions

Sustainable construction is seen as the building industry's response to achieving sustainable development. The (Kibert) definition for sustainable construction: *"the creation and responsible management of a healthy built environment based on resource efficient and ecological principles"* was taken as a starting point for this project. The objective was to interpret and to describe its meaning in different countries and, if appropriate, to give it a better definition from their national point of view.

The word *sustainable* (suggesting the idea of constant, permanent or continuous) is translated to some languages (e.g. Dutch, Finnish, Romanian or French) as *durable*. The concept of "durable construction" may change the vision on the intended objectives, laying stress on resistance in time.

Sustainable construction has different approaches and different priorities in different countries. Some of them identify economic, social and cultural as part of their sustainable construction framework, but it is raised as a major issue only in a few countries. The main emphasis in national definitions is on ecological impacts to the environment (bio-diversity, tolerance of nature and resources).

The problems of poverty and underdevelopment or social equity are sometimes ignored in the definitions of sustainable construction. In addition to economic prerequisites or social questions, numerous other variables and their importance vary from country to country. Features such as density and demography of population, national economy and standard of living, geography and natural hazards, availability of land and water, energy production and supply, the structure of the building sector or the quality of the existing building stock, etc., all have an influence and interpretation in national definitions.

Figure 7 (based on [Vanegas, DuBose & Pearce, 1996]) tries to illustrate how traditional engineering will be widened, when environmental demands are considered. The economic and socio-cultural issues are presented in the global context together with the environmental issues.

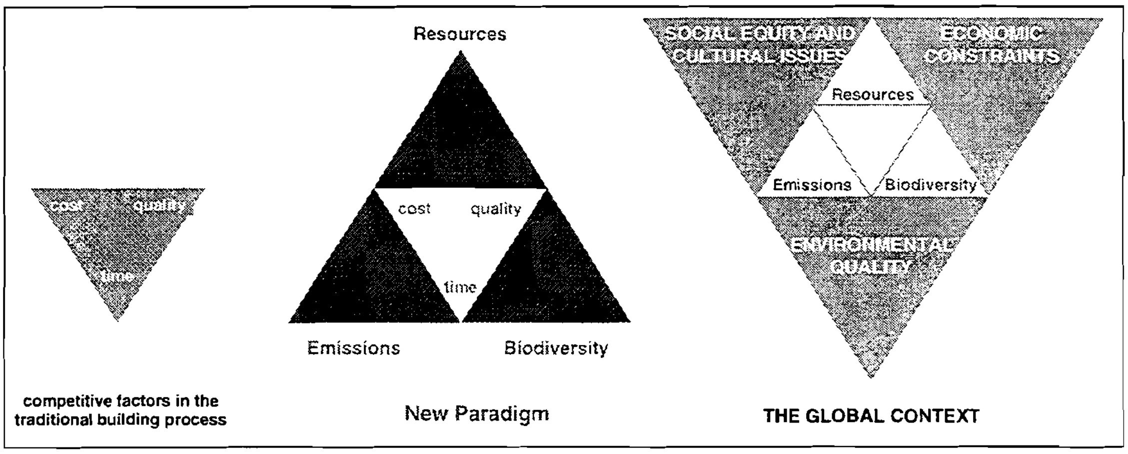

Figure 7: The New Approach in a Global Context

The categories of problems identified behind the notion of sustainable construction can also be classified as:

- physical problems linked to the issue of resources;
- biological problems linked to the life of mankind;
- sociological problems having socio-political, socio-economic or socio-cultural facets.

The key elements in various sustainable construction definitions are:

- reducing the use of energy sources and depletion of mineral resources;
- conserving natural areas and bio-diversity;

- maintaining the quality of the built environment and management of healthy indoor environments.

In a more detailed level, the following extrinsic or intrinsic topics are identified:
- quality and property value (BE, FI, FR, IT),
- meeting user needs in the future, flexibility, adaptability (FR, NL),
- prolonged service life (FR, FI, JP, NL),
- use of local resources (FI, IT),
- building process (FR),
- efficient land use (FR, JP, NL),
- water saving (JP, NL),
- use of by-products (FI),
- distribution of relevant information to their decision making (FI),
- immaterial services (FR),
- urban development and mobility (BE, FR, NL),
- human resources (HU),
- local economy (ES).

The proposed short definitions of sustainable construction are considered as good guidelines or as a general framework to be developed further and to be agreed on at a national level. In a short form they remain too general and are often found too vague and ambiguous. At a detailed level, local constraints, specific features and national priorities have to be taken into account. Therefore, agreeing on a common short definition at this stage was not seen as an important issue in this project.

3. ANSWERS TO THE FIVE QUESTIONS

3.1 Introduction

The content of this synthesis is based on answers given on the five questions that formed the main body of the national reports.

The main question to be answered in each national report was:

*"What will be the **consequences** of sustainable development to the **construction industry** by the year 2010?"*

The ancillary questions to be answered were:
1. What kind of buildings will we built in 2010 and how will we adapt existing buildings?
2. How will we design and construct them?
   - What does this entail for initiating, designing, constructing, maintaining, operating and demolishing buildings?
3. What kind of materials, services and components will we use then?
   - What does this entail for manufacturers of building products and systems?
4. What kind of skills and standards will be required?
   - What does this entail for human resources and skills needed in the construction industry?
5. What kind of cities and settlements will we have in 2010?
   - What does this entail for city planners and the built environment?

Each ancillary question raises an issue that should be further elaborated in terms of consequences for the construction industry as a whole. The answers to the questions were to be subdivided into four topics of environmental concern (land, energy, water and materials), although not all national reports fully adopted this format.

In this chapter of the synthesis, the answers to question 1 and 2 are combined. The subdivision into the four topics as outlined above was retained as far as possible. In the appendix tables, the answers given by the countries are classified into two sections: 'main issues' and 'consequences'.

3.2 Answers to the questions

3.2.1 What kind of buildings will we build in 2010 and how will we adapt existing buildings?

This question was merged with the second one that includes several subquestions:
- How will we design and construct them?

- What are the consequences for initiating, designing, constructing, maintaining, operating and demolishing buildings?

These subquestions address the whole building process and its actors. The synthesis of the answers given is subdivided into the following sections:
- Initiative and design
- Construction and deconstruction
- Operation and maintenance.

On the whole it is not expected that buildings will look much different from what they now appear. Major changes involve their functionality (flexibility/adaptability and life cycle performance) and energy performance. A vital topic mentioned by most countries will be the refurbishment or conversion of existing ill-performing buildings mainly for housing purposes.

3.2.1.1 Consequences for initiative and design

These consequences are summarised in Table 1.

3.2.1.1.1 Land

The issues with respect to the use of land address three aspects:
- efficient use of land,
- design for long service life,
- adapt/convert existing buildings.

The choice of site and land use land has not only local environmental effects, but also social and economic impacts. Efficient use of land appears to be vital for those countries where population density is high and mainly confined to urban areas (e.g. the Netherlands, South Africa, Malaysia). Solutions are sought in buildings combining more functions at the same time, better use of the underground (industrial/commercial buildings) and optimising the use of the roof surface (parking, recreation).

Improving the longevity of new buildings was mentioned by most countries as a means to conserve space and to push back the need of new land for development. Consequences are:
- design for flexibility and adaptability including support/fit-out modularity,
- better use of (environmental) life cycle costing techniques and quality control,
- better understanding of the needs and requirements of future users.

To extend service life of existing buildings refurbishment and retrofit activities will increase substantially requiring new technologies like light weight constructions for building extension and new tools like decision support systems (refurbishment/redestination versus demolition) and condition assessment techniques.

3.2.1.1.2 Energy

Emerging new energy saving technologies marked as being successful in the next decade involve super insulation, passive heating/cooling, day lighting/passive lighting together with the use of renewable energy sources. These technologies will require new designs of roof, facade and foundations (e.g. for heat/cold storage). Another consequence is that architects and designers should integrate their building and system designs allowing easy retrofit of these components during the lifetime of the building.

Many national reports stress the importance of safeguarding indoor air quality and climate in connection with strong penetration of energy saving technology in building design.

In some countries (e.g. Finland, Greece) fuel switching will become important requiring hybrid systems for heating.

Although the energy saving potentials within the existing building stock are quite high, the topic of improvement of the energy performance of existing buildings was only mentioned by a small number of countries. There is a need for new retrofit technologies that are economically affordable to building owners.

3.2.1.1.3 Water

Drinking water conservation and reduction of sewage water will lead to building integrated water saving equipment. In South Africa the focus is on waterless sanitation systems and landscaping with draught resistant plants.

3.2.1.1.4 Materials

The differences between countries are not very large with regard to this topic. Selection of materials should be based on their environmental performance and on their individual service life. Optimisation will take place using eco-balance tools. Jointing and assembly should be designed to allow for easy disassembly (reversible building process). In the developing world a balance is sought between improved indigenous technologies (self-built) and mass-produced units (prefab) in order to cope with the housing demand. There is a need to improve the life expectancy of indigenous building technologies and materials, instead of replacing them with alien technology.

Other specific issues mentioned are building integrated waste collection systems and improved techniques for better acoustic insulation.

3.2.1.1.5 Other aspects

Because the design process will become more important and more complex there is an urgent need for an integrated approach requiring among others co-engineering partnerships between designers, engineers and manufacturers and the development of advanced (environmental) design tools. Information technology will be used in integrated design models to provide a seamless flow of information during the life of a project providing continuous feedback loops. This will enable all project participants to work together in exchanging design information and apply design tools to optimise the design and construction process.

Environmental product information systems and environmental accounting of buildings will assist clients and designers in designing more environmental friendly buildings. Environmental awareness of architects can also be raised by post completion design assessment and feed back as mentioned in by several countries.

Some countries raised the question whether a demand for these buildings will really emerge. Information and communication next to customer participation are by many countries seen as the solution to this question.

3.2.1.2 Consequences for construction and deconstruction

These consequences are summarised in Table 2.

3.2.1.2.1 Land

Obviously this is not the main issue for contractors. Topics mentioned are:

- improved site management to protect nature,
- redevelopment of heavily polluted or derelict areas.

3.2.1.2.2 Energy/water

Again this is an issue of minor importance although the minimisation of transportation needs for construction and deconstruction is an important topic with cost-saving potential.

3.2.1.2.3 Materials

For building contractors the consequences mentioned pertain mostly to material use and facilitation of material recycling:

- use of local materials and reuse of serviceable building parts;
- construct for disassembly using modular approaches;
- labelling of components to facilitate selective removal and recycling;
- introduction of quality standards for recycled materials;
- contractors to produce operating and maintenance manuals for buildings and systems.

In the developing world the creation of jobs is important and where appropriate contractors will use more labour intensive construction methods and improved indigenous materials.

The importance of renewal engineering will exceed that of new constructions at least in the developed market economies. Opportunities for contractors lie in:

- developing refurbishment processes which cause minimal disruption to occupants and the immediate environment;
- developing modular systems for refurbishment.

Demolition contractors will have to develop new deconstruction and stripping techniques to facilitate optimal recycling and re-use of building materials.

3.2.1.2.4 Other aspects

An important number of topics were raised concerning the re-engineering of the building process Important business opportunities were identified by the various countries:

- increased partnership between designers, contractors and manufacturers; new styles of procurement;
- better management of the building process through total quality management and improved project co-ordination facilities;
- specialisation in specific market segments (e.g. refurbishment) or construction systems (e.g. robotic construction);
- opportunities for recycling (in particular in the developing economies) and brokering services.

3.2.1.3 Consequences for operation and maintenance

These consequences are summarised in Table 3.

3.2.1.3.1 Land/materials

Sustainable management of buildings also implies the extension of the service life of buildings in order to prevent the uptake of more land for new developments. For building managers, the following issues were presented in the national reports:

- adapt buildings for the future needs of occupants;
- re-commission old non-functioning buildings for new functions;
- consider both within an ecological and economic context the benefits of decommissioning versus regeneration;
- use planned maintenance and refurbishment programmes.

3.2.1.3.2 Energy

The widening gap between the energy performance of old and new buildings calls for extensive retrofit programmes and organisation and management procedures:

- retrofit of installations,
- domotics and energy management systems,
- extended use of day lighting,
- better control of indoor air quality, noise and health risks.

3.2.1.3.3 Water

Water management in existing buildings may well lead to substantial savings. Topics mentioned are retrofitting buildings with water saving equipment like rainwater and grey water storage and use facilities together with water saving guidelines for building managers.

3.2.1.3.4 Other aspects

From the national reports a consensus emerges about better education of facility managers and building owners with respect to environmental issues, leading to recommendations such as:

- use of feedback mechanism to increase awareness;
- use of facilities maintenance and management systems, manuals and guides;
- adoption of performance standards for existing buildings.

3.2.2 What kind of materials, services and components will we use then and what are the consequences for manufacturers of building products and systems?

Many of the issues raised are a logical result of the future needs of the construction industry realising buildings in the coming decade (Table 4).

3.2.2.1 Land

The indirect use of land for the production of building materials is extensive. Large scale quarrying of minerals for the construction industry in highly populated areas may lead to unacceptable loss of natural areas. Many countries stress in their reports that the environmental performance of building materials should be improved by:

- use of renewable materials and the use of local resources;
- considering full life cycle energy cost;
- improved durability;
- low emissions during use;
- recyclability.

For components that can be easily reused, the first priority is durability and long service life. For components that are difficult to reuse the requirement will be easy biodegradability.

3.2.2.2 Energy

A high demand for energy saving technologies was identified. Systems that will be introduced in the near future are:

- heat recovery and storage,
- small CHP-units,
- electrical heat pumps,

- PV-cells,
- passive and hybrid technologies for heating and cooling,
- passive lighting systems,
- translucent insulation,
- advanced sensor technology and building domotics,
- new acoustic/thermal insulation materials and systems.

The demand will not only focus on new buildings but also on the existing stock. The consequence will be that the developed systems must also be easily retrofitted in the existing building fabric.

South Africa expects that high technology production systems, materials with high embodied energy and poor energy saving attributes will still be used, especially in the mass housing market.

3.2.2.3 Water

What is said about energy saving also applies to water saving equipment although this issue is only mentioned by a few countries (GR, NL, MY, ZA). Components include rainwater storage systems, low flow showerheads, dual flush toilets and self-composting toilets.

3.2.2.4 Materials

Quite a few countries expect an increased responsibility of manufacturers for their products from cradle to grave. This being far from imaginary will force manufacturers into the development of:

- new materials, recycled or made from renewable resources,
- plug-in systems, easy to disassemble and re-use,
- standardisation and modularity of components,
- improved tools for the prediction of service life of components and systems,
- new logistics for closed-loop recycling,
- on-line product information systems (Internet).

3.2.2.5 Other aspects

The penetration of new technologies will also lead to new building concepts. A closer co-operation between architects and building material manufacturers is expected in product development. As a consequence subsystems will be fully integrated in building components for roofs and facades (function integrated systems).

3.2.3 What kind of skills and standards will be required and what does this entail for human resources and skills needed in the construction industry?

The following main points of interest have been identified around this subject (see also Table 5).

3.2.3.1 Human resources

On the building sites specialised jobs will gradually disappear in favour of multi-skilled autonomous crews. The emphasis will lie on assembly and disassembly techniques and the ability to handle both new and old materials.

The building process itself will become more complicated requiring excellent management skills and integrated knowledge of the whole process (life cycle thinking). Information technology will impact on all aspects of the building process, requiring the skills necessary to cope with this level of information transfer.

Increasingly new forms of partnership will be adopted like design build and operating contracting. Professional barriers will become less important and the focus will be on risk management

Total quality management and better us of feedback mechanisms will improve the performance of all partners involved in the process.

3.2.3.2 Decision making processes

Incorporating sustainability into the decision making process requires:
- public participation,
- new decision support systems making full use of information technology,
- skills in negotiating and facilitating.

3.2.3.3 Education

To overcome professional barriers and to improve knowledge on the cause-effect relations of decisions taken, interdisciplinary education of designers and construction engineers is needed. This refers in particular to specialisation in environmental issues.

Other important groups of actors mentioned in the field of better training in environmental matters were building operators and facility managers.

3.2.3.4 Public awareness

Full acceptance of the concept of sustainability by the public at large can be achieved by demonstration projects and information campaigns. Special attention was called for better information on self-building (GB). Incorporation of environmental costs in the tax system may also add to more awareness.

3.2.3.5 Standard and regulations

To make the environmental performance measurable and certifiable, more tools are needed such as:
- performance based standards in the building codes,

- 'green' certification and eco-labelling systems based on LCA.

In South Africa the perspective is standards will have to be adapted to suit local traditions and indigenous building technologies.

3.2.4 What kind of cities and settlements will we have in 2010 and what are the consequences for city planners and the built environment?

The main changes expected with respect to urban development are centred on the following issues: use of land, energy conservation and social sustainability (Table 6). The major issues facing South Africa are the eradication of spatial segregation and the integration of the various apartheid townships in the city structure and its economy.

3.2.4.1 Land

All countries concerned stress the need for efficient use of land and the conservation of open space and the structure of existing settlements. The consequences for the built environment and city planners can be summarised as follows:

Better use of available space within the city limits leading to:
- restricting urban sprawl and avoid fragmentation of the countryside;
- remediation of brownfield site involving new soil cleaning technologies;
- adaptation and regeneration of the existing built environment taking account of future needs.

Countries with a high degree of urbanisation and a high population density like the Netherlands and Japan expect a more intensive use of land involving underground building and the double use of land simultaneously creating new open space for recreation.

Compact communities where housing, work, services, facilities and public transports are all within walking distance will emerge. Some of these will be developed as self-sufficient settlements with ecological closed-loop systems.

The separation on racial and economic lines faces South Africa with the special concern of spatial integration of employment and residence. Development corridors will be used to integrate the various areas and integration into one metropolitan management structure will contribute to social sustainability and improved service delivery. Urban agriculture will be actively encouraged to compensate for the loss of land through urbanisation.

3.2.4.2 Energy and traffic

Energy is a topic that received much attention in all national reports. It is anticipated that energy conservation at the level of districts or whole cities will rely more on local sources and renewable sources. The main issue will be the upgrading of the energy performance of the existing building stock. New developments are expected for autonomous or self-sufficient buildings with respect to energy supply. An issue in South Africa and Malaysia is the provision of energy for cooking and heating to the disadvantaged in a socially, economically sustainable way.

In the next decade traffic reduction will be an important issue. Transport infrastructure will be an integral part of site development along with advanced public transport systems. Information technology is used to optimise the capacity of existing transportation networks. In the emerging economies (e.g. Hungary, Romania, Malaysia) there is a need for modernisation of the transport networks while the aim in South Africa is to localise resource use in order to cut down on the needs for more super highways.

3.2.4.3 Water

Dehydration and water conservation is a topic receiving increasing attention at least in highly populated countries and developing countries (like South Africa, Malaysia). Both new and existing settlements will reduce their consumption of high quality drinking water by relying more on rainwater and the cascade use of drinking water. Most countries mention urban water management and groundwater protection. The major consequences will be to create closed water systems and to reduce urban run-off (porous brick paves). A special concern in Malaysia is the adequate supply of clean drinking water.

3.2.4.4 Materials

Major efforts are needed to upgrade the ageing underground infrastructure (sewage systems, water supply networks, etc). New in-situ repair techniques will be developed. In the developing world the emphasis is on catching up with the backlog of infrastructure provisions and installing more sustainable options to begin with.

Also urban waste management creates opportunities for new collection systems and waste recycling or energy production from waste.

3.2.4.5 Other aspects

Social sustainability needs much attention as well in city planning as in urban renewal. Issues mentioned are:

- respect for the existing city fabric and retaining rural settlement structures;
- develop city master-plan based on sustainability principles (sustainable renewal);
- function integration at city and district level;
- more public involvement in new developments and interventions in existing settlements;
- 'affordable housing' projects (Hungary, Romania, South Africa);
- crime prevention through environmental design (South Africa).

3.3 Conclusions

Current practices are widely different depending on how well the concept of sustainable building is developed in the various countries. There is also a marked difference between the developed market economies, transition economies and developing economies. The more mature economies pay more attention to the creation of a sustainable building stock either by new developments or by upgrading their existing building stock. In the transition economies the emphasis is on new developments largely to reduce the housing shortage and to improve their transport networks. In the developing economies social equity is much higher on the agenda than environmental concerns. Social and economic sustainability (e.g. job creation) is given much more thought.

However looking further ahead there is less divergence in the issues identified.

Use of land

The prevention of urban decline and the reduction of urban sprawl are concerns expressed by most countries. In the Western and Eastern European countries conservation of open space and safeguarding the structure of rural settlements is a major issue. Some divergence is seen between high-density building versus low-density building. In highly urbanised countries (the Netherlands) there is a tendency towards high density building while in other countries with high density mega-cities (Japan, Greece) there is a move towards low density building. Efficient use of land is sought in increasing the longevity of new buildings through flexibility and adaptability and more refurbishment activities to increase the life span of existing buildings.

To achieve social and economic equity, South African city planners will have to deal with new concepts integrating the current spatial and racial segregation into viable city structures.

Energy and traffic

The main issues adopted in practice turn out to be energy saving measures. Almost every country indicates a need for improved energy efficiency of buildings and the built environment. The main topics mentioned focus on the use of renewable energy, local energy resources and a wide range of opportunities for producers to market innovative energy saving materials and systems. However, in South Africa and Malaysia the major concern is how to provide energy and other services to the disadvantaged in a sustainable way.

Traffic reduction is an issue common to all countries and solutions ranging from better physical planning to increased use of information technology are mentioned. Contrary to this, the emerging economies express an urgent need for improved transportation networks in order to be competitive with their more developed neighbours. In the United States of America the car-oriented transportation infrastructure and the low petrol prices offer no significant scope for major changes in mobility. South Africa aims at preventing future mobility problems and an emerging need for superhighways by using local resources and promoting self-sufficiency of communities.

Water

Water saving in the built environment is a topic receiving increasing attention in European countries (e.g. Mediterranean countries). South Africa and the Netherlands particularly mention dehydration and drainage of water tables.

Materials and waste

The difference between countries with respect to the environmental performance of building materials and the recycling of building and demolition waste are not very large. Main topics are renewable materials, recyclable/reusable materials, easy disassembly, standardised dimensions, low embodied energy, and non-toxic materials. The advantage of the emerging economies and the developing economies is that they already have a long tradition in the use of traditional materials, many of which are sustainable. The aim is to continue this tradition in order to prevent problems from arising in the first place. The developing world aims at improving the life expectancy of indigenous building technologies and materials and to assure that labour intensive materials and methods remain in use. Although, to cope with housing shortages mass-produced units using high energy building systems will still be needed.

Other aspects

Many issues were raised under this heading, especially topics around social and economic sustainability. Their consequences relate predominantly to process innovation with emphasis on public participation, consumer participation, interdisciplinarity, co-engineering and re-engineering of the building process as means to a better incorporation of sustainability issues in decision making.

Skills and standards

Professional barriers will become less important and a need will emerge for multi-skilled, multi-disciplinary managers and operators. To overcome existing professional barriers many countries stress the need for interdisciplinary education.

Sustainability is a new aspect among the many issues governing decision making in the building process. This requires more specialisation of stakeholders in environmental matters. Eco-labelling, certification and environmental standards were mentioned by many as an expedient to that cause.

3.4 Summary Tables

Table 1: What kind of buildings will we built and how will we adapt existing buildings?

a) What does this entail for initiating and designing?

Resources	Main issues	Consequences
Land	• Efficient use of land (FR, NL, FI, HU, BE, IT, GB, GR, ZA, MY)	• Multi-functional buildings (NL, FI, GB, GR, ZA, MY) • Temporary or transportable buildings (NL)
	• Intensive use of land (NL)	• Flat roofs for recreational purposes (NL) • Double use of land (above and underground) (NL)
	• Longevity of buildings (NL, IT, FR, FI, GB, JP, US, IE, ZA, MY)	• Design for flexibility/adaptability (NL, FR, FI, GB, ES, US, ZA, MY) • Support/infill modularity (NL, BE, GB, JP, US) • Design for life cycle performance and high quality (IT, FR, FI, JP, IE, US, ZA, MY) • Standards for longevity in building codes (GB) • Environmental life cycle costing tools LCA + LCC (NL, FI, GB, US, ZA) • Understand needs and requirements of future users (NL, FI, IT, MY)
	• Site assessment	• Consideration of local environment (climate, topography, visual impact, noise, local economy) (ES, RO, ZA, MY) • Environmental/social impact assessment and public participation (ZA)
	• Greater use of existing buildings (GB, NL, FR, FI, HU, RO, BE, IT, ES, GR, MY)	• Redestination/conversion of non-functioning buildings (NL, FI, ZA, MY) • More refurbishment and retrofit activities (FR, NL, FI, HU, RO, GR) • Refurbishment techniques (vertical/horizontal extensions; lightweight constructions) (NL, HU, US) • Performance standards for regenerating existing building stock (NL) • Better condition assessment methods (HU) • Decision support tools: demolition versus renewal (NL, GB, ES, IE)
Energy	• Energy-efficient buildings (NL, FI, IT, FR, BE, GB, JP, GR, MY)	• Integrated design for energy efficiency (roof/facade design; heat/cold storage) (NL, FR, FI, IT, US, ZA, MY) • Super insulation (GB, ES); airtight construction (US) • Renewable energy sources (FI, NL, GB, ES, US, GR, ZA, MY) • Safeguarding indoor environment (NL, FR, HU, IT, US, ZA, MY)

	• Optimising heating/ cooling/lighting	• Bio-climatic construction (ES) • Day lighting/passive lighting (FI, GB, ES, GR, ZA) • Refrain from air conditioning (IT, MY) • Passive heating/cooling (IT, FR, NL, FI, GB, ES, GR, ZA, MY); Optimise building mass (FR) • Energy management systems (GB, ES, ZA) • Design for short service life if new technology will emerge in near future (FI, NL)
	• Fuel switching will become important (FI)	• Hybrid systems for heating (FI, GR)
	• Upgrading energy performance of existing building stock (NL, HU)	• Heat recovery systems (NL, ZA), improved insulation systems (NL, ES) • Individual metering of energy consumption (HU)
Water	• Drinking water conservation (NL, GB, BE, ZA, MY)	• Building integrated water saving equipment; greywater use (NL, FI, GB, IT, ES, US, ZA)
	• Reduction of sewage water (FI, ZA)	• Waterless sanitation systems (ZA)
Materials	• Upgrading existing building stock (NL)	• New function integrated components for retrofitting (NL)
	• Waste management (NL, HU, FR)	• Building integrated waste collection systems (NL, FR) • Utilise collective organic waste as energy source (ZA)
	• Acoustic insulation (BE)	• Improved products (BE)
	• Durable building materials (NL, FI, FR, ZA, MY)	• Durable coating systems (NL, ZA, MY) • Improve life expectancy of indigenous building technologies and materials (ZA) Selection based on individual service life (FI)
	• Non-toxic materials and climate control	• More consideration of health and environmental toxicity (LCA) (FR, IT, ZA, MY)
	• Recyclable/reusable buildings (NL, BE, ES, MY	• Design for disassembly (reversible building process) (NL, FR, ES, US, MY) • Recyclability of short lived components (FI, ZA)
	• Raw material efficient building	• Use of local materials and traditional building methods (IT, FR, RO, US, GR, ZA, MY) • Lightweight constructions (NL, FR, US, MY) • Renewable or recycled materials (NL, IT, GB, RO, ZA) • Materials with low embodied energy (FR, JP, US, ZA)
Other aspects	• Will an environmental demand emerge	• More information and communication (FR, NL, MY) • Experimental projects (FR) • Customer participation (NL, FI, GB, FR, MY) • Environmental accounting of buildings (FI, GB, MY)
	• Affordable housing (ZA, MY)	• Balanced mix of indigenous technologies (self-built) and mass-produced units (prefab) (ZA, MY)

	• Increase in tele-working (NL, FR, MY)	• New building designs taking account of tele-working and IT applications. (NL, FR, MY)
	• Design process is becoming more important (FI)	• Performance based design approach (US) • Optimisation through eco-balance tools (LCA/LCC) (FI, GB, IT, ZA, MY) • Tools for assessment of social and economic impact of buildings (ZA) • Interdisciplinary approach (ES); integrated approach (US); co-engineering (US) • Adopt open building approach (NL, US) • Integration of building functionality's (FR, GB, MY) • Integrated project database and design model (ZA) • Post completion design assessment and feedback (GB, ZA, MY)

Table 2: What kind of buildings will we built and how will we adapt existing buildings?

b) What does this entail for constructing and demolishing?

Resources	Main issues	Consequences
Land	• Protect nature	• Insure flora and wildlife protection (FR, MY) • No blasting to create building site (FI, MY)
	• How to cope with existing soil pollution	• Advanced in-situ remediation technologies (GB) • Fiscal measures to promote redevelopment of land (GB)
Energy	• Energy efficient construction sites	• Minimise transportation need to the site (FI, FR, GR, ZA, MY) • Energy saving refurbishment (FI, GR, MY)
Water	• Water saving	• Reduce water consumption on site (ES, ZA)
Materials	• Efficient use of materials/recycling	• Produce operating manuals for buildings and systems (FR, MY) • Use of local materials; reuse of serviceable building parts (FI, IT, GB, RO, US, ZA) • Use more labour intensive materials and construction methods (ZA) • Construct for disassembly (NL, FR, US, MY); Modular approach (GB, FI, ES, US, MY) • Expand industrialised building practices (US, JP, NL) • On site waste management (FR, FI, ES, US, MY) • New deconstruction/stripping techniques for optimal recycling (NL, FI, IT, HU, ES, US, ZA) • Labelling of products to facilitate selective removal and recycling (FR, MY) • Quality standards for recyclable waste (FI) and recycled materials (GB)

	• Renewal engineering becomes more important	• Waste utilisation for energy production (FI) • Refurbishment without nuisance for occupants (NL, FR, MY) • In-situ diagnosis and repair techniques (NL) • Modular systems for upgrading existing buildings (JP)
Other aspects	• Optimise building process	• Build, operate and transfer constructions (NL); Turn key process (FR, MY) • More specialisation in specific market segments or building systems (NL, FI, IT) • Increased partnership between designers, contractors and manufacturers (IT, NL, JP, GB, US, MY) • Improved project co-ordination facilities (US) • Total quality management (NL, FI, GR); quality standards for whole buildings (NL, GB, GR, MY) • Improved site logistics (FR, NL, MY) • Improved working conditions (FR, ZA, MY), more robotic construction (GB, NL, ZA) • Improved indigenous building technologies (ZA) • Combination of excellent human skill and more automation (JP) • Closer link between deconstruction and recycling processes (NL) • Business opportunities for recycling (ZA, MY): Service leasing (FI); Brokering services (GB)

Table 3: What kind of buildings will we built and how will we adapt existing buildings?

b) What does this entail for operating and maintenance?

Resources	Main issues	Consequences
Land	• Minimise non-public transportation needs	• Education of building managers and employees (GB, GR)
Energy	• Optimise energy consumption	• Tools and systems for energy management (FI, IT, ES, GR, ZA) • Extended use of day lighting (FI) • Easy retrofit of energy saving systems (NL, MY)
Water	• Optimise water consumption	• Use of rain water and re-use of grey water (FR, GR, ZA) • Tools and systems for water management (FI, ES, GR, MY)
Materials	• Extend service life of buildings	• Decision support systems to make a choice between building refurbishment or demolition (FI, NL, IT, IE, MY) • Adapt buildings for future needs of occupants (NL, HU, GR, MY) • Re-commission old non-functioning buildings for new functions e.g. housing) (NL, HU, ZA)

		• Planned maintenance and refurbishment programmes (GB, JP, GR, MY) • Use of durable finishes and fittings (ZA)
Other aspects	• Awareness of building operators and users	• Facilities maintenance and management systems (FMMS) (ZA); Tools for control (manuals, guides) (IT, FI, MY) • Education, feedback and standards (GB, IT, FI) • Management of operation costs (FI, IE) • Better control of IAQ/noise and health risks (FR, FI, GB, MY) • Develop performance standards for existing buildings (NL)

Table 4: What kind of materials, services and components will we use then? What does this entail for manufacturers of building products and systems?		
Resources	**Main issues**	**Consequences**
Land	• Life cycle performance of building products	• Renewable materials, use of local resources, durability, low emissions in use, recyclability. (NL, BE, IT, JP, IE, ZA, MY); • Environmental performance indicators (US) • Genetically engineered renewable materials (wood) (ZA)
Energy	• Energy performance of building products/ systems	• Consider full life cycle energy (NL, IT, JP, US, ZA, MY)
	• Energy saving	• Optimum use of new technologies: Heat recovery and storage, CHP-units, Electrical heat pumps, PV-cells, passive and hybrid technologies for heating and cooling, sensor technology; building domotics, passive lighting systems, translucent insulation (NL, HU, IT, ES, US, GR, ZA, MY) • Systems for easy retrofit in existing buildings (NL, IT, US, MY)
Water	• Water saving systems	• Rain water storage systems, cascade use of water (NL, GR); water saving components (ZA) • Integrate into building design (NL, MY)
Materials	• Product stewardship (cradle to grave)	• Plug-in systems, easy disassembly and re-use (NL, IT, US, ZA, MY) • Logistics for re-use and closed-loop recycling. (NL, MY) • Exchangeability of components through standardised dimensions (NL, ES, US, MY) • Online electronic product information systems (Internet) (US) • Zero-emission manufacturing; use of by-products from other industries (ZA)
Other aspects	• Low emission products	• Advanced coating systems and pre-treatment in the factory (NL) • Standards for composition and leaching (BE) • Healthy non-toxic/non-allergenic materials (MY)
	• Need for improved sound proofing of (existing) buildings	• Development of new materials/systems for easy retrofit (NL)
	• New building concepts	• More co-makership between architects and building material manufacturers. (NL, US) • Function integrated systems (IT, NL)
	• Technical service life	• Improved tools to predict service life of components and systems (NL) • Ability for self-diagnosis, self-healing and structural control (ZA)

Table 5: What kind of skills and standards will be required?	
Main issues	**Consequences**
Qualified labour	• Expertise, autonomy and responsibility (FI, MY) • Skills to cope with Information Technology for information transfer (ZA) • Multi-skilled crews; non-specialisation; professional barriers become less important (FI, NL, BE, GR) • Multi-skilled operators trained in non-destructive disassembly techniques (NL, JP, IE) • Multi-skilled labour able to handle both old and new materials (NL, FI, GR, MY)
Building process management becomes more complicated	• Integrated knowledge of whole building process (IT, GR, MY) • Design, build and operate contracting; partnership; risk management (GB, NL) • Performance based project management (FR); Excellent skills to manage the construction process (JP) • Better quality control (HU, FI) • Better use of feedback (GB) • Better training of building operators (GB)
Decision making processes becoming more complicated	• Use of information technology to support life cycle thinking (NL, GB, ZA) • Pubic participation; skills in negotiation and facilitation (ZA) • Life cycle costing tools (NL, US) • Risk assessment (health and environment) (IT)
More need for interdisciplinary education	• New curricula for designers and construction engineers to overcome professional barriers (NL, GB, U, IE, GR) • More specialisation in adapting building stock to meet future needs (NL, IE) • More specialisation in environmental issues (BE, IT, GR, ZA, MY)
Public awareness should increase	• Better information on self-building (GB) • Environmental taxes (BE, GB) • Demonstration projects, information campaigns (FR, BE, GR)
Standards and regulations	• Performance based (environmental) building regulations (FI, NL, US, MY) • Certification and eco-labelling (IT, GB, JP, ES, US) • Standards should suit local practices and indigenous technologies (ZA)

Table 6: What will cities look like and what are the consequences for city planners ?

Resources	Main issues	Consequences
Land	• Efficient use of land (NL, FI, HU, BE, IT, GB, US, GR, JP, RO, ZA, MY)	• Reduce urban sprawl (NL, FI, HU, ES, US, GR, ZA, MY) • Denser cities and infill development of vacant spaces within city limits (ZA, NL, MY) • Adaptation and regeneration of the existing built environment taking account of future needs (NL, GB, FR, BE, IT, RO, US, ZA, MY) • Remediation of brownfield sites (GB, FI, HU, IT, ZA) • New soil cleaning technologies (FI, NL) • Land reclamation for industrial use (NL) • More low density building (JP, GR)
	• Intensive use of land (NL, MY)	• High density building (NL, MY), underground building (NL); double use of land (NL, FI) • Underground drilling techniques (NL) • Building in nuisance zones (NL) • Combined transport corridors (roads, rail, cables, ducts) (NL, MY)
	• Compact development and integration (ZA)	• Location of low income residential areas within the developed city limits; Integration through development corridors (ZA) • Compact self-sufficient communities (ZA) • Integration of apartheid townships in city structure and its economy; one metropolitan management structure with improved service delivery (ZA)
	• Conservation of open space and green areas (FR, FI, NL, HU, JP, BE, IT, ES, GR, MY)	• Creating space by underground construction (NL) • Encouragement of urban agriculture (ZA) • No fragmentation, no ribbon building (BE, NL) • Taking account of dangers of flooding, landslides, earthquakes (HU, ES)
Energy	• Reduce energy consumption (NL, FI, IT, GB, MY, GR)	• Use local resources, district heating, CHP, renewable sources (NL, FI, GB, GR) • Do complete site and (energy) resource assessment (US, MY) • Upgrading energy efficiency of existing building stock (GB, NL, HU, GR) • Self-sufficient settlements (NL, FI, IT, ZA)
	• Energy provision (ZA, MY)	• Sustainable/affordable energy provision to the disadvantaged (ZA)
	• Reduce transport needs (FR, NL, FI, BE, IT, GB, MY)	• Transport infrastructure is integral part of site development (GB, NL, FR, FI, BE, US, ZA, MY) • Site development along public transport corridors (GB) • Advanced public transport systems (FR, FI, HU, IT, MY)

	• Optimising transport infrastructure (NL, FR, FI, HU, GR, MY)	• Information technology for optimising existing capacity (NL, FI) • Modernisation of the transport infrastructure (HU, RO, GR, MY)
Water	• Drinking water conservation (NL, GB, US, MY)	• Structured refurbishment to increase efficiency (GB) • Combined use of drinking water and grey water (GB, NL, US, MY) • Adequate and clean water supply (MY)
	• Urban water management, groundwater protection (FR, FI, NL, HU, ZA, MY)	• Closed systems, no run-off to sewage system (NL, ZA, MY) • Landscaping with draught resistant plants (ZA)
	• Coastal management (NL)	• Building with nature (NL)
Materials	• Upgrading under-ground infrastructure (NL, MY)	• New in-situ diagnosis and repair techniques (NL, MY)
	• Urban waste management (NL, HU, ZA, MY)	• Building integrated systems; underground collection and transport (NL) • Recycling and reuse of waste (ZA) • Integrated waste management systems
	• Building materials	• Use of local materials (no transportation) (FI, ZA, GR, MY)
Other aspects	• Social sustainability (NL, GB, HU, ZA, FR, RO, GR, MY)	• Spatial integration of employment and residence (NL, GB, ZA) • Accessibility, function integration offering services and recreation (NL, FR, FI, ZA, MY) • Design for future value; City masterplan HU; respect for existing city fabric (FR, NL, HU) • Equitable distribution of community facilities and economic opportunities; Create sustainable local social and economic community systems (eco-villages) ('ubuntu' concept) (ZA) • 'Affordable housing' projects (HU, RO, ZA) • Maintain rural settlement structure (HU, GR, MY) • Crime prevention through environmental design (ZA)
	• Sustainable planning (NL, GB, IE, IT, ZA)	• Integrated physical planning and design methodologies (ZA) • Public involvement in development (citizens' juries) (GB, ZA, MY) • Decision making tools to weigh the pros and cons of the combined sustainability issues (NL) • Imply ecological principles in physical planning (IT, NL, GB, IE, MY)
	• Urban renewal (NL)	• Renewal engineering without disrupting living and working conditions (NL)

4. STRATEGIC RECOMMENDATIONS

4.1 Introduction

The content of this chapter is based on the elements given in the part "Recommendations" of the available national reports. Fifteen national contributions have been taken into consideration, that is to say the Belgian (BE), Finnish (FI), French (FR), Greek (GR), Hungarian (HU), Irish (IE), Italian (IT), Japanese (JP), Malaysian (MY), Dutch (NL), Romanian (RO), South African (ZA), Spanish (ES), British (GB) and American (US) contributions.

This synthesis of the national recommendations includes two parts. The first one gives the main features of the recommendations introduced by each national report. The second one tries to present a condensed and organised view of all the recommendations.

4.2 Main features of national recommendations

4.2.1 Belgium

In its conclusion, the Belgian report introduces some main issues for the future, which can be seen as recommendations:

- increasing regulation on the use of land with more respect for open space and green areas,
- stimulating renovation of existing buildings,
- increasing mobility planning and new related concepts for city planning,
- increasing waste prevention and recycling,
- increasing environmental "taxes" (waste treatments, emissions...),
- saving resources (energy, water, primary materials),
- putting more emphasis at the R/D level on global studies such as life cycle analysis and multi-criteria evaluation of materials, services, constructions...

4.2.2 Finland

The recommendations given in the Finish report are gathered in the conclusion of the report. They are directed at nine categories of actors of the building sector, in the following way:

- building owners: setting concrete environmental demands for the design and the maintenance phases, taking care of property values considered as a tool for productivity,
- building users: considering environmental qualities as one selection criteria, seeing environmental issues as one factor affecting space use productivity, operating the building in an environmentally friendly way,

- clients: selecting project partners on their environmental expertise, making sure that environmental goals are considered by the owner,
- designers: considering environmental qualities of construction materials as a starting point, optimising the design process, developing methods and tools to assess the numerous variables involved,
- manufacturers of building products: seeing life cycle considerations as the basis of product development, stressing environmental qualities in the product information, minimising environmental impact of production processes,
- contractors: seeing environmental consciousness as a factor of competitiveness, reducing environmental impacts of business processes (site operations, logistics and material selections),
- building maintenance organisations: seeing environmental consciousness as a factor of competitiveness, showing initiatives and giving feedback to building owners regarding environmental issues, expecting co-operation from suppliers and partners,
- officials: creating mechanisms that lead to life cycle thinking, considering environment as one criteria in all buildings, using appropriate guidance (regulations, supervision and sanctions),
- researchers: producing environmental qualities for building parts and buildings, developing methods and means to be used by professionals, pushing life cycle thinking as the guiding principle for construction processes, producing research based information to contribute to the "ethical discussion".

4.2.3 France

The part of the French report that deals with recommendations introduces three categories:

- a <u>general strategic recommendation</u> which insists on the way of positioning the construction sector into the global approach of sustainable development:
    - to define a few simple but strategic and sensitive issues,
    - to focus on important recognised aspects,
    - to approach sustainable construction through three <u>problem categories</u>:
        - physical problems linked to the issue of taking account of natural heritage,
        - biological problems linked to the issue of not signing mankind's life away,
        - sociological problems linked to the issue of ensuring an inter- and intra-generation solidarity,
- eight main technical recommendations:
    - going on with energy savings policy,
    - improving air quality,
    - decreasing health risks,
    - improving waste management (work sites and communities),
    - foreseeing fresh water shortage,
    - developing construction materials saving,
    - developing assessment methods,

  - modulating the "Building-to-Last" concept,
- the necessity to take action at once to act preventively and to prepare the building sector to changes which are needed in the construction process.

4.2.4 Greece

The Greece partner who joined the project listed a set of strategic recommendations that are reported below:
- the need for land use regulations with respect for green areas and open space,
- the planing for renovation of the existing building stock,
- the introduction of rules and regulations regarding sustainability in construction,
- the introduction of standards dealing with longevity and multiple use of buildings,
- the completion of the highways national system,
- sustainable urban development,
- the saving of resources in construction activities,
- support for environmentally friendly materials,
- the development of educational programmes in the higher levels,
- training courses and practice dissemination,
- life-cycle considerations in product development.

4.2.5 Hungary

The part of the Hungarian report which deals with recommendations stresses essentially on aspects of "strategic recommendations for the management of construction companies", as the related section is entitled. The two main aspects raised are:
- the need for a thorough study of the ongoing processes in the national and international building field,
- the need for short- as well as long-term forecasts of construction activities.

In addition, three main tasks are identified for the Hungarian construction industry:
- the completion of the system of superhighways with the major concern of minimising negative environmental effects,
- the serving of trade and industry building needs, with an organising of the work to cause minimum trouble,
- the creation and renovation of residential buildings.

4.2.6 Ireland

The Irish report includes a chapter that deals with recommendations for action:
- setting up a high-level national research group to examine the concept (taking account of human and social development),
- establishing a national forum on Sustainable Construction to develop a suitable response to the concept,
- compiling a first set of "performance indicators" to cover:
  - the process of construction,

    - completed buildings and civil engineering projects,
    - the operation of existing construction works,
    - de-construction and disposal (including re-use).
- developing a concerted programme of awareness raising and education.

4.2.7 Italy

The part of the Italian report that deals with recommendations stresses four main aspects:

- the introduction of rules and standards for sustainability and eco-compatibility in the planning and design activities,
- continuous and permanent education,
- control of the construction activity: definition of sustainable and responsible construction companies and manufacturers,
- exploitation "built and natural inheritance" as a resource.

4.2.8 Japan

The Japanese report introduces recommendations that are directly derived from the listing of the main barriers against a comprehensive approach by the whole construction industry. These recommendations deal with:

- the dissemination of knowledge about responsibilities,
- the development and dissemination of methodologies for reviewing environmental impacts,
- education and training,
- agreements in terms of role sharing and responsibility allocation in the projects,
- good practice dissemination,
- comprehensive data bases,
- encouraging development of environmentally friendly materials and technologies,
- awarding,
- developing environmental management systems,
- creating a profession of "construction environment consultant"

4.2.9 Malaysia

The Malaysian reports introduces recommendations in five domains:

- policies
    - continuing and re-emphasising existing regulations and strategies,
    - reviewing and developing measurable performance standards,
    - promoting interdisciplinary training and courses,
    - promoting awareness and R&D on sustainable development,
- design
    - developing new design standards,
    - adopting open system,
    - adopting and adapting jointing and assembly techniques,

    - imposing minimum recycled material content,
    - considering environmental qualities of material,
    - adopting more integrated approach to design,
- manufacturing
    - product development based on life cycle consideration,
    - practising better waste management,
    - practising reliable labelling scheme,
    - reengineering production process of standardised elements,
- construction
    - reducing environmental impact during process,
    - reengineering process to meet the concept of open building,
    - increasing partnership between designers and manufacturers,
- operation and maintenance
    - establishing maintenance programs,
    - developing and applying decision support system for refurbishment.

4.2.10 Netherlands

Two parts of the Dutch report mainly deal with recommendations.

One of these parts is dedicated to the listing of R&D themes that are needed by 2010:
- issues and associated tools linked to the incorporation of environmental costs into the economic system,
- the improvement of the building process itself,
- several R&D needs in the technical field; eight themes have been identified:
    - impact of human activities on ecological systems,
    - performance-based environmental standards,
    - tools for the certification of life-cycle performance of buildings,
    - models for the service life prediction,
    - dynamic behaviour of constructions in soft soils,
    - renewal engineering methods,
    - innovative design, systems and products for energy-efficiency goals: integration of solar systems, retrofitting adapted systems...
    - understanding of the natural sand transport phenomena.

The other part is dedicated to strategic recommendations towards five main topics or categories of actors:
- public and private policies: measurable performance standards to be developed, training courses and interdisciplinary training,
- management and business practices,
- design technology: new design standards for designers, open systems, advanced jointing and assembly techniques,
- construction: open building, process reengineering,
- materials and systems: new function integrated building components, durability, reparability and retrofit ability of the products.

4.2.11 Romania

The recommendation chapter of the Romanian report deals with the problem of including Sustainable Development concepts in the economy.

The main problem is that life quality improvement, which is an absolute priority objective, leads to numerous investments which in the end imply a high pressure on environment, unless complementary actions are provided. The economy re-launching does not favour very ambitious objectives in relation with Sustainable Development even if the construction sector is one of the most dynamic ones.

Some correction could be gained through training and knowledge transfer (which is not easy because effects do not emerge in the short term). Communication is also a prerequisite of the new concept success, but communication will be successful only if:

- a common language is accepted,
- a multilingual glossary of the sustainable development concept is defined,
- a collection of worldwide practised methods for the assessment of constructions is available.

4.2.12 South Africa

The strategic recommendations included in the South African report are gathered under four main headings which correspond to four main aspects of sustainability applied to the construction sector: environmental sustainability, economic sustainability, social sustainability and technical sustainability.

The main items mentioned under these headings are listed below:

- environmental sustainability
    - land: to be chosen not only according to environmental factors, but also according to the impact it will have on the local community in terms of socio-economic factors, development aiming for compact land use,
    - energy: address the issue of energy provision for the poor, energy efficient design of low cost housing, use renewable energies, consider embodied energy for the choice of materials and construction technologies,
    - water: install water-saving devices in both new and existing buildings, capture rain water, reduce water run-off in landscaping,
    - materials: develop the use of indigenous construction materials, set up incentives for developing new environmentally friendly building materials and improving the performance of existing ones,
- economic sustainability
    - basis for competition: the three factors are quality (satisfying the clients needs), profitability and sustainability; apply quality indices and service life prediction in building design and construction process,
    - poverty alleviation: combine labour intensive methods with skills transfer, outsourcing to local actors instead of importing manpower,

- finance options: set up creative finance solutions to help development for the poor,
- social sustainability
    - public participation: develop a methodology for true public participation,
    - gender equity: work towards greater gender equity especially in blue collar employment,
    - cultural acknowledgement and spiritual well-being: include the concept of 'ubuntu' in the construction industry decision making and operation to contribute to sustainable development,
    - education: adaptation of tertiary curricula, continuous re-education of professionals, raising awareness in clients end educating the end-user,
- technical sustainability
    - decision support: make an inventory of all life cycle costs and identify suitable indices for measuring pertinent performance,
    - indigenous technology: develop the life expectancy of indigenous construction materials and technologies.

4.2.13 Spain

The following recommendations are presented in order to fulfil the ecological objectives mentioned in the Spanish report:

- promoting the eco-labelling of buildings,
- reducing the environmental impact of the construction waste through its minimisation and recycling,
- taking into consideration, during the design phase, the impact on health, comfort and security of users,
- promoting maintenance and rehabilitation of buildings as a strategy to enlarge their period of use,
- increasing the degree of environmental education of technicians in order to introduce these criteria into the sector,
- accelerating the integration of ecological constructive solutions in the construction companies by means of including them in the administration promoted constructions,
- promoting investment in the environment by means of fiscal deductions and/or eco-tax that burden the process of contaminating or consuming.

4.2.14 United Kingdom

The recommendations which are presented in the GB report are in fact distributed among the various chapters of the document: development and planning, design, construction, operation, deconstruction.

These recommendations are also clearly addressed to three identified categories of actors acting at the levels of government, education, or R&D.

The main items mentioned deal with:

- development and planning: amendment of the planning system, fiscal measures for sustainable construction and redevelopment of brownfield sites, refurbishment program to implement the Home Energy Conservation Act and water conservation, improvement of contaminated land clean-up procedures,
- design: fiscal incentives for environmentally friendly materials, measures to reduce the adversarial nature of building design, increase (longevity) building standards, reliable labelling scheme, imposing minimum recycled material content, better information and education,
- construction: impose strict built quality standards, greater information on self-building, investigate social sustainability issues surrounding self-build,
- operation: impose noise insulation standards, education on implications of sustainability for activities, building handbooks, develop usable environmental accounting tools,
- deconstruction: brokering service for waste construction materials, quality standards for reused/recycled materials.

4.2.15 United States

The recommendation chapter of the American report deals with metrics, process, policy, technology and education. The main items mentioned are:

- metrics: apply finance and accounting theory to the valuation of new energy and efficiency options, develop new appropriate eco-rating procedures for integral sustainability assessment, develop a complete set of environmental performance indicators, define procedures to obtain reliable LCA data of materials and components and build a data base, develop nation wide accepted performance based specifications for materials and systems,
- process: re-engineer the way the building process is regulated, develop and embed collaborative engineering models, protocols and systems into collaborative CAD environments, develop useful tools and multi-disciplinary integrated design environments, build co-engineering partnerships for customised product development and remove barriers to shorten time to market,
- policy: imagine new concepts rather than incremental improvements for sustainable development, develop energy savings in buildings, streamline innovation, develop performance standards, building guidelines and practices, target technologies that produce buildings that use 50% less energy than today, identify best practices and promote proven technologies, establish a process to manage liability concerns,
- technology: design for recyclability, expand industrialised building practices, develop co-makership alliances to develop integrated solutions, develop plug and play building components that are re-configurable, explore an international dimension to system modularity in building components and systems,
- education: expand education and training on implementing new technologies and building practices, share knowledge with developing countries and adopt local sustainability metrics in exported technologies.

4.3 Condensed view of all recommendations

4.3.1 General recommendations

A few general recommendations are given, which cannot be addressed to a specific actor of the sector but in fact should be addressed to all of them.

The way of positioning the construction sector into the global approach of sustainable development should be clarified and clearly claimed. It is proposed for instance to define a few simple but strategic and sensitive issues, to focus on important recognised aspects, and to approach sustainable construction through three problem categories:

- physical problems linked to the issue of taking account of natural heritage
- biological problems linked to the issue of not signing mankind's life away
- sociological problems linked to the issue of ensuring an inter- and intra-generation solidarity

It should be also stated that it is needed to take action at once to act preventively and to prepare the building sector to changes, which are needed in the construction process.

Several reports recommend taking account of human/social development as an important component of "sustainable development".

At last it should be borne in mind that for certain countries the economy re-launching does not favour very ambitious objectives in relation with Sustainable Development even if the construction sector is one of the most dynamic ones.

Table 7: Main general recommendations

- defining few simple but strategic and sensitive issues (FR)
- focusing on important recognised aspects (FR)
- approaching sustainable construction through three problem categories (FR):
    - physical problems linked to the issue of taking account of natural heritage
    - biological problems linked to the issue of not signing mankind's life away
    - sociological problems linked to the issue of ensuring an inter- and intra-generation solidarity
- taking action at once to act preventively and to prepare the building sector to changes which are needed in the construction process (FR)
- taking account of human/social development as an important component of "sustainable development" (IE)
- being conscious that for certain countries the economy re-launching does not favour very ambitious objectives in relation with Sustainable Development (RO)

4.3.2 Clients, owners, developers and investors

These actors should have a very important role in disseminating sustainable construction, since they represent the demand of the building sector.

They should set concrete environmental demands to the parties involved in the design process, as well as to the final product, during the initial design phase.

They should also set concrete goals regarding building maintenance that are based on environmentally friendly methods and include these goals in, for example, the building maintenance agreements.

They should also assure the productivity of their own business by emphasising environmental issues, quality and preservation of property values.

Table 8: Main recommendations to clients, owners, developers and investors

• setting concrete environmental demands for the design phase (FI)
• setting concrete environmental demands for the maintenance phase (FI)
• taking care of property values considered as a tool for productivity (FI)
• establishing maintenance programs (MY)
• developing and applying decision support system for refurbishment (MY)
• setting up creative finance solutions to help development for the poor (ZA)

4.3.3 Authorities

In a market economy, the demand expressed by the building owners could be seen as the only factor, which will lead to a development of sustainable construction. However, in many countries (excepted Germany and to a less degree Northern European countries), the lack of interest from the population does not pull the market. In France, for instance, the demand from the private or public building owners is very low, excepted when there is a regulation (waste) or when the population pressure is quite high (health problems or work site nuisances).

In these conditions several reports introduce the need of a voluntary policy from the authorities. It is why besides an education and training policy already mentioned, several proposed recommendations deal with financial incentives, regulation, labelling...

A general recommendation deals for instance with the establishing of high-level national research groups, which would examine the concept of "sustainable development" and its practical implementation in a given country. A national forum should also be established to develop a suitable response, in built form, to that concept and to act as a focus for construction related activities at national level. Human / social development should require special attention in these areas.

As far as objectives and goals could be set up in the framework of a voluntary policy, officials should consider environmentally sound construction as one criterion in all buildings. They should envisage measures to reduce the adversarial nature of building design. They should also confirm the creation and existence of mechanisms that lead to life cycle thinking. A specific attention should be borne to saving resources (land -both above ground and underground-, energy, water, and raw materials) and to waste prevention and recycling.

The increasing of building standards should be seen as a global objective in general, with a specific need for introducing standards that deal with longevity and multiple use of buildings in particular.

The stimulation of renovation of existing buildings is also seen as a necessary general objective for authorities.

Finally land and human settlements patrimony should be exploited in terms of resource more than constraint, in the perspective of real economic development with effects in all sectors.

As far as planning is concerned, the introducing of rules and standards for sustainability and eco-compatibility in the planning activities is referred to, at each level of the transforming activities of the land and human settlements. This should also deal with the interdependencies between the different levels of planning and design. Generally speaking, the planning system should be amended in order to promote sustainable development. More mobility planning should be reached. Car use should be reduced and public transport favoured. Home-working and combining office and living space should be increased.

An increased regulation on the use of land with more respect for open space and green areas should be envisaged. In certain countries refurbishment and use of brownfield sites is recognised as essential to make construction more sustainable and incentives from government such as fiscal measures should be set up as means of achieving this.

Finally, in certain countries such as Hungary, the need for completing the system of superhighways and other infrastructure with the major concern of minimising negative environmental effects is stressed.

As far as construction materials and the products industry are concerned, authorities should encourage them to provide environment-friendly materials since these are not available at reasonable prices on the market today. Awards for good practice and fiscal incentives could be a solution. Imposing a minimum recycled material content for all building material is also suggested.

As far as construction is concerned, it is recognised that rules, standards and certification schemes for sustainability and eco-compatibility should be introduced into the design activities. More generally, officials should use appropriate guidance (regulations, supervision and sanctions) in order to achieve environmental goals. Measurable performance standards based on sustainability principles at the levels of both urban development and building design should be drafted, as well as long-term targets for a step by step approach for future development set up.

Like for products and materials, fiscal incentives should also be developed for environmentally friendly construction activities.

Some control of the construction activity is also suggested, for instance through increased public responsibility on behalf of the construction companies or even through an increase of the environmental taxes on waste or emissions.

More drastically, it is also recommended to impose strict built quality standards for all building types to cover new build and refurbishment projects, to impose for instance severe noise insulation standards.

Quality standards for reused/recycled materials, which minimise concerns over their use, but do not place undue barriers to their sale, should also be introduced.

Finally, the creating of a profession of "construction environment consultant" is suggested.

Table 9: Main recommendations to authorities

General initiative

- setting up a high-level national research group to examine the concept (IE)
- establishing a national forum on Sustainable Construction to develop a suitable response to the concept (IE)
- developing a methodology for true public participation (ZA)

Objectives

- considering environment as one criterion in all buildings (FI)
- measures to reduce the adversarial nature of building design (GB)
- creating mechanisms that lead to life cycle thinking (FI)
- saving resources (energy, water, primary materials) (BE, GR)
- developing energy savings in buildings (US)
- increasing waste prevention and recycling (BE)
- increase (longevity) building standards (GB)
- promoting maintenance of buildings as a strategy to enlarge their period of use (ES)
- stimulating renovation of existing buildings (BE, ES, GR)
- the creating and renovating of residential buildings (HU)
- exploiting the resource "built and natural inheritance" (IT)
- imagining new concepts rather than incremental improvements for sustainable development (US)

Initiatives towards planning

- the introducing of rules and standard for sustainability and eco-compatibility in the planning activities (GR, IT)
- amendment of the planning system (GB)
- increasing mobility planning and new related concepts for city planning (BE)
- increasing regulation on the use of land with more respect for open space and green areas (BE, GR)
- fiscal measures for redevelopment of brownfield sites (GB)
- reduce water run-off in landscaping (ZA)
- land to be chosen according to environmental factors and according to socio-economic impact on local community; development aiming for compact land use (ZA)
- the improvement of transportation corridors necessary for social and economic development in a way which minimises its negative impact on the environment (HU, IT)

Initiatives towards industry

- the encouraging of environmentally friendly materials and technologies (GR, JP)
- fiscal incentives for environmentally friendly materials (GB)
- incentives for developing new environmentally friendly building materials and improving the performance of existing ones (ZA)
- awarding (JP)
- imposing minimum recycled material content (GB)

Initiatives towards construction

- promoting awareness and R&D on sustainable development (MY)
- the introducing of rules and standard for sustainability and eco-compatibility in the design activities (GR, IT)
- continuing and re-emphasising existing regulations and strategies (MY)
- the introducing of standard dealing with longevity and multiple use of buildings (GR)
- using appropriate guidance (regulations, supervision and sanctions) (FI)
- measurable performance standards to be developed (MY, NL)
- fiscal measures for sustainable construction (GB)
- promoting investment in the environment by means of fiscal deductions and/or eco-tax that burden the process of contaminating or consuming (ES)
- promoting the eco-labelling of buildings (ES)
- identify best practices and promote proven technologies (US)
- building guidelines and practices (US)
- the control of the construction activity (IT)
- increasing environmental "taxes" (waste treatments, emissions,...) (BE)
- construction: impose strict built quality standards (GB)
- operation: impose noise insulation standards (GB)
- deconstruction : quality standards for reused/recycled materials (GB)
- energy: address the issue if energy provision for the poor; use renewable energies (ZA)
- creating a profession of "construction environment consultant" (JP)
- refurbishment program to implement the Home Energy Conservation Act and water conservation (GB)

4.3.4 Education and training

An important feeling is that education and training should be largely used to have sustainable development concepts well known and accepted by all people. In particular, understanding the impact of the construction sector on the global environment is not matured in the whole construction industry or within authorities.

The need of a large concerted program of awareness raising and education is often mentioned. The programs should aim, not only, at all of the actors of the construction industry, but also the public, politicians, and government administrators. Sustainable building principles should be incorporated into the curricula of training courses for architects, designers and construction engineers.

Not only initial, but also continuous and permanent education of the operators should be promoted.

Building designers should be better educated to adopt a more integrated approach to design, to appreciate the fundamentals of sustainable building design, and how to interpret environmental labelling.

Construction firms should be approached at the level of the executive board members about the significance of their responsibility to the global environment. Methodologies for environmental impact reviewing should be disseminated. Training of employees and operatives should be promoted. Agreements in terms of role sharing and responsibility allocation among the members of the "construction team" in the projects should be established.

Interdisciplinary training in design, construction and exploitation processes should be favoured as much as possible and good practice examples should be largely disseminated.

People operating buildings should be educated on the implications of sustainability for personal and professional activities if a more efficient operation of buildings is obtained.

Table 10: Main recommendations on education and training

- education and training (JP)
- developing a concerted programme of awareness raising and education (IE)
- developing educational programmes in the higher levels (IT)
- better information and education towards designers (GB)
- raising awareness in clients end educating the end-user (ZA)
- the continuous and permanent education (ES, IT, ZA)
- the dissemination of knowledge about responsibilities (JP)
- training courses and interdisciplinary training (GR, MY, NL)
- good practice dissemination (GR, JP)
- education on implications of sustainability for building operation/use activities (GB)
- greater information on self-building (GB)
- expanding education and training on implementing new technologies and building practices (US)
- sharing knowledge with developing countries and adopting local sustainability metrics in exported technologies (US)
- communication will be successful only if (RO):
    - a common language is accepted
    - a multilingual glossary of the sustainable development concept is defined
    - a collection of world-wide practised methods for the assessment of constructions is available

In countries where the self-build movement is particularly strong (GB for instance), greater information on self-building should be disseminated.

However, because sustainability effects do not emerge in the short term, communication will be successful only if certain conditions are met. At least, the following conditions seem to be necessary:

- a common language is accepted,
- a multilingual glossary of the sustainable development concept is defined,

- a collection of world-wide practised methods for the assessment of constructions is available.

4.3.5 Designers

As already mentioned, designers should adopt a more integrated approach to design, appreciate the fundamentals of sustainable building design, and know how to interpret environmental labelling.

Designers should consider the environmental qualities of construction materials as a starting point of the design. They should develop design solutions from the point of view of environmental goals of the final product, develop the design process together with other professionals in order to achieve the optimal situation, and use methods and tools which will enable them to control not just the static's and cost but many other variables, such as life span and maintenance intervals, pollutants and health factors, heating and moisture, technology...

The attention of designers should focus on the exploitation stage during functional design (long service-life and flexibility of the building during its use). Technical design should focus on the durability of components, as well as the reparability and (de)construct-ability of components by adopting open systems and advanced jointing and assembly techniques.

Table 11: Main recommendations to designers

• considering environmental qualities of construction materials as a starting point (FI)
• optimising the design process (FI)
• developing methods and tools to assess the numerous variables involved (FI)
• taking into consideration the impact on health, comfort and security of users (ES)
• paying attention to functional design, durability, reparability and (de)construct-ability (NL)
• designing for recyclability (US)
• developing new design standards (MY)
• adopting and adapting open system and jointing and assembly techniques (MY)
• imposing minimum recycled material content (MY)
• considering environmental qualities of material (MY)
• adopting more integrated approach to design (MY)
• applying quality indices and service life prediction in building design (ZA)

4.3.6 Industry

Manufacturers of building products should see the life cycle considerations (environmental impacts, life span) as the basis of product development. Another stake should be to minimise actively the environmental harms of their own production processes.

In order to inform users, manufacturers should explain in the product information the environmental qualities based on life cycle analysis, together with information regarding use and conditions of use, recycling - and stick to this.

Manufacturers should co-operate with designers in creating new designs (jointing/assembly technologies, flexible engineering and system modularity) for new building designs as well as for renewal projects. Co-operation with related industries (e.g. plastic manufacturers, electronics) should be attempted to develop new function integrated building components. Manufacturers should improve the durability, reparability and retrofit ability of their products.

In order to facilitate recycling of materials, it is also suggested to industry to establish some kind of brokering service for waste construction materials.

Countries like Hungary also recommend the serving of the trade and industry needs, with an organisation of the work causing minimum trouble.

Table 12: Main recommendations to industry

- seeing life cycle considerations as the basis of product development (FI, GR, MY)
- minimising environmental harms of production processes (FI)
- stressing environmental qualities in the product information (FI)
- practising reliable labelling scheme (MY)
- materials and systems: new function integrated building components, durability, reparability and retrofit ability of the products (NL)
- reengineering production process of standardised elements (MY)
- practising better waste management (MY)
- brokering service for waste construction materials after deconstruction (GB)
- the serving of the trade and industry building needs, with an organisation of the work causing minimum trouble (HU)
- increasing partnership between designers and manufacturers (MY)
- working towards greater gender equity especially in blue collar employment (ZA)
- include the concept of 'ubuntu' in the construction industry decision making and operation to contribute to sustainable development (cultural acknowledgement and spiritual well-being) (ZA)
- expanding industrialised building practices, developing co-makership alliances to develop integrated solutions, developing plug and play building components that are re-configurable, exploring an international dimension to system modularity in building components and systems (US)

4.3.7 Contractors

It is recommended to contractors to see environmental consciousness as a factor of competitiveness and to develop their own services to be environmentally sound.

That includes reducing the environmental impact of their own business processes regarding, for example, site operations, logistics and material selections.

That includes informing owner's of the environmental impacts regarding the construction project, to make sure that environmental goals are part of the owner's demands and implementation plans and, if needed to set them together with the owner.

That includes to select the parties involved in the building project based on their expertise on environmental issues, and to require readiness from other parties (sub-contractors, material and product suppliers) to work in co-operation towards environmentally sound goals. That should lead for instance to establish agreement in terms of role sharing and responsibility allocation among members of the "construction team" in the projects (including clients). It is also necessary to keep a budget for sustainable construction, or to set up information networks to introduce good practice to other departments of the firm.

Environmental management systems should be developed.

It is also proposed that efficient production in construction should be met by open industrialisation and by making decisions (setting requirements) at different scale levels ("open building"). This would create a controlled process that would be beneficial to sustainability in terms of better quality, less squandering of raw materials, and less building and demolition waste. Large companies could take the lead by re-engineering their processes and by developing complete consumer-oriented (flexible) concepts that use standardised production methods that are universal applicable, independent of project type or size. A strong balance should be established between demand-side (user requirements) and supply-side (production techniques). Small companies should specialise in market segments or specific trades, and should seek a competitive edge by standing out in terms of sustainable construction.

Table 13: Main recommendations to contractors

- seeing environmental consciousness as a factor of competitiveness (FI)
- reducing environmental impacts of business processes (site operations, logistics and material selections) (FI, MY)
- selecting project partners on their environmental expertise (FI)
- making sure that environmental goals are considered by the owner (FI)
- agreements in terms of role sharing and responsibility allocation in the projects (JP)
- project life cycle management (NL)
- reengineering process to meet the concept of open building (MY)
- developing environment management systems (JP)
- apply quality indices and service life prediction in construction process (ZA)
- combining labour intensive methods with skills transfer, outsourcing to local actors instead of importing manpower (ZA)

4.3.8 Building users

Building users should act as a demanding customer when selecting spaces and considering the environmental qualities of the building over its life span as one selection criterion.

They should see the environmental issues as one aspect of comfort and consequently as one factor that affects the productivity of the use of the spaces.

They should develop their own activities to be more environmentally friendly in the occupied building.

Table 14: Main recommendations to building users

- considering environmental qualities as one selection criteria (FI)
- seeing environmental issues as one factor affecting space use productivity (FI)
- operating the building in an environmentally friendly way (FI)

4.3.9 Building maintenance organisations

Building maintenance organisations should see environmental consciousness as a factor of competitiveness and develop their own services to be environmentally sound.

Table 15: Main recommendations to building maintenance organisations

- seeing environmental consciousness as a factor of competitiveness (FI)
- showing initiatives and give feedback to building owners regarding environmental issues (FI)
- expecting co-operation from suppliers and partners (FI)

They should correct their own processes so that they are based on sound environmental thinking, show initiative and give feedback to the building owners regarding environmental issues. They should expect co-operation from suppliers and partners regarding environmental issues.

4.3.10 Technical and R&D recommendations

A lot of technical and R&D recommendations are addressed. Below is a list of these topics which are mentioned in the chapter "recommendations" and which are therefore considered as particularly important for sustainable construction. A few examples of specific aspects mentioned by some countries are also listed.

Table 16: Main recommendations on R&D topics

Built environment and ecological systems

- understanding impact of built environment on eco-systems (FI, FR, IE, NL)
- impact of human activities on ecological systems (NL)
- producing research based information to contribute to the "ethical discussion" (FI, FR, IE, NL)
- producing environmental qualities for building parts and buildings (FI)
- investigating problems and solutions for the sprawl of city agglomerations (HU)

Energy saving

- going on with energy savings policy (FR)
- targeting technologies that produce buildings that use 50% less energy than today (US)
- having an integrated approach to the use of energy (NL)
- innovative design, systems and products for energy-efficiency goals: integration of solar (and other renewable energy) systems, retrofitting adapted systems... (IT, NL)
- developing energy efficient design of low cost housing (ZA)
- assessment of embodied energy for the choice of materials and construction technologies (ZA)

Health and comfort

- understanding impact of built environment on health (FI, FR, IE, NL)
- improving air quality (FR, HU)
- decreasing health risks (FR)

- investigating social sustainability of self-build (GB)
- improving clean-up procedure for contaminated land (GB)

Waste

- bettering waste management (work sites and communities) (FR)
- reducing the environmental impact of construction waste through minimisation and recycling (ES)

Resources saving

- foreseeing fresh water shortage (FR)
- water-saving devices in both new and existing buildings (ZA)
- systems for capturing rain water (ZA)
- developing construction materials saving (FR)
- developing the use of indigenous construction materials (ZA)
- recycling, re-use and substitution by renewable materials (FR, HU, IE, IT)
- developing ways for an efficient use of raw materials (service life, system repair and retrofit, improved quality of materials, components and services) (NL)
- developing new innovative materials (IT)
- dynamic behaviour of constructions in soft soils (NL)
- understanding of the natural sand transport phenomena (NL)
- improvement of contaminated land clean-up procedures (GB)
- on-line products information systems (FR, US)
- improving durability of coatings (HU)
- developing the life expectancy of indigenous construction materials and technologies (ZA)

Building Stock

- upgrading performance of existing building stock (FR, IT, HU, NL)
- developing non destructive diagnostic tools for condition assessment (HU, NL)
- models for service life prediction (NL)
- new technologies/systems for renovating and retrofitting (FR, HU, IT, NL)

Tools

- developing methods and means to be used by professionals (FI)
- best practices in sustainable buildings (HU)
- building handbooks (GB)
- developing assessment methods (FR)
- performance-based environmental standards (IE, NL, US)
- reliable labelling scheme (GB)
- putting more emphasis at the R/D level on global studies such as life cycle analysis and multi-criteria evaluation of materials, services, constructions... (BE)
- tools for the assessment and certification of life-cycle performance of buildings (GB, NL)
- inventory of all life cycle costs and suitable indices for measuring pertinent performance (ZA)
- issues/tools linked to the incorporation of environmental costs into the economic system (NL)
- usable environmental accounting tools for construction projects and building operators (GB)
- modulating the "Building-to-Last" concept (FR)
- models for the service life prediction (NL)
- tools to estimate preference for temporary buildings or long-lasting buildings (GB)
- comprehensive data bases (JP)
- develop usable environmental operation accounting tools (GB)
- the development and dissemination of methodologies of reviewing environmental impacts (JP)
- compiling a first set of "performance indicators" to cover (BE, FR, GB, IE, JP, US):
    - the process of construction
    - completed buildings and civil engineering projects
    - the operation of existing construction works
- de-construction and disposal (including re-use) (IE)

- tolerance levels for radio-active building materials (HU)

Building process

- the need of short- as well as at long-term forecasts of construction activities (HU)
- the need of a thorough study of the ongoing processes in the national and international building field (HU)
- the improvement of the building process itself (NL)
- pushing life cycle thinking as the guiding principle for construction processes (FI)
- renewal engineering methods (NL)
- management and business practices (NL)
- design technology: new design standards for designers, open systems, advanced jointing and assembly techniques (NL)
- construction: open building, process reengineering (NL)
- materials and systems: new function integrated building components, durability, reparability and retrofit ability of the products (NL)
- investigate social sustainability issues surrounding self-build (GB)

4.4 Conclusions

The challenge the construction sector is facing today is not only to find the best balance between the various contemporary constraints of the building act (technical, architectural, social or economic constraints) but also to endeavour to favour "decisions without regret" in the compromise solutions that the building act necessitates at every moment in the life cycle of a building, and especially in the construction phase.

The previous chapters dealing with definitions of sustainable construction and visions of the various consequences of a sustainable development for the building sector showed already the complexity of the items which are raised and the role of nearly all of the numerous actors of the sector. This chapter tried to summarise the main recommendations given in the national reports towards these actors: clients, owners, developers, investors, authorities, educators, designers, industrialists, contractors, users, maintenance people, researchers...

Building owners and clients should have a very important role in disseminating sustainable construction since they represent the demand of the building sector. They should set concrete environmental specifications to the parties involved in the design process. They should also assure the productivity of their own business by emphasising environmental issues, quality and preservation of property values.

If the demand cannot be seen as a sufficient pulling factor, a voluntary policy by authorities is needed. They should favour the development of a suitable response to the concept of sustainable construction, stimulate the actors, take measures, create mechanisms... Initiatives should be especially taken towards planning, industry and constructors through adapted regulations, standards or fiscal measures and incentives.

An important feeling is that education and training should be largely used to have sustainable development concepts well known and accepted by all people. In particular, understanding the impact of the construction sector on the global environment is not mature in the whole construction industry and within authorities. This awareness raising and education program should aim not only at all the actors of the construction industry but also the public, politicians and government administrators. However a preliminary condition is to reach a common language.

Designers should adopt a more integrated approach to design, appreciate the fundamentals of sustainable building design, and know how to interpret environmental labelling. They should consider the environmental qualities of construction materials as a starting point of the design, but also focus on the exploitation phase during functional design.

Manufacturers of building products should see the life cycle considerations as the basis of product development. They should co-operate with designers in creating new designs and facilitate recycling of materials.

Building users should see the environmental issues as one aspect of comfort and consequently as one factor that affects the productivity of the use of the spaces.

Building maintenance organisations should see environmental consciousness as a factor of competitiveness and should expect co-operation from suppliers and partners regarding environmental issues.

A lot of technical and R&D recommendations are finally addressed in order to produce environmental quality for building components and buildings. Most of these recommendations deal with energy saving, health and comfort, waste management, and resources saving. An important part of the recommendations is concentrated on the development of adapted tools to help designers and other actors to introduce sustainability concern in the compromise decisions they have to take at every moment. The improvement of the building process itself is also considered as a significant topic for research activities.

Finally, a general recommendation that is stated is to take action at once to act preventively and to prepare the building sector to changes which are needed in the building process.

5. EXAMPLES OF BETTER PRACTICE

5.1 Introduction

5.1.1 Background to this chapter

The idea for this chapter came from discussions amongst the project team at a progress review meeting in Budapest in November 1997. It was realised that the reports presented scenarios for sustainable construction in the year 2010 from the broadest point of view. What the construction industry would require was an understanding of better practice and what the key drivers of change would be. The first suggested title for this section was "Market Opportunities" recognising that the development of new market opportunities would be a key driver of change in the industry. Based on the principles of a market economy this is true. However, it has become evident, as the national reports are completed, that sustainable construction means different things in different countries and solutions will need to be found which are suitable for organisations in market economies, transition economies and developing economies.

Therefore, in order to reflect the wide range of responses which have already been made and those which might be expected from construction industries throughout the world, the chapter is entitled: "Examples of Better Practice".

5.1.2 Considering the industry perspective

For many in the construction industry the components of sustainable development pose unfamiliar challenges. They involve a wide range of stakeholders many of which have not been direct participants in construction activities before and may also be experiencing dramatic change in their own sphere of activity. Whilst the construction process and built environment have a substantial impact on people's lives many of the social, environmental and broader economic issues which characterise sustainable development are not considered in the current construction industry protocols and practices. Therefore, for construction activities to become sustainable those in the industry must find ways of "buying-in" to the principles of sustainable development by:

- initially, building an understanding of sustainable development;
- secondly, identifying how their activities impact upon others, in relation to the aims of sustainable development;
- thirdly, defining and accepting their role in its achievement;
- and finally, putting theory into practice.

5.2 Better practice case studies

This section presents extracts of the case studies which are presented in the national reports. The full case studies provide an insight into the many approaches people have taken to putting the theory of sustainable construction into practice. It is hoped that these examples will help shape and define our own vision of sustainable construction and encourage the wider application of sustainable construction practices. There is no attempt to grade, rank or value the examples presented although an attempt has been made to categorise them in line with the five areas of investigation carried through many of the national reports. These are:

1. Urban planning - which includes any examples of community planning
2. Product development and design - including new uses of traditional materials
3. Manufacturing and construction - looking also at new partnerships for construction
4. Operation - including integrating new technologies for greater efficiency
5. Deconstruction.

In total there are 59 examples presented in this section, categorised as follows:

1. Urban planning	20 examples
2. Product development and design	17 examples
3. Manufacturing and construction	6 examples
4. Operation	15 examples
5. Deconstruction	2 examples

In themselves they make an interesting indication of the current priorities and the types of organisations who can be leaders in sustainable construction practice.

5.2.1 Urban planning

The Centre for Sustainable Construction (Heusden-Zolder) - Belgium

Principles: centre for the community, demonstration project

A new Centre of sustainable construction is planned for construction in a renovated ancient mine building. The work will be carried-out as a large demonstration project and will contain conference- and meeting rooms, demonstration facilities, space for starting companies a child museum etc. In the neighbourhood of the centre, there is space for demonstration buildings and for new companies, operating within the framework of sustainable construction. The centre is a joint initiative between the Construction sector (BBRI, Federation of construction industry, etc), the Energy sector and Public authorities (Flemish Waste Administration, Water Supply Administration, etc). The centre will co-ordinate different initiatives in Belgium in the field of sustainable construction, stimulate application, demonstrate new technologies and show concrete products and services.

The mobility plan of the city of Hasselt - Belgium

Principles: traffic management

This is one example of the public transport plans developed for some Belgian towns. An interesting case study is the city of Hasselt, where a global mobility plan is implemented. Elements of this plan are:

- traffic black points were inventoried and as much as possible soluted;
- a "speed reduction plan": 30 and 50km/hr in inhabited areas; 70 and 90 for other roads;
- the inner ring of the city is completely reorganised:
    - reduction of a 4 lane-road to a 2 lane one;
    - traffic is only admitted in 1 direction;
    - the new space is used for "slow traffic" (walking and biking) and trees;
- a complete network of bike-lanes;
- public traffic:
    - increase of the bus traffic by a factor 4;
    - all busses are free within the city;
- large parking outside town, free bus-shuttles to the centre.

The first months of the new public transport organisation showed an increase of the use of busses with a factor 10 and a considerable decrease of car traffic within the centre of town.

Ecological criteria for experimental construction (Viikki) - Finland

Principles: ecological design principles for city sites, enhancing regulation

The purpose of the criteria developed in this project is to be appended to regulations concerning building practices at city sites. The City of Helsinki and the Eco-Community Project organised a design competition for experimental building in a rural area including ecologically sensitive and valuable protected waterfronts at Viikki near the centre of Helsinki. The competition aimed to save nature and natural resources, to have a high quality with regards to their architecture and functionality of the dwellings, and to be feasible to construct. The competition also was a means for a search for solutions which follow the principles of sustainable development and which could be more generally applicable. A group of building consultants devised a tool for the ecological assessment of building plans which defines minimum ecological levels for building and estimates the ecological degree of various development projects. Minimum ecological levels for building have been dimensioned to enable their implementation in residential construction to be carried out at a reasonable additional cost. The fulfilling of ecological criteria will also achieve cost savings during the use period.

Electric and District Heating Energy Plant (Vuosaari B) - Finland

Principles: community planning, energy efficiency

About 50 % of the heat from the new energy plant, Vuosaari B are used in the densely built area of Helsinki. The plant uses natural gas as its fuel and produces a nominal electric power of ca. 450 MW. The fuel is fossil but offers the advantage of practically no particle and sulphur emissions. The NO_x emissions are low: for NO_2 only 35 mg /MJ of fuel. In comparison, modern coal-fuelled plants emit ca. 50 mg/MJ, and 10 years ago typical emissions for coal were above 200 mg/MJ. Also carbon dioxide emissions are low, only 56 g/MJ (more than 90 g/MJ for coal).

The heat from Vuosaari B is lead outside of this area, to North and East parts of the city, via a new 20 km long district heat tunnel (an investment of ca. 500 million FIM). About 90 % of the building volume in Helsinki are covered by district heating.

Le Clos des Vignes - France

Principles: Site integration

Integration of the site with specific characteristics from the geographical, cultural and social points of view is the main characteristic of this development comprising 56 flats at SAINT MAX (Meurthe et Moselle - Eastern France). It includes 6 flats dedicated to disabled people. . Several themes have been considered in this operation, such as the site integration but also water and domestic waste management. Also, the history and geography of this site have been taken into account for the gardens and surroundings. Various communications have been conducted with local inhabitants and timber (from the Vosges forests) has been heavily used in the construction, on the façades and inside the common areas.

Place du Vigneron - FRANCE

Principles: Visual comfort and integration

This project in UNIEUX (Loire - southwest of Paris) is for 44 flats and stores. This REX HQE, with three 5-storeys buildings, takes place in a heavy restoration of the centre of a middle-size town. The problem of visual comfort has been studied in particular. A light shaft, located in the middle of each building, brings "second lighting" to landings, bathrooms and livingrooms. The natural lighting concept includes also:

- larger glazing in the light shaft at the lowest floors in order to balance the lack of light,
- "transparent" lifts to improve natural lighting of landings and lifts,
- appropriate design of the window frames,
- light-coloured cladding and covering,

All these topics have been deeply through modelling/simulation and laboratory testing.

Urban Planning case study SALINE - OSTIA ANTICA, ROMA, 1995 - Italy

Principles: nature protection, renewal and recyclable

Saline-Ostia Antica represents an urban organism covering 900 ha on the outskirts of Rome, whose history has alternated between consolidation and cycles of decline. With the recent agricultural reclamation operation, it has regained its structure and identity. But today the agricultural crisis and progression of the built city are compromising the morphological and structural continuity. The project will reconstruct the relationship between built city, agriculture, and natural environment in a visibly global system. The organisation of innovative technological elements such as the "Energetic Power Ecostations" will re-establish the flow of circulation, infrastructure, and create new urban polarities.

The New Urban Masterplan of Cavalese (Trento) 1991 - Italy

Principles: conserve, re-use, integrate

The urban masterplan of the Municipality of Cavalese promotes a series of technical and co-ordinated measures, normative for energy savings interventions, discouraging law evasion, for an adequate solar energy use in the new buildings constructions and/or in retrofitting and in general in the research of building quality and in the valorisation of existing buildings.

Five levels of building intervention are checked in the Cavalese masterplan, some of them enter directly in the normative and technical advisory, while some other belong more properly at the dimensional-program- management of the administration. The first two levels individuate the planning level and the building level, which much more are involved in the sustainable development of the city.

'Environment symbiosis' building and NEXT 21 projects in Osaka City - Japan

Principles: harmonisation with nature

Japanese traditional culture involves the paradigm of harmonisation with nature. It is acceptable for Japanese people to define human as only one of the players in the environment.

Based on these cultural bases, the word of 'environment symbiosis' building is more frequently used than sustainable building, environmental conscious buildings and green buildings in Japan.

Housing and Urban Development Corporation (HUDC) and local councils are now constructing environment' friendly' estates in nation-wide. Remarkable example is Fukasawa Housing Complex in Setagaya-ku Tokyo. It is typical example of environment symbiosis building. It was designed by architect Kazuo Iwamura. He involves feasible environmental friendly measures in the council housing project where budget is extremely tight.

LEIDSE RIJN: development of a new medium sized town. - Netherlands

Principles: public consultation, partnership, new construction methods and technologies,

Leidse Rijn will be a new residential district of the city of Utrecht. The area is still predominantly agricultural, but is also very diverse. The new residential development will consist of 30,000 homes, which will house about 100,000 people. In effect, it means that a medium-sized town will be created out of nothing.

The urban planners have adopted a new approach in Leidse Rijn which used a multidisciplinary committee to assess claims put forward by interest groups affected by the development. The various members of the project team went to all the public meetings, armed with the maps. "A great deal of attention was focused on communication in the project. Listening and explaining was a very important part of the design process. The team, only two-thirds of which were local government officials, all worked together in one room, which is very unusual.”

Working in this way increased the range of options and the following initiatives have been developed:

- Use of land - An underground motorway uses a method never used before bringing the ideal of compact development a lot closer.
- Energy - The energy performance of the dwellings will be 40% better than the current legal requirements. Moreover district heating will be applied.

  Transportation and mobility - Another point of attention was the concurrent development of a high quality public transportation system.
- Water - A 50% decrease in the consumption of high quality drinking water will be realised by using a double water supply system. One system supplying drinking water quality and one system supplying lightly treated surface water for washing, toilet flushing, etc. The sewage system is only designed to transport domestic wastewater. Rainwater is infiltrated in the groundwater or discharged in the existing waterways.

Orange Farm Informal Settlement, Johannesburg - South Africa

Principles: self-governance, community participation

This settlement is an example of entrepreneurial self-governance. Lacking any formal municipal structure, the community embarked on a creative approach to develop the area. The community identified the leaders in the community, people known for resourcefulness and community concern. A self-governance structure, the Orange Farm Creative Action Development Forum was formed - an acceptable local structure for community development to improve the management and delivery of essential services. The community has since mobilised and channelled development funds through this forum and successfully developed schools and other services for the community. Several people in the forum have received national honours for their endeavours. The Centre of Lifelong Learning of the Technikon Southern Africa has made the principles established by the forum the basis for a special Integrated Community Building Programme, which encourages communities to be more self-reliant and self-responsible in their planning, decision-making and actions. (Hill, RC, and al., 1998)

Tlholego Development Project, Rustenburg - South Africa

Principles: rural planning, integration, appropriate technologies

The Tlholego Development Project (TDP) was established in 1991, in order to pilot research and development into sustainable technologies for rural development. These technologies include: ecological building, household food security, natural waste management, permaculture and education/training on these subjects.

The Tlholego village pilot is an important demonstration in the replacement of sub-standard housing with high quality, affordable houses, which use modern techniques of unburned brick and appropriate technologies. One of the main objectives of Tlholego is to establish a rural settlement model, which demonstrates to South Africans real options for living sustainably in the 21^{st} century.

A Zonal urban plan for Sighisoara - Romania

Principles: regeneration, heritage conservation, urban planning, regulations

The city of Sighisoara developed around the medieval firtress built in the XIVth century. The city has experienced cycles of development and decline which resulted in recent years in the wholesale demolition and "neutralisation" of the specific character of the city and its environment.

In 1991 a pilot project commenced to develop an urban zonal plan and to reinstate construction regulations which had been abandoned for over 40 years. The new building regulations contain provision for:

- protection and classification of certain buildings,
- spatial re-organisation,
- protection and revitalisation of green spaces,
- improving quality of surrounding areas,
- functional re-organising and aesthetic regulation,
- diversity by restructuring,
- patterns for public services,
- land transactions.

Urban regeneration and rehabilitation, apartment blocks, Targoviste - Romania

Principles: urban regeneration, improved quality of life

The core of this project is based on the refurbishment of apartment blocks built in the 1960's which provided the most basic living conditions. The main objectives of the project were to improve living conditions and the external out-look. The choice of rehabilitation has resulted in costs accounting for only 45% of the cost of new build and through careful design the number of apartments has been retained but the following improvements have been achieved:

- 25-30% increase in living space,
- improved thermal insulation,
- improved quality,
- updated infrastructure,
- new storage space,
- improved external aesthetics.

Additional benefits in the quality of the urban framework and surrounding residential area have been realised.

Metropolitan Territorial Plan for Barcelona - Spain

Principles: balancing quality of life in developments, integrated transport

Although not ratified, this plan tries to avoid the habitual and undesirable situation that is generated in the surroundings of large cities. The objective of this plan is to obtain a homogenisation of the living quality throughout the congested urban centre and the dispersed territory surrounding the city. The Plan proposes a solution based on distributing the territory in a system of "open spaces" and "metropolitan islands" where high quality services and communications are provided to encourage less dispersion.

An interesting proposal of the Plan is the system of segregated roadways, structured as a homogenous and orthogonal network, that will channels the through traffic. This system is complemented with a net of "civic" thoroughfares and service corridors that will channel the intra-metropolitan short distance transport flows and serve, at the same time, to carry the different main service networks (water, electricity, gas, telephones...).

Car Free Housing Development - Edinburgh, Scotland - UK

Principles: integrated transport planning, mixed development

This scheme is being developed on disused rail land in Edinburgh, and is due to be ready for a mixture of rented, bought and social housing by 2000. It will consist of 121 flats which will provide energy efficient homes in a car free environment. People wanting to buy or rent flats will have to sign an agreement not to own a car and have no plans to buy one. Edinburgh City Council plans to extend its 'car club' to the development, allowing residents to hire vehicles preferentially. Two new bus routes and a possible new suburban railway station, will provide sufficient public transport services for the residents. The land that would have normally been allocated for parking will be used for terraced gardens, allotments and reed beds. The site is to be developed to a density of around 50 units to the acre, a high density compared to typical developments.

Holy Island Retreat Centre, Scotland - UK

Principles: holistic design, integrated, autonomous community

This project, yet to be started, is intended to be a truly sustainable development on an island off the west coast of Scotland. It will house a Buddhist community, who desired to be part of a sustainable environment and a wholly self-sustaining community. Thus, the design had to take account of agricultural needs, integration of water and crops, waste management and disposal, and rigorous energy efficiency strategies. The overall objectives of the project were:

- to be energy self-sufficient;
- to be water self-sufficient;
- for all waste to be processed on site or recycled.

The community plans to self-build a part of the project on site soon. Although for some parts of the construction precise finishes are required (such as for the back walls, roof and facades), other less critical areas present the possibility of self-build for the community.

Planned Unit Developments - USA

Principles: self-sufficiency, integration, community

Village Homes - The development of Village Homes in Davis, California was begun in 1975 and was based on principles of self-sufficiency, community, energy conservation and market appeal. It occupies 70 acres and was designed for 200 homes. The main components of the development are narrow streets, cul-de-sacs, on-street parking, interconnected pedestrian ways, communal green space, including agricultural land, smaller lots, and the orientation of every house lot for southern exposure. Commercial and recreational uses were provided in the community centre to decrease automobile usage.

Dewees Island - Dewees Island is a 1,206-acre barrier island off the coast of South Carolina. The premise of the development is a high-end retreat in tune with the 350 acres of existing wildlife preserves on the island. Environmental regulations for wetlands and coastal development as well as environmental groups placed severe restrictions on development. As part of a community outreach environmental education program, the developers built an education centre on the island for visitors and residents to have an information source to learn about the native flora, fauna, and ecosystems.

Civano -Tuscon Solar Village - Civano in Tucson, AZ is the first attempt to create a new land development with social amenities, affordable housing, and a job-to-housing balance required to make it economically feasible while also designing in energy and water efficiencies in the buildings, landscape and infrastructure.

Traditional Neighborhood Development (TND) - USA

Principles: integrated communities

Traditional neighborhood development (TND) grew out of Andres Duany and Elizabeth Plater-Zybek's belief in the connection between community form and function. If the structural elements which embody a traditional American small town are recreated in new and infill developments then the values and functions of community will follow. TND ordinances go beyond the measurable character of land uses by also defining aesthetic and materials codes for buildings.

Seaside in Florida - was the first built expression of the TND principles begun in the mid 1980's. The 80-acre town is expected to grow to about 650 dwellings and 2,000 residents. The plan consists of a mixed-use town center located off the main through-road with a pattern of limited access streets radiating outward to the small-detached single-family home lots. A grid overlay ties the radial streets together and connects to the main through road, distributing traffic throughout the community. Parking is limited to areas outside the development and on-street within the development. A strict architectural code determines the materials and appearance of the development as well as ensuring certain features such as front porches and picket fences which are meant to engender community interaction.

Haymount, Virginia - is a 4,000 dwelling unit, 1,605-acre development on farmland in eastern Virginia on the Rappahannock River. The land planning process used an extensive environmental assessment overlay mapping process that outlined all environmentally sensitive areas and individual trees of 18 inches in diameter or greater. The multi-disciplinary planning team, common to the best of sustainable construction, included planners, landscape architects, architects, engineers, and hydrologists.

Harbor Town in Memphis, Tennessee - is built on an island in the Mississippi River in Memphis, Tennessee. The development is meant to embody the traditional values of a Southern town through its physical character. The plan is a combination of a grid and axial street system, with three major focal points. The homes are built on smaller lots, 3,000 to 5,000 sq. ft., with front porches, many small neighborhood parks, and back alleys with parking on the streets. Smaller single family homes are designed in the «shotgun» style, a traditional form so-called because it utilizes a circulation spine through the building from front to back, with the front and back doors in line. This style makes cross-ventilation feasible with front and back porches to cool the air as it passes. The rectangular shell, the circulation path which passes from one room to the next without use of a hallway, and the use of one room for living, dining, and kitchen, reduces materials use to the absolute minimum.

Celebration in Florida - is a 4,900-acre new town developed by The Celebration Company, a subsidiary of The Walt Disney Company, and opened in 1996. Celebration was to create a model of neo-traditional planning. The major design elements are; a central commercial "downtown" core, mixed housing types, a public school, health facilities, a 109 acre office park, and a golf course. An advanced infrastructure system of telecommunications and fiber optics, pedestrian paths and trails are all intended to reduce transportation needs and create a pedestrian friendly environment. The development uses a series of guidelines and controls, including approved builders and stylistic controls, for the architecture of housing types. These types range from townhouse to single family, with designs based on traditional American architecture. The land development pattern creates a secondary street network of alleys and hidden or rear-located garages to remove vehicles from the principal street frontage.

Transit Oriented Development (TOD) - USA

Principles: transportation efficiency

The architect and planner Peter Calthorpe developed the design strategy for cities called Transit Oriented Development (TOD) in the 1980's. The foundation for this development type centered around mass-transit is the high rate of automobile use in the USA. TOD is an attempt to alter the patterns of transport use in the US. The guiding force is transportation efficiency and the fundamental connections between home and work and one community to the next. 'Pedestrian pockets' link the nodes of commerce and transit stops with the residential and recreational areas in close proximity. TOD is explicitly energy conserving by supporting mass-transit, pedestrian access, density and mixed-use, infill around existing transportation infrastructure and consequently, the preservation of surrounding natural areas. One example of a TOD is Laguna West in Sacramento, California.

5.2.2 Product development and design

Pleiade - Belgium

Principles: energy efficiency, integrated design

The PLEIADE (Passive Low Energy Innovative Architectural DEsign) dwelling is the Belgian contribution in the framework of the Task XIII project of the International Energy Agency (IEA). It is a two-storey row house of about 240m² net floor area (including the attic which is part of the inhabited space) located in the new city of Louvain-la-Neuve. Special attention is given to the integration of the bioclimatic architectural concepts, the achievement of good thermal comfort in winter and summer, and good indoor air quality. Accordingly the design of the envelope was important. Daylighting the central part of this 10-m deep row house was another objective. Features include: a balanced ventilation system with heat recovery, shading of the south-facing glazing, night-time natural ventilation, two heating systems - a gas air heating system and an electrical heating system, a control system for optimal energy use and thermal comfort, improved double glazing (Argon filling and double low-emissivity coating).

CFC-Free Low-Energy Office Building (METOP) - Finland

Principles: low energy systems

The building module prototype METOP for a low-energy office building was built for testing the performance of new structural, electrotechnical and HVAC solutions developed in different development projects of different companies. The main objective was to put into practice good indoor air quality, thermal comfort and low energy consumption simultaneously and economically. Its heating energy consumption was measured 13 kWh/m^3 (55 kWh/m^2), which is 60 % lower than the average consumption in Finnish office buildings. The consumption of electricity was 16 kWh/m^3 (72 kWh/m^2), which is equal to average consumption. According to the measurements, there was no problem with the indoor air quality. Concentration of odours, radon, particles, microbes, volatile organic (VOC) and other chemical compounds were low. Thermal indoor climate was pleasant in winter and in summer. The satisfaction index was over 90 %.

Energy-Conscious Dwelling (Soidintie) - Finland

Principles: linking design selection with operating efficiency

The purpose was to find out the actual influence of structural and technical systems on construction costs and comfortable dwelling when ecological alternatives are favoured. The goal was a 30 per cent reduction of annual heating energy without significantly increasing construction costs. First, performance and costs of various exterior walls and windows were calculated. A trade-off comparison between a better thermal insulation of exterior walls and windows and, on the other hand, building costs and dwelling comfort was performed. The results indicated the fact that a better insulation gives an opportunity of using floor and air heating based on low temperature technique.

Les Jardins de Rabaudy - France

Principles: Environmental quality of materials, site integration

In this REX HQE situated in the hearth of a protected "green zone" in CASTANET TOLOSAN (Haute Garonne - West-southern France), a heavy attention has been brought to the integration of the buildings and their neighbourhood into the site. The choice of environmentally friendly materials has been deeply studied and the following materials have been chosen for the 50 rental houses:

- baked clay (tiles, 20-cm-hollow bricks, facing bricks, window ledges, chimney ducts, life cycle studied with an industrialist),
- wood (skeleton, shutters, garage doors, internal doors, plinths, stairs),
- zinc (gutters),
- traditional coating,
- non toxic glue,
- labelled paints.

"Internet" Office and Ecohouse Pavilion, Lough Derg - Ireland

Principles: eco-design, integration of new technologies

This project was completed in 1995 and provided an imaginative extension to an existing building which included many special features. State-of-the-art environmental technology was incorporated in the design including PV cells, low-pollution, "breathing" materials.

The pavilion is south facing in order to maximise the passive solar energy and an existing well was incorporated into the design to allow for irrigation of a year round vegetable garden as well as for cooling purposes.

Building component case study, the active intelligent window - Italy

Principles: renewable energies, advanced technology

The Active Intelligent Window comprises of a range of elements each with specific or variable functions depending on outdoor conditions. The elements are contained in two main sections: the upper section contains the glazing panels, which in turn enclose variable transparency film operated on a roller system. The lower section is within a compartment clad on the interior by a filter panel and on the exterior by a punctured opaque glass panel; contained within these panels is the rotary heat exchanger and an upper and lower fan for air intake and exhaust respectively. The intelligent control system and sensors are also located here, as well as the local control for the different configurations. The heating strategy of the window covers the concepts of solar collection, heat storage and heat distribution; while the cooling strategy refers to solar control, internal gain minimising and heat dissipation. The entire unit is contained by a PVC frame that allows the insertion of the whole element into the building structure, as well the substitution of damaged elements.

OM Solar House - Japan

Principles: modularity, innovative technology

A specific type of passive solar house called the OM solar house has been rapidly disseminated among timber framed houses. Around ten thousand OM solar houses have been constructed in Japan.

Novalis - Ubuntu Centre (Kenilworth, Cape Town) - South Africa

Principles: holistic design

The centre is to function as a training facility for teachers in the Waldorf system of education. The structure is to be a *building for the human soul,* and thus the main emphasis in the design was the quality of the spaces and indoor environment that are created in the building.

Physical and spiritual well being was an important issue for the Novalis-Ubuntu Centre as part of their whole educational philosophy. A 'geomancer' was commissioned to identify 'geopathic stress spots'. These are points of adverse or negative energies that usually originate from underground water sources, magnetic grid lines and radiation, amongst others. Where buildings are sited above them, these forces become confined within the buildings and are said to cause stress and illness in people working within these buildings. Organic forms and human scaled designs further contribute to the well being of occupants of the centre.

The client's brief also stipulated that training of local workers on site was compulsory, and labour intensive construction methods were used.

The Barn, Kuthumba Nature Reserve, Plettenberg Bay - South Africa

Principles: use of traditional materials, deconstruction, community involvement

The Barn is to provide accommodation for visitors to this private nature reserve and makes use of clay construction techniques, organic building forms and the use of natural materials to create buildings that are environmentally sensitive, as well as being sensitive to the surrounding landscape. A gum pole structure was used with wattle and daub infill panels.

The wattle, an alien plant, was harvested from the surrounding indigenous forest. Other materials used for the infill panels were locally-sourced clay, and straw that had been treated with old motor car oil. Thatch was used as a roofing material.

Provision was made for the reuse of grey water and a wetland sewage system is used.

The Barn also addressed the issue of deconstruction as the main construction materials used, clay and wood, are recyclable after demolition.

A 'clay building festival' was organised for the local community and friends to do most of the clay mixing and panel infill work. Local workers were trained in clay construction during the building of the Barn.

The Klein Constantia Wine Cellar - South Africa

Principles: effective use of materials

The Cellar provide an example of the way in which conventional building materials and methods can be used to create energy efficient and biophysically sensitive design solutions. It features passive design measures that involve orientating buildings and using materials in such a way as to make the most of natural energy for lighting, ventilation and temperature control. The cellar is partly buried, thereby making use of the insulating properties of soil. The roof is built of brick vaults filled with high mass concrete, which adds to the insulating properties of the building. These and other design features allow natural regulation of temperatures within the building and have eliminated the need for mechanical systems to maintain required temperatures. The cellar won an Eskom Design Award for energy efficiency in 1990.

The choice of site avoided damage to vulnerable farmland and vegetation that would have resulted from using the initially proposed site. The alternative site chosen was an old 'grey' site that had been used in the past to support farm sheds and other buildings. These old ruined buildings were demolished and the new cellar built on the site. Thus, no new land had to be cleared or damaged by the construction process.

House of Mr. Justice HA Fagan, Cape Town - South Africa

Principles: passive design

Apart from design measures involving the orientation of the building and using materials in a way that makes the most of natural energy, lighting and temperature control, the Fagan house also uses passive solar design to regulate internal air temperatures. This building uses a combination of a large skylight on a north-facing roof, situated above a heavy concrete floor finished in terracotta tiles. The tiled floor acts as a heat sink, absorbing the heat entering via the skylight, and releasing it at night or in winter months. The rooms were designed to maximise the flow of heat from this heat sink throughout the house. Large, adjustable blinds below the skylight prevent excessive heat gain in summer.

A six flat block with solar conduit in Horta, Barcelona - Spain

Principles: conserve, re-use

This building consists of three floors and a parking level and has been equipped with bioclimatical solutions to satisfy the ventilation, air conditioning and lighting requirements. One of the most novel characteristics of this building is the incorporation of a solar conduit for the illumination of the kitchens which is also used at the same time to provide natural ventilation. Other bioclimatic measures have been applied to this building for the ventilation and illumination of the parking areas and stairs also incorporate skylights. Another main field of consideration has been power saving in heating and the insulation of walls using HD polystyrene to improve thermal inertia. In the main facade, oriented to the Southeast, there are 53.2 m^2 of double glazed windows, whereas in the rear facade there are 14.5 m^2. This improves solar lighting, reduces the thermal losses and allows the crossed ventilation in summer. Thanks to the gains obtained from the passive solar pick up and the good insulation, the degree of power saving in heating reaches the 68%.

Eco Centre - Groundwork South Tyneside, England - UK

Principles: design for autonomy

Designed to lead by example, this building (completed in 1996) was originally intended to be totally self-sufficient, creating the UK's first truly autonomous office. Cost considerations have prevented this vision being wholly fulfilled, but the combination of low energy design, water conservation and on-site electricity generation means that the Eco Centre places only a small burden on the local utility supplies. The building obtains its heating and cooling via a ground source heat pump, recycles human waste via composting toilets, recovers rainwater for fire sprinklers and toilets, and uses greywater for site irrigation.

The construction materials were obtained where possible from renewable sources and recycled materials were used. The building is timber framed, with timber supporting the roof structure and internal brickwork supporting the intermediate floor slab. The reclaimed bricks came ready cleaned and palleted. The building is 30% double-glazed, with the timber window frames from a sustainable timber source.

Hellmuth, Obata & Kassabaum (HOK) - USA

Principles: design tools for sustainable development

Being one of the world's largest design firms, HOK has demonstrated a special commitment to sustainable construction through implementing a variety of procedures, guideline databases and protocols to stimulate and support the generation of sustainable designs.

A significant element is the 'Sustainable Design Guide', which is a tool to assist project teams in defining and prioritizing sustainable design goals. The checklist is organized by three design phases: Pre-Design, design and Documentation, Construction Administration, and by sustainable design topic: Planning and Site work, Energy, Building Materials, Indoor Air Quality, Water Conservation, and Recycling and waste Management.

Rocky Mountain Institute - Office and Residence - USA

Principles: design principles for energy efficiency and sustainability

The Rocky Mountain Institute (RMI) is a non-profit organization that promotes energy-efficiency and sustainable construction world-wide, based in Snowmass, Colorado. The founder of the Institute, Amory Lovins has become an renowned expert in the design of energy-efficient building systems with a focus on lighting and the calculation and documentation of the benefits of efficient commercial building systems for both utility savings and productivity gains resulting from good indoor environmental quality. RMI focuses on the reduction of electrical power consumption due to the enormous environmental costs of its production.

Sustainable Development and Construction Initiative, Inc. Abacoa Residences - USA

Principles: mixed commercial development, environmental design

Sustainable Development and Construction Initiative, Inc. (SDCI), is a non-profit group centered around the University of Florida, Center for Construction and Environment, in Gainesville, Florida. The group consists of academics, architects, developers, engineers, building contractors, and energy and waste specialists devoted to sustainable construction education and implementation. The Abacoa development in Jupiter, Florida is a 2,000 acre mixed-use development that is expected to build-out in 20 years at 6,000 dwellings, plus approximately 3,000,000 sq. ft. of commercial space, a university branch and a baseball training camp. The development is located adjacent to a mass-transit rail system which links it to cities along the Florida southeast coast. The existing land is pine flatwoods and agricultural land that is expected to be restored to its native ecosystems within the community as a whole and through a wildlife corridor "greenway" which extends completely through the development.

Croxton Collaborative - Audubon House

Principles: holistic design principles and practice

The Croxton Collaborative architectural firm is one of the leading U.S. architectural practitioners of green design and construction. They have been involved in several high profile design projects including the Natural Resources Defence Council office renovation and the National Audubon Society office renovation, both in New York City.

The Audubon House was created from the renovation of an 1891 office building, reusing the resources and restoring the architectural character of an existing structure instead of building a new building. A major component of the effort was the multi-disciplinary approach that also brings the client and non-traditional consultants such as environmental scientists and indoor air quality experts into the design team to a greater extent than is typical. This holistic approach was utilized to realize sustainability design goals of a healthy and pleasant working environment, environmental soundness, and quantifiable dollar, energy and material-use reduction.

5.2.3 Manufacturing and construction

Business based on recycling of wastes (SKJ Companies) - Finland

Principles: eco-efficiency, recycling

SKJ Companies, a subsidiary of the Finnish steel group, Rautaruukki Oy, is responsible for utilising the by-products of the steel industry. Activities cover the whole range of the by-product business from by-product treatment to product development, marketing and export. SKJ has developed into products and is marketing approximately 90% of the above mentioned by-products of Finnish steel industry totalling about 1.4 million tonnes. Slags are the largest product group by volume, and they are marketed to road construction, agriculture and the building materials industry. SKJ companies have activities in the fields of by-product treatment, product development and technology know-how. With regard to the technology know-how SKJ also has activities within export. The primary export countries have been Russia and East European countries.

National Package for Sustainable Building - Netherlands

Principles: good practice, demonstration, standards, whole industry participation

A national package for sustainable building has been drawn up by the building industry and is aimed mainly at the residential market. The State Secretary for Housing, Spatial Planning and the Environment has added a recommendation that should give substance to the principle of sustainable building from 1996. Thirteen organisations were involved in drawing up the national package for sustainable building.

The national package for sustainable building consists of some 160 voluntary measures. The involvement of many trade associations and the clear nature of the package mean that it should become standard for everyone. Sustainable building is therefore also to be incorporated in the Housing Act. Those who decide to work with the national package now will therefore have an advantage in terms of experience and know-how when the measures become mandatory.

SA Wildlife College (Kruger National Park) - South Africa

Principles: construction in partnership

The college is claimed to be the most advanced example of sustainable architecture built in South Africa to date. Much of the design is determined by energy and resource efficiency considerations. The protection of natural systems was a high priority, given the pristine natural environment that surrounds the college. The design and construction processes involved local communities as much as possible, to ensure the equitable sharing of the social and economic benefits ensuing from the construction of the college. Locally obtained materials that can be sustainably harvested and managed (e.g. thatch) were used.

Most of the building work was contracted to the Bushbuck Ridge Builders Association, a consortium of Murray and Roberts (one of the largest construction firms in South Africa) and local builders and artisans. As far as possible local suppliers, craft workers and manufacturers were supported by the development. Unskilled labour was recruited from 11 surrounding villages. Over the 18-month construction period, the project provided employment for an average of 200 people, of whom 40% were women.

Straw Bale Farmhouse, Wales - UK

Principles: new construction techniques, use of natural materials

This straw farmhouse, costing in the region of £15,000, is situated in a small village in mid Wales. It is built with large bales of tightly compacted straw, and sits on a concrete foundation. The house will be centrally heated by a solid fuel stove attached to a boiler, but as the straw bales are estimated to provide ten times more insulation than manufactured blocks, the house is very energy efficient. The building's roof will be insulated with wool, supplied by the farm's own sheep, and is built from wood cut from a nearby forest and machined by a local supplier. The owner hopes to finish the roof with timber shingles, again made out of the local wood. All of the windows and most of the other timbers used in construction were reclaimed.

Interface Inc. - USA

Principles: eco-efficiency

Interface, Inc is a $1 billion a year international manufacturer and marketer of commercial interior products: carpet tile, broadloom carpet, fabrics, raised flooring and specialty chemicals. Energy efficiency projects first received serious attention at Interface in 1995. The interest in reducing energy consumption has been driven by two different but compatible forces: Interface's CEO, Ray Anderson and COO, Charlie Eitel.

The company has launched an enterprise wide initiative called QUEST (Quality Utilizing Employee Suggestions and Teamwork) aimed to eliminate all waste. Waste is broadly defined as anything that goes into end products that does not come out as value to the customer.

In 1994 CEO Ray Anderson created a movement called EcoSense to push Interface toward sustainability and the two programs together have resulted in thousands of projects ranging from lighting retrofits to photovoltaïc arrays, saving the company a cumulative $40 million.

Habitat for Humanity - USA

Principles: new ways of working, community, partnership, team work

Habitat for Humanity is a non-profit non-denominational religious international organization devoted to the construction of 10,000 low-income housing units annually. The group sells completed homes to qualified participants with interest-free loans. Participants are obligated to contribute personal sweat-equity in the construction of both their own home as well as others, along with community volunteers and vendors who contribute labor and materials. Homes are constructed over the course of several weekends when a full crew of dozens of volunteers assembles for intensive housing-raising sessions.

The Jordan Commons project is a 200 home, 40-acre project meant to provide affordable sustainable housing in the lower-income community of Homestead, Florida which was severely damaged by Hurricane Andrew in 1992. The principles of community, community services, energy-efficiency, and affordability make this project a comprehensive approach to sustainable development. Specifically, the ideas of environmental responsibility, economic viability, and social equity are combined in one project using housing as the foundation.

5.2.4 Operation

Le Pré de la Cour - France

Principles: energy and water management

A block of flats and 5 houses have been built in Meillonas (Ain - Eastern France) in a small village of 1000 inhabitants. The owner (OPAC HLM de l'Ain) has looked for decreasing the services charges and has given importance to energy and water saving solutions.

Three technical solutions to collect and store rain water have been envisaged:

1. A total collecting of rainwater above the last floor, with a distribution to all toilets by gravity, which implies overraising the roof.
2. A storage under the first floor, which implies a pump and a surpressing device.
3. A solution which is a mix of the two previous ones. This solution allows for an easy collecting and a storage below the first floor, and a distribution by gravity from a buffer storage at the top of the building. A small pump, powered by solar photovoltaïc cells, ensures the water transfer to the storage. This solution has been chosen, but without the solar cells.

Elementary School of Ponzano, Emploli, - Italy

Principles: conserve, integrating renewable

The project of the school building poses an interesting problem for the energy designer from the point of view of energy conservation. Occupancy is both various and impermanent: classrooms are used to a greater or lesser extent according to their function; the length of a school day is generally shorter than a working day but after hours activities in the form of cleaning and extra curricular/adult education courses result in the extension of energy utilisation in any given day. Defining the areas where energy is used and sequentially identifying the areas of waste is the logical and essential process which must be executed. The energy saving strategy in this school building includes:

1. *Ventilated roof*
2. *Super-insulation of walls and roof*
3. *Insulating glazing*
4. *Natural ventilation*
5. *Thermal bridges*
6. *Buffer space*
7. *Special glazing*

Retrofitting Historical building case study integration of renewable energies, Bianchi Palace, Perugia 1995 - Italy

Principles: Conserve, re-use

The basis of the case study project for Bianchi Palace derives from important historical research on the environmental and climatic morphological matrices, the project is a part of the Rebuild Pilot Project and was launched under the RECITE Programme of the European Union, in response to their policy for the promotion of renewable energies.

Principal concepts of the project

- Functional and energetic rationalisation in the use of the building (atrium, elevator, services, horizontal and vertical distribution elements).
- Elimination of the sixth floor addition.
- Emphasis on the reconstruction of the "Atrium", as a reminder of the original "corte", with the function of vertical element distributing energy flows for solar passive heating, passive cooling and natural illumination of the internal spaces.
- Utilisation of the consistent masses of the wall structure as thermal accumulation elements (for cooling or heating according to the different seasonal conditions).
- The transparent covering system, composed holographic- optical elements and photovoltaïc modules, allows to direct solar radiation into the atrium below in order to illuminate the internal spaces and thermally charge the existing wall masses during warm periods, while it allows to intercept direct solar radiation during warm periods, directioning it towards the photovoltaïc modules in order to produce electric energy. Due to the "chimney-effect", the atrium also permits the cooling of its wall masses during the nighttime in warm periods, for the passive cooling of the building.

- Integration of the bioclimatic system with technical systems through the use of the same air circulation system; expulsion air as cool source for the heat pump during warm periods in order to increase its efficiency.

Eco – Balance Dwellings in Nieuwland – Amersfoort – The Netherlands

Principles: energy and water management, integration of renewable technologies

The Eco Balance dwellings in Amersfoort have been designed to incorporate the best technology currently available. Many measures adopted form also part of the National Package Sustainable Construction.

The main emphasis lies on energy saving and water saving.

Green Buildings for Africa Programme - South Africa

Principles: energy efficiency, optimal use of resources

This is an assessment system that was developed by the Division of Building Technology at the Council for Scientific and Industrial Research (CSIR), to encourage and reward building owners who voluntarily implement profitable energy-efficiency upgrades in their buildings, i.e. to go beyond the normal requirements and to ensure sustainable development through the optimal use of non-renewable resources and the sustainable use of renewable resources with the minimum damage and risk to the environment and human health, whilst maintaining a healthy economy.

It uses the Green Buildings Environmental Assessment, the first such system in South Africa for existing commercial and industrial buildings. The system specifies a range of environmental issues covering the design, maintenance, operation and management of existing office buildings. Credits are awarded where the said issues have been addressed and satisfied. The system will be tested and refined in the 'Green Buildings for Africa' showcase programme.

Although the initial thrust of the programme is on energy efficiency, it also has the scope to address many other environmental dimensions that are reflected in the assessment system. It covers both global and local issues. These issues are approached firstly from the perspective of the Building and its services and secondly with regards to the operation and management of the building.

Facilities Management and Information System (FMIS) - South Africa

Principles: management system

Facilities Planning and Management Programme, Division of Building Technology, CSIR

The system allows detailed information to be captured on capacity, condition, suitability and the likely cost of ensuring continued functionality in existing facilities. A graphic visualisation language component enables people from different disciplines to understand and interpret data quickly, and to make informed decisions.

System of management of the facilities in a large commercial building in Barcelona - Spain

Principles: management systems, energy efficiency, integration

In the Barcelona-Glòries commercial building a control and management system has been installed. This system allows to control, in unified and efficient way, the electrical consumption, the lighting system, the air conditioning, the low voltage distribution, the ventilation, the garden watering, the electricity-generating groups (used in the rush hours of consumption as auxiliary generators) fire-protection systems, cesspools and the elevators.

This centralised management system is helped by other solutions more usual to see as: low solar factor glazing, free-cooling system to diminish the heat pumps operation at intermediate weather, the installation of time-lag switches in the auxiliary premises.

All these systems allow a power saving of 25% in relation to the electrical consumption forecast initially done.

Air conditioning system in a building of the Universitat Pompeu Fabra in Barcelona - Spain

Principles: integration of renewable technologies for management

The "Jaume I" building of the "Universitat Pomeu Fabra" is the result of remodelling the old military barracks of the "Parc de la Ciutadella". The building has strong air conditioning requirements. During most of the year, a simultaneous provision of cooling and heating is needed. Taking in consideration the water volume extracted by the pumps which control the phreatic level, the possibility of installing water condensed machines, that allow to obtain optimal power results (because they provide cold and warm water simultaneously), was studied. After a hydrologic study of the zone, it was determined the existence of two water-bearing strata, the higher one located between 6 and 12 m deep and the lower one located between 30 and 35m deep, both of them separated by an impermeable layer, it was chosen to take water from the higher one and, once used, inject it in the lower one. With this solution the water of the subsoil can be controlled and the phreatic level maintained at a level that does not endanger the building, while, at the same time, water is injected in the lower water-bearing strata contributing to recover it from the marine intrusion.

Other solutions adopted in this building are: the use of the free-cooling system, cold and warm radiating ground, individualised air conditioning system for each space and management of the air conditioning and lighting systems based on presence detectors and computer control.

Thermal-photovoltaïc building of the Pompeu Fabra Library in Mataro, Barcelona - Spain.

Principles: integration of renewable technologies

The building that houses the Pompeu Fabra Library in Mataró have been designed attending to reach an optimal balance between energy saving, comfort, lighting, aesthetic and economy. In order to achieve this objective photovoltaïc panels, formed by prefabricated multifunctional modules with a large surface were integrated in the building. The project has served to show the possibilities that the European photovoltaïc industry offers, and to show the different technologic possibilities using monocrystalline cells, policrystalline cells and of amorphous silicon cells in their opaque and semitransparent versions.

The system is formed by a photovoltaïc system installed in the facade. This system is constituted by semitransparent multifunctional photovoltaïc modules formed by solar photovoltaïc policrystalline silicon cells, and four rows of 37° inclined photovoltaïc skylights installed in the cover. The building absorbs or gives energy to the network depending on if its power consumption exceeds its power generating capacity or if its power generating capacity exceed its power consumption. Another feature of the project is the use of the hot air obtained in the chamber formed between the solar modules and a transparent glazed wall. This hot air is used in winter as preheated air in the conventional heating system of the building as well as it is expelled outside of the building in summer. This thermal system allows a power saving upper than the 30%.

The Oxford photovoltaïc House, England - UK

Principles: autonomous operation

The house was designed by Dr. Sue Roaf of Oxford Brookes University and has the only UK example of a domestic photovoltaïc roof. The aim of the project was to demonstrate that by creating a superinsulated low energy house a photovoltaïc array is a technically feasible method of supplying a significant proportion of the energy required.

The energy saving measures, integrated into the building design, lead to a reduced electricity demand, so that the PV array is able to produce a greater percentage of the energy needs of the occupants than would be possible in a typical situation. During the winter approximately 44% of the total average 24-hour load is met by the array. The area in which the house is situated receives approximately 4 hours of sun per day in the summer, but only 0.6 in the winter. A major problem of domestic rather than commercial building PV systems is that the times of peak energy production (daytime) are times of minimum load. Maximum loads occur in the evening and in winter, when production is low. In this case, a system of battery storage of the excess production was rejected in favour of an importing and exporting energy to the National Grid.

Autonomous House, Southwell, England - UK

Principles: design for autonomy, energy efficiency, integration

This house is the only example in the UK of a fully occupied urban autonomous dwelling. It is of a conventional appearance, located in a medium density country town. It is extremely energy and water efficient, and uses a range of autonomous technologies.

Energy needs for the Southwell autonomous house are met entirely by solar gains, heat production from inhabitants, a wood-burning stove, and a 20-m2 bank of photovoltaïc panels. This generates around 1800 kWh of electricity per year, which passes directly through an inverter when being used within the house. Surplus electricity is sold to the grid, which also provides extra power to the house when needed.

The demand for water use within the house is reduced by the inclusion of a chambered composting toilet connected to two ground floor toilets. All of the water for the house comes from rainwater collection.

The house requires very little extra maintenance than a conventional, utility served house. The composting toilet needs no cleaning, but has to be stirred every six weeks. Most problems that do occur can be sorted out as normal, by an electrician or plumber.

Ebworth, England - UK

Principles: water conservation and management

The Ebworth Centre is a National Trust property consisting of woodland and six farm buildings that are now in the process of conversion into an Education Centre, offices and countryside workshops, with the inclusion of several environmental features. The buildings are listed and the local planning authority has been closely involved with the conversion to date Rigorous conditions have been associated with the planning permissions granted so far with the visual aspect of the estate having been of great consideration and which has limited the technologies appropriate on the site, as has the need to restore the buildings in a vernacular style.

There is no mains water connection to the buildings and fresh water is sourced from a nearby stream by means of a hydraulic ram pump. Water conservation on the site is maximised by use of composting toilets that serve the main visitor area. The model used has three toilet cubicles whose waste pipes all connect to one main chamber. Greywater from the hand basins in toilets, the kitchen sink and the workshops is discharged into a soakaway via a grease trap. Several problems have been experienced with this system due to the clogging of the perforated pipes with grease and other substances, however these have been rectified by slight structural changes and the careful consideration of the type of substances disposed of in the sinks.

The on-site warden's house has conventional plumbing, however all the waste from the house is treated in a system of bark rings and reed beds. Future modifications are planned, including the direct linking of the liquid effluent from the composting toilets with the reedbeds. The greywater from the kitchen and workshop may also be connected to the reedbeds, eliminating the problems that have occurred with the soakaway.

Allerton Park, Leeds, England - UK

Principles: autonomous operation

This development is a terrace of three self-built houses in Leeds. One of the priorities of the self-builders was to attain total autonomy from water and sewage mains systems. This is enabled by the use of a composting toilet in each house, which means that there is no sewage effluent to be disposed of. Grey water from all remaining discharge sources is passed through a grease trap and collected communally in an underground storage tank. The water is then discharged to a vertical flow reed bed and from there to a pond via a submersible pump. The pond water is also supplemented by rainwater draining from the surrounding land. The reedbed and pond system overflow directly to a soakaway. The water is finally pumped to a storage tank through a mesh filter and then a 12.5-micron filter (which has an automatic backwash facility).

Environmental Showcase Home - USA

Principles: demonstration, conservation

The largest single user-group of the Good Cents Environmental Home Program is various electrical utilities around the country. The Arizona Public Service utility in Phoenix, Arizona, used the guidelines of the Goods Cents program and consultation with Steve Loken of CRBT to design and build a demonstration home using all of the sustainable construction goals of energy, water and material conservation. Water-use and extreme variations in temperature are paramount concerns in the desert Southwest, whereas a high availability of solar energy presents a unique opportunity for the utilisation of solar energy systems.

Southern California Gas Company - Energy Resource Center - USA

Principles: energy efficiency, recycling

Southern California Gas Company is one of the largest utilities in the U.S. In 1995 they completed the Energy Resource Center for large commercial customers that utilizes the cutting-edge of material and energy resource efficiency in a model sustainable construction showcase and educational facility. This 43,000-sq. ft. office building in Downey, California uses an existing office building that was partially dismantled and renovated. Approximately 400 tons or 70% of the original building materials were either reused directly or put into recycled waste stream. The building cost between $5.9 million and $6.5 million to build, excluding an estimated $3.2 million saved by using the existing site and materials. The specific green features of the building add about $225,000 to $275,000 to the cost, but operating savings are expected to be $25,000 dollars a year giving a simple payback of 10 years.

5.2.5 Deconstruction

The recycled house - Belgium

Principles: re-useable materials, design for deconstruction

This demonstration project concerns the construction of a demonstration building incorporating a significant proportion of new materials derived from recycling building debris and from the reuse of waste or by-products from other industrial sectors. The goal is to demonstrate that it is possible in the construction sector to make use of a high proportion of recycled materials without harming in any way the functional properties of the building or without increasing the construction costs. The project covers all the traditional phases of construction. It begins with the planning stage and includes materials selection, specifications, etc. until completion of the building and the access routes. It will be built on CSTC experimental station site at Limelette (Ottignies - Louvain-la-Neuve) and will consequently be accessible at all times.

Ecological Single-Family House (Marjala) - Finland

Principles: Ecological compatibility, local materials

The aim was to develop and build a house that during its life cycle disturbs the processes of nature as little as possible, e.g. exists in harmony with nature. The house should be a simple and cheap basic house for everyone, still having good architectural quality and providing occupants good quality and flexible living spaces. The Marjala house [13] is built largely of wood and wood products using local products, simple technical solutions, repetition of same details and components, thus decreasing the number of different components. It gets its energy for heating and hot water from firewood and sun and achieves a heating energy requirement 42-50 % of that of eight reference houses. It is supplied with an owner's manual and service instructions for the next 50 years.

5.3 Factors influencing change

5.3.1 The challenge for construction

How can the industry transform the demand for sustainable development into an opportunity, to create and access new markets, find innovative responses which satisfy traditional industry demands and the new societal demands for sustainable development?

The challenge for the industry is to identify new and innovative practices, technologies and ways of working which satisfy the need for a modern, competitive, efficient, responsive and socially responsible industry. This is an enormous challenge; however, the achievement of sustainable construction will depend on the construction industry's willingness and ability to drive much of this change. It is evident from the examples of better practice presented in this report that many organisations have achieved new and exciting results from the innovative use of new and existing technologies, integrated planning and design, new partnerships and new ways of working. Yet it is also evident from the national reports that characteristics such as: conservatism; risk aversion; conflict and highly competitive trading environments, are common to many market lead and centrally funded construction industries with the consequential lack of change necessary to achieve a sustainable construction industry.

Typical concerns throughout the construction industry are common to many industries or sectors that are well established. Why should I change? What are the areas of risk and security? How can I profit and what will it cost me? Who are the key stakeholders in sustainable decision making processes? Which construction activities contribute or conflict with sustainable development? What are the market potentials and competitive threats? What should I do and how can I do it?

The examples of better practice presented in this report will provide stimulus and inspiration for many people. However, the following sections provide further direction, ideas and, perhaps, understanding about how different organisations can adopt sustainable construction practices and thereby contribute to sustainable development.

5.3.2 External drivers for change

There is considerable evidence to suggest that the dominant driving forces for sustainable development will remain external to the construction industry. It is likely also that they will remain politically orientated at local, regional, national and global levels. In global terms we will all be aware of the commitments made at Rio in 1992, HABITAT II and Kyoto in 1997. The decisions and commitments made at these summit meetings are already having an impact on national policy in terms of energy efficiency, habitat protection, pollution control and social provision. Initiatives more closely aligned with regional and local construction businesses include Local Agenda 21, another example of a key driving force for change. Whilst there has been little, if any, impact on business so far there is evidence that measures are being introduced to increase the integration of business into the principles and activities of LA21.

Such measures include [1]:

- setting up a representative, multi-sectoral planning body or "stakeholder forum" as the co-ordinating and policy group for developing and monitoring a long-term sustainable development action plan;

- implementing a consultation programme with community groups, NGOs, businesses, churches, professional groups and unions to identify proposals and priorities for action;
- setting up monitoring and reporting procedures that hold the local authority, business and households accountable to the action plan.

In Holland in 1989 the Environmental Council for the Construction Industry (MBB) was set up on the initiative of a number of organisations within the construction industry, with a brief to formulate a joint approach to environmental problems. The council consisting of representatives of construction industry associations and umbrella organisations is the main forum for consultations between government and construction industry on ways of implementing environmental policy in the sector. It monitors how well targeted approaches in the National Environmental Policy Plan are carried out by this particular sector. The Council also drafted in conjunction with government the Declaration of Environmental Targets for Construction and Housing in 1995 and has input into the National Environmental Policy Plan for the coming period, providing information and advice.

Participation in the Council can generally be taken as a willingness to reach binding agreements, whether they take the form of government regulations or self-regulation by industry.

An important factor that will affect how industry responds to sustainable development is the state of the nation. This could mean the wealth of a country, its economic and political structure, its position in the development cycle, its cultural heritage, national values and aspirations.

Whilst in the UK or the USA, we might see a market opportunity in selling longer lasting services rather than product, and valuing the ability to reuse and recycle materials, in Romania, the mechanism of recycling may be rejected because, reuse and recycling are still seen as signs of poverty and the "opportunity" which is highly valued is the increasing ability to afford new products. [Romania national report].

In Hungary there is the need to complete superhighways which form a vital international road-trading network. Yet in many countries with developed market economies, there is a move to integrated transport policies primarily targeted at reducing the use of cars and lorries. [Hungarian national report]

In South Africa, social equity is higher on the agenda than environmental concern. Therefore, more thought is given to the impact of construction on social and economic sustainability. In South Africa, for instance, the majority of the population is under the age of 25. The construction industry is thus geared towards job creation and more about labour intensive practices. This approach has obviously different objectives than the practice of system building in Holland or off-site fabrication in many countries such as the UK, Japan and USA. The move towards mechanisation and robotics is to improve quality, reduce cost and reduce construction times.

5.3.3 Possible strategies for change

The Greening of Industry report [2] lists four strategies for change which industry can take towards sustainable development:

- the defensive strategy,

- the offensive strategy,
- the eco-efficiency strategy,
- the sustainability strategy.

These four strategy definitions provide a useful framework on which to analyse the opportunities which might be taken by construction businesses. Cross-referenced with current examples it is possible to build a comprehensive picture of what sustainable construction might mean to different construction firms in different countries.

5.3.3.1 The defensive strategy - complying with regulation

This is a typical response from organisations in the construction industry where quality is largely governed by regulations. Typically, the cost of the environmental component in an industrial activity is counted as a cost of compliance with regulation and minimum standards. Often, the cost of non-compliance is the primary motivator to make improvements and so to reduce the environmental impact of industrial operations. For some the solution might be to find an environmentally less sensitive site or to conceal the impacts altogether.

Organisations motivated by predictability and security are likely to predominate in this approach. Organisations with a hierarchic culture are likely to concentrate on activities like systems that monitor performance and report outcomes. Market orientated organisations will take account of regulation as a matter of good judgement to minimise future risk of non-compliance.

Typically, in organisations that follow this strategy, there will be low levels of environmental awareness and understanding although there are some notable exceptions.

Undoubtedly there will be many construction businesses which continue to respond to change in this way and, unless there is a dramatic change in the construction industry as a whole, this confirms the importance of continuously developing regulations which underpin improved performance in the industry. It is likely that the market opportunities arising in this category will continue to be in the form of:

- specialist consultancy,
- systems development and monitoring,
- development of technologies for monitoring and remediation,
- environmental monitoring services such as pollution control, etc,
- development of regulations.

Four good examples of raising standards through regulation and codes from the Netherlands

1. The Dutch building codes rely on a performance base approach. At the present Building Decree environmental requirements are mainly focussed on energy saving and indoor air quality (asbestos, formaldehyde). For new buildings an energy performance standard was developed. This performance-based standard is formulated in such a way that the standard can be easily tightened (which happened in 1998 and is again scheduled for 2000). Policy is now to introduce in 2004 an energy performance

standard for existing dwellings and office buildings built before 1985. In 2010 this will lead to a total energy saving in housing alone of 30%.

2. Recently, the Building Decree was amended to incorporate also requirements pertaining to sustainable construction. Ongoing studies look at the introduction of a performance standard for the concentration of volatile organic compounds in indoor air and a performance requirement on water saving.

3. Plans are being made to introduce in the building codes an environmental performance standard based on LCA methodology. This approach will probably rely largely on the Dutch Ecoquantum model.

4. In order to facilitate the recycling and reuse of building and demolition waste an environmental law will be introduced in 1999 giving requirements and conditions under which recycled materials and industrial waste may be applied in constructions without causing undue soil and water pollution. The requirements pertain to limit values for leaching of toxic components during the use phase. Another law with the same general objective stipulates a ban on dumping of reusable/recyclable building and demolition waste. This waste should go to recycling plants for reuse in the building cycle.

5.3.3.2 The offensive strategy - beyond compliance

This strategy introduces, for example, the development of environmentally friendly products, or going beyond compliance for competitive advantage.

In the service sector particularly, the environmental component of a product or service can be portrayed as a market benefit, adding value for its clients and customers. Typically, organisations with a market orientation are likely to respond in this area. Improved quality and customer focus are key components required to move from a "defensive" strategy to an "offensive" strategy and these are in keeping with a market orientation. In the UK, quality and customer focus are also common components for the cultural change which is being sought as a result of the Latham review published in 1994 [3]. There is thus a close relationship between the requirements on industry to deliver improved environmental performance and the need to continuously improve commercial performance.

BREEAM [4] is an example of an environmental quality standard which has proved to add value and to provide market benefits for its users. The list of organisations which sponsored BRE to develop BREEAM in 1990 were predominantly market orientated organisations. The list included: Barclays Property Holdings, BBC, Cable and Wireless Plc, Jones Lang Wootton, Lloyds Bank Plc, Nat West Bank Plc, Prudential, Stanhope Properties Plc and DOE Property Holdings.

The quality standards required to achieve BREEAM ratings are above those required by law but achievable by designers and constructors. It complies perfectly with the approach which we could expect market-orientated organisations to take.

An interesting observation on BREEAM developments is that BREEAM is now specified for all new buildings commissioned by the UK Government and a growing number of local authorities. This has come about due to the increased political profile of environmental issues but also because the benefits of BREEAM certificated buildings are better known and more quantifiable.

The US Green Building Council have recently introduced a new American commercial building assessment method called Leadership in Energy and Environmental Design (LEED) This method rates the environmental aspects of a building and the behaviour of its occupants to arrive at a final score rated at Platinum, gold, silver or bronze.

Interestingly, the motivation for developing this scheme has also come from organisations throughout the buildings supply chain with a market perspective.

Two further examples from the USA of schemes which rate the environmental quality of products based on the eco-efficiency of operations are the National Fenestration Rating Council and the Smartwood Program of the Forestry Stewardship Council (FSC) both of which relate to the sustainability and quality of timber products.

Three further examples of assessment tools, developed by CSTB, come from France. INIES and EQuity are two complementary tools for assessing the environmental quality of buildings products and ESCALE is a method for assessing the environmental quality of buildings.

5.3.3.3 Eco-efficiency strategy

This strategy tries to identify win-win solutions by reducing environmental impacts and costs; it includes concepts such as total quality environmental management and industrial ecology.

This strategy goes one step beyond the offensive strategy and builds in a win-win outcome for supplier and client. There are examples of this response where supplier and customer collaborate to provide mutual benefit over and above the normally accepted contractual provision. However, to succeed, this strategy requires understanding and change on both the supply and demand sides.

"An important aspect of eco-efficiency strategy is its service provision" [2].

"Value enhancement must be sought through focusing on providing the service connected to their products to customers instead of selling as much product as possible" [2].

Sustainable development is built upon three pillars: economic growth, ecological balance, and social progress. Authors such as Dodds [1], Lovins [5] propose that industry's contribution to sustainable development come through "eco-efficiency". Getting more from less. Dodds [1] goes on to identify three components which are necessary for this strategy to succeed:

- eco-efficiency (systems and processes),
- leadership - which he describes as having vision, being proactive, transforming organisations and people,
- effective and innovative use of technology.

ISO 14000 - environmental management systems provide the basis of a management system which enables organisations to improve their environmental performance.

There are several examples of management systems that enhance the eco-efficiency of buildings and operations in the Operation section of Better Practices. Examples include:

- Barcelona - Glories commercial centre has installed a control and management system
- Facilities Management and Information System developed by CSIR in South Africa.

Successful "eco-efficiency" demands more than good environmental systems and processes. Successful "eco-efficiency" requires change management skills and new working practices, examples of which are emerging in the USA and UK construction industries as Partnering.

Partnering is a term which describes an approach to construction procurement which can (and often does) eliminate competitive tendering as part of the process. A partnership is built between customer and supplier(s) which can be strategic, i.e. set up with a long time horizon, or project-based (where the partnership is established for the duration of the project alone). Inevitably there is a process of comparison, often at the very outset of the process where clients make a selection of potential partners from a proposal or submission. However, selection criteria are a combination of cost, quality, approach, style and skill in partnering. There are three key elements which define "partnering":

- mutual objectives - shared by the partners on both customer and supply sides;
- problem resolution - where a process of conflict resolution is agreed at the outset of the partnership;
- continuous improvement - where partnership aims to learn and build its capabilities from one experience to the next. This element includes the process of evaluation, feedback and review.

Collectively, these three elements describe an approach to construction procurement which was encouraged by Latham in the UK and is being taken forward by the UK construction industry's Construction Industry Board (CIB).

QUEST (Quality Utilizing Employee Suggestions and Teamwork) is another approach to partnering and change management which has been developed by Interface Inc. in the USA. Here the company has launched an initiative to eliminate waste across the enterprise by harnessing the interest, skills and ideas of every employee. Waste is broadly defined by the Interface CEO, Ray Anderson, as anything that goes into end products that does not come out as value to the customer.

SKJ Companies of Finland have developed their business to include 1.4 million tonnes of by-products from the Finnish steel industry. SKJ Companies have activities in the fields of by-product treatment, product development and technology know-how which it exports to many countries including Russia and Eastern European countries.

The third component of successful eco-efficiency is the effective use of innovation and technology. This requires, not only technological advances, but an understanding of how the technologies relate to the needs and requirements of the users, their ability to use and maintain them and the pressures which these new technologies will bring to their normal modes of operation. The construction industry has experienced many failures which appear to be failures of technology. An interesting example is the "failure" of systems building in the UK during the 1960's, resulting in obsolete buildings and massive maintenance and repair costs. It could be argued that the technology was not at fault but that it was a lack of the skills and training for those who constructed the buildings which resulted in poor quality and faulty installations.

"Important improvements will result by matching an available technology with the appropriate application" - USA National report. A good example is reported in DOE study on a "Cool Communities" strategy applied in hot climates, e.g. in scuthen California. The implementation of lighter coloured re-roofs and resurfaced pavements and shade tress has been conducted. It was found that these measures can directly lower annual air conditioning bills in Los Angeles by $200M, cool the basin by 3degrees C, save indirectly $160M more in air conditioning and reduce smog by 10%, worth another $360M.

There are many examples from national reports that exemplify the use of new and innovative technologies. Many are being integrated into existing buildings and many are providing completely new possibilities of performance and control.

A typical example is the:

Thermal Photo voltaic building, Pompeu Library, Mataro, Barcelona - has been designed to reach an optimal balance between energy saving, comfort, lighting, aesthetic and economy. The building incorporates semi-transparent, multi functional, photovoltaic modules formed out of policrystalline silicon cells installed in the facade. The building gives and receives energy from the electricity supply network. Another aspect of solar power is the use of hot air obtained from the chamber formed between the solar modules and the transparent glazed wall. This thermal system allows a power saving of 30% on preheating the air in the conventional heating system.

Other examples include:

- PLEIADE - low energy house - demonstration project - Belgium
- "Internet" Office and Eco-house, Lough Derg - Ireland
- The active intelligent window - Italy
- The OM Solar House - Japan
- The Barn, Kuthumba Nature Reserve - South Africa
- The Oxford photovoltaïc House - UK

Key components required to move from the offensive to the eco-efficient strategy include: the valuing and costing of environmental impacts; and identifying and valuing the full cost of development, over time, for all stakeholders.

An excellent example of an eco-efficient approach was a carpet manufacturer in the USA who contracted to provide a "carpeted area" throughout a building for an agreed period of time and to take back the carpet at the end of its useful life, when it would be recycled.

The key step towards environmental improvement in this case was the provision of a service, rather than sale of product. Benefits included:

- for the client - quality products appropriate to location, elimination of waste materials, maintenance free provision, free replacement in heavily trafficked areas leading to consistent image and condition;
- for the supplier - long term contract, reduced waste, reduced manufacturing costs using recovered carpet material, improved environmental management performance.

5.3.3.4 Sustainability strategy

This strategy focuses on new and emerging partnerships between business and other stakeholders. This is the most advanced strategy, requiring an understanding and tolerance of complexity. It is likely that this strategic response will be achieved through decision-makers adopting new values that reflect the aims, objectives and aspirations of sustainable development. For businesses used to short time horizons with defined, discreet client groups and markets, the risk of including and responding to the range of stakeholders and potential "clients" may be too high. What shape might the sustainable business take? What shape might the sustainable business opportunity take? From a range of policy research projects, there are indications that sustainable business will be more holistic, systemic and integrated [6]. Core values are likely to include [2]:

- "Wholeness" - understanding and accepting the system relationships between industry behaviour and its impact (usually known as the externalities in economic theory). This means taking responsibility for the impact of the business, so recognising that businesses do not operate in isolation to their surrounding environment. This approach leads to a shared responsibility and unity between the business and its community.
- "Care for future generations" - where a "future generation" representative may be included in the boardrooms of industry to challenge their time horizon for decision making, requiring more emphasis on whole life costing and long term impacts. The business takes responsibility for the impacts of its process but extends this over time.
- "Smallness" - utilising small work teams, defining responsibility at the lowest level possible, requiring an ability to attend to detail "at the coal face", with increased ability to respond flexibly and innovatively.

The change from eco-efficient to sustainability strategy poses, perhaps, the greatest challenge to construction businesses. However, there is evidence to suggest that changes are taking place at community level in terms of long-term, multi-faceted integrated planning and within the industry itself in terms of new approaches to value management, partnerships, shared ownership, shared risks and benefits.

At community level there are many examples from the national reports which document initiatives considering the long term environmental and community impacts of commercial developments:

- Ecological criteria for experimental construction - Finland
- Le Clos des Vignes - France
- Urban planning, Saline - Italy
- Environmental symbiosis and NEXT 21 projects, Osaka - Japan
- Leidse Rijn, development of a new medium sized town - Netherlands
- Holy Island Retreat - UK
- Planned unit Developments - USA
- Traditional Neighborhood Development - USA

The South African report reminds us of the indigenous knowledge which exists in many communities and how these communities have lived in harmony with their environment for generations. The report also reminds us that Indigenous knowledge, whilst systematically devalued and suppressed, can offer valuable insight and guidance on drought resistant crops, new medicines and designing more sustainable settlement patterns which incorporate the use of appropriate technologies. The concept of - *umunta wabantu ababantu* - literally translates to "a person is a person because of other people".

Within the construction industry there are developments taking place to increase the time horizon of decision-makers and include wider criteria for consideration.

Two procurement protocols emerging in the UK which provide the framework for long term relationships between client and supplier are Design Build Finance and Operate (DBFO) and Private Finance Initiatives (PFI). Both of these practices are employed, in the UK construction industry, to give better value to customers and ensure that their requirements are accurately represented. Whilst commercial benefit is the main motive for using these approaches the results are a higher level of client satisfaction, less conflict between the client and the supplier and a better product which requires less maintenance and repair through faulty workmanship and inappropriate specification. They are providing opportunities for a more socially responsive and eco-efficient approach to development.

A recent example in the UK is where a Joint Venture project team bidding for a privately financed school project has included a provision for environmental management and the development of teaching materials which can be integrated into the curriculum of the school. Thereby following the principle of adding-value for the client by utilising good environmental management practices and the innovative use of skills and knowledge to provide an educational resource for the community.

Whilst the examples presented here are based on UK practice there is every evidence to suggest that this approach will be an important mechanism for development and redevelopment in many market and transitional economies. The principles can be widely applied.

The management technique called Value management provides the basis of an approach that is applicable to many decision making levels in sustainable development.

Value Management focuses on producing a better definition of the client's requirements. Value management should not be confused with value engineering which can be described as the provision of function at least cost. Value management requires that a careful analysis of "need" be carried out. Here all possible requirements of a client are considered prior to commencing the normal procurement process (i.e. design, pricing, detailed design, construction). The benefit of this is that the full range of skills can be applied to finding solutions for the client. Priorities are defined - in terms of value and importance - and then design, procurement and construction solutions are applied to deliver those priorities throughout the development process. The structure allows for review and the introduction of changing priorities occurring during the process. Value Management is particularly applied to projects with high value and high strategic risk.

The key stage in Value Management is the beginning where, usually in a facilitated workshop environment, the customer and supplier teams combine to:

- share aims and aspirations,
- share values and identify priorities,
- identify shared and individual benefits,
- define decision making protocols,
- set and agree strategic objectives,
- set and agree means of measurement of success, and establish the partnership.

5.4 Conclusion - mechanisms for achieving change in future construction markets

Whilst the demand for construction will continue the broadening of societal values and interests challenge the motives and values which have previously driven growth and development and which have previously defined industrial success.

Therefore sustainable development, from a construction industry perspective, undoubtedly means change. For an industry which is inherently defensive the prospect of, and opportunity for, positive change is not always apparent, particularly in the context of the complexities of sustainability.

Whilst for many construction businesses, eco-efficient and sustainable strategies may well appear to be impracticable and too far from their current trading reality, there is evidence from the UK and USA construction industries that procurement strategies such as Design Build Finance and Operate, Private Finance Initiatives, Partnering and Value Management are providing a platform for the development of working practices which go some way towards achieving these strategies. In Holland where a higher level of community responsibility is acceptable in business the response has been to issue standards of sustainable construction to which the whole industry can respond. In South Africa the opportunity is there to create sustainable developments from scratch, using the indigenous knowledge of sustainable communities. In transitional economies such as Romania there is the demand for new and previously unavailable goods.

The industry will have to adapt to these new and emerging construction markets which have environmental and social dimensions. Construction businesses will be expected to integrate into, and consider more fully, the issues valued by others at national, regional and community level where the driving forces will be a mixture of political, social and market forces, requiring products which respond to genuine need and concerns.

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6. CONCLUSION

Sustainable construction should be an important component of creating a sustainable development. However, no clear consensus on the exact meaning of such a concept seems to be agreed today. This W82 Project aimed at contributing to reaching such an agreed clear vision of the future of construction within a sustainable development assumption.

At the moment, the Project led to a set of fourteen national reports and an international synthesis, gathered in this CIB Publication, which contain:

- the identification of the issues, constraints and currently followed policies in the involved countries in the field of sustainable construction;
- the identification of the foreseen changes and mutations for the construction sector in these countries through answers given by experts on five main questions;
- the analyses of the consequences of sustainable development for the phases of the construction process;
- the identification of main strategic recommendations to be given in these countries to the main driving actors of the construction sector;
- an illustration of best practices through some case studies, design methods, buildings or building products.

The main goal of the present international synthesis was to extract main issues from the national reports, to detect the common ones and to stress the main differences (in scenarios, consequences, recommendations to actors...).

The next step should be to reach a more consensus vision through a global common model (with of course eventually items specific to regions or countries) and to set up indicators and policies to translate this vision into reality.

REPORT 1

SUSTAINABLE CONSTRUCTION IN BELGIUM

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NATIONAL REPORT

CONTENTS

1. THE FRAMEWORK: THE POLITICAL AND SOCIAL SITUATION IN BELGIUM

Belgium became a real federal state in July 1993, divided in three regions, Flanders, Wallonia and the City of Brussels. However, the regions have been responsible for their own environmental and building policy and legislation, since the eighties. Due to different political accents and due to distinct geographical difference the demand and supply of recycled materials varies from one region to the other.

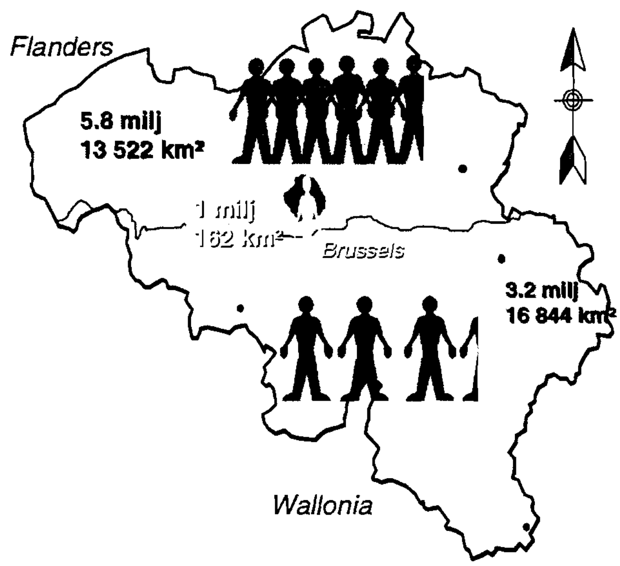

Figure 1: Map of Belgium

Flanders (13,512 km²), which is situated in the North of Belgium, has a very high population density of 422 inhabitants per square kilometre. Nearly no natural aggregates are available.

Brussels, i.e. the urban region of the city of Brussels, is the smallest (161 km²) of the three regions and counts 6025 inhabitants per square kilometre. No quarries and dump sites whatsoever are available.

The third region, Wallonia, is situated in the south of Belgium and has a population density of 190 inhabitants per square kilometre. A large number of quarries are dispersed over the territory.

2. THE CONSTRUCTION INDUSTRY IN BELGIUM

In Belgium the construction industry contains mainly SME's. On a population of 10 milj. people, there are 67 000 construction companies. 80% of them have less then 10 collaborators. They have an over all turn-over of 940 bilj. BEF (24 000 milj. ECU). Yearly some 40 000 residential buildings are constructed; 6 000 non residential.

A very typical phenomenon is that private construction is very predominant in Belgium: only 5% is social housing; 75 % of the buildings are inhabited by the owners.

The construction industry in Belgium has a collective research centre (BBRI, Belgian Building Research Institute), offering the technical support for the sector. Every construction company is a member of the BBRI.

3. SUSTAINABLE CONSTRUCTION IN BELGIUM: ACTUAL SITUATION AND PERSPECTIVES

3.1 Town and country planning - Urban development

3.1.1 Introduction : the historical context

The authority concerning town and country planning is nowadays a regional one. The three regions Flanders, Brussels and Wallonia have therefore developed, or are in the process of developing their own policy and legal instruments.

The legal basis for urban and country planning was in most regions until recently the national law of 1962 on urban development and country planning. In the seventies 48 sector plans ("gewestplannen-plans de secteur") were installed in which regulatory aspects of town and country planning are described. The division of the Belgian territory into 48 sectors was based upon regional, socio-economical and geographical data. In the sector plans (25 for Flanders, 22 for Wallonia and 1 for Brussels) zoning schemes for land allocation were defined taking into account the economical and social needs of the different sectors and considering the necessity of transport infrastructure. A difference was made between residential areas, green areas and areas for agriculture, industry, etc.

On a more local level municipal general plans and special plans for construction ("algemene en bijzondere plannen van aanleg - plans particuliers d'aménagement") were defined. A general plan for construction should describe in detail the land allocation of the total territory of the municipality. The special plans for construction contain the urban development and technical prescriptions for the different zones of the municipality.

3.1.2 Regional developments

Most of the principles of the former national town and country planning legislation have remained current in the regional policies. However in the near future some important changes are expected.

3.1.2.1 Wallonia

The Walloon code for town and country planning, urban development and the patrimony (the CWATUP, i.e. the "Code wallon d'aménagement du territoire, d'urbanisme et du patrimoine") is at this moment being reviewed. This code, which was based upon the national legislation, allows the regional government to edit urban development regulation in order to safeguard the health requirements, the structural stability, the beauty and the safety of buildings, installations, infrastructure and their accessories. At the same time this code makes it possible to take measures which affect unoccupied dwellings, the thermal and acoustic qualities of buildings, the energy use and energy recuperation.

A very important order implementing these possibilities relates to the regulation concerning the thermal isolation and ventilation of buildings. The measures which were originally defined in art. 322/1 to 8 of the Code, were recently modified by the Walloon Government order of February, 15th, 1996 and the Ministerial Order of February, 15th, 1996. In these documents the thermal isolation coefficient was reconsidered for new dwellings. At the same time the scope of this regulation was broadened from new constructions to transformations and reconstruction's of dwellings and offices and to school buildings and accommodation buildings in general. Requirements concerning ventilation were also indicated. A summary of the requirements is indicated in table 1.

Real estate	*New construction*	*Transformation of a construction with a change of use*	*Transformation of a construction without a change of use*
Houses and dwelling buildings	K55 or Be 450 + k_{max} values	K65 + k_{max} values	k_{max} values
School buildings and offices	K65 + k_{max} values	K70 + k_{max} values	k_{max} values for windows and renovated opaque facades

Table 1: Thermal isolation and ventilation in Wallonia (since 1996)

(K value indicates the global thermal insulation quality of buildings as defined in NBN B62-301, the Be value is an estimate of the net energy needs for heating taking into account the solar and internal heat gains and is calculated by a regulated method published in the Moniteur Belge of April 30th 1996, k_{max} must be calculated following NBN B62-002)

The Code CWATUP is now under revision. The draft Order modifying the CWATUP, approved by the Walloon government in April 1997 and currently under investigation at the Walloon parliament, states that the public authorities should manage the Walloon territory in order to meet in a ***sustainable*** way the social and economic needs of the collectivity *"par la gestion qualitative du cadre de vie, par l'utilisation parcimonieuse du sol et de ses resources et par la conservation et le développement du patrimoine culturel, naturel et paysager"*. This general goal can afterwards be realised by adapting amongst others the sector plans, the municipal (general and special) construction plans and the allotment prescriptions. The introduction of a regional Walloon plan for town and country organisation, formerly known under the name "Plan Régional d'Aménagement du Territoire pour la Région Wallonne (PRATW)" and now entitled "Schéma de Développement de l'Espace régional (SDER)", is considered as another interesting tool for implementing these objectives.

Interesting to note is that measures are foreseen to counteract linear infrastructure and uncontrolled urbanisation. In future a new urban or residential area would only be accepted in sector planning if it is situated besides an existing urban or residential area already under development. To develop linear urban or residential zones along road infrastructure would become impossible. It would also be very difficult to institute urban or residential zones in areas which have been identified as crucial regarding the protection of the patrimony, nature or ground or surface water or where there is a danger of flooding, landslide, etc.

3.1.2.2 Brussels Capital Region

The sector plan for Brussels, realised in 1979, was originally intended to protect the weaker activities (housing, workshops, trade and equipment) and the architectural and urban characteristics of the different areas and divided Brussels into different areas. In this sector plan a distinction was made between typical residential areas, mixed residential and company areas, administrative areas, company areas with an urban character, industrial areas, green and rural areas and areas for equipment for the common good or for public services.

The Regional Development Plan ("Plan Régional de Dévelopement (PRD)") and the Regional Zoning Plan ("Plan Régional pour l'Affectation des Sol (PRAS)") are two important tools used by the Brussels Capital Region to realise a sustainable development of the city. In the first plan, i.e. the PRD, the objectives of the political majority concerning town and country planning are described. The second one, i.e. the PRAS, which still has to be finalised, will become the regulatory reference for land occupation and will therefore replace the sector plan of 1979.

The PRD and the PRAS were installed in order to assure a well balanced development of the capital area in terms of population growth, economic growth and industrial and administrative activities. The objectives of the PRD are *"to design a pleasant city, in which it is good to live and to work, where the socially weak are protected, and where the ambitions of the economic strong are encouraged and managed"*. One of the instruments used is the definition of areas, called perimeters, where certain activities like housing, industry, trade and transport activities are promoted or protected.

Regarding urban development the Brussels Capital Region is drafting a regional regulation, called "Projet de Réglement Régional d'Urbanisme". At the moment 5 parts of this regulation are prepared and discussed :

- *Part I : Characteristics of the constructions and their immediate surroundings*
- *Part II : Standard necessities for dwellings in terms of surface, hygiene, equipment, etc.*
- *Part III : Nuisance due to the realisation of works and conditions for running construction sites*
- *Part IV : Accessibility of buildings for disabled persons*
- *Part V : The thermal isolation of buildings*

With respect to the thermal isolation of buildings a distinction is made between buildings used for housing (dwellings) and office and school buildings. Different requirements are placed upon new construction activities and renovation or transformation activities. The requirements, based upon the NBN B62 series, are summarised in the following table 2.

Real estate	*New construction*	*Transformation or renovation*
Houses and dwelling buildings	K55	K 55 + 10 A_T/s
School buildings and offices	K65	K 60 + 10 A_T/s

Table 2: Thermal isolation in Brussels (under preparation)

(K value as defined in NBN B62-301, A_T is defined as the heat loss surface of the building and s is defined as the sum of the surfaces through which heat loss can take place and which are transformed or renovated)

3.1.2.3 Flanders

The country planning in Flanders is also based on the National Law of Urban and Country Planning of 1962 and has combined with national planning laws originally created in the 70's. Both these lawful means are limited until a passive support comes from the administration. A request for a building permission is given on the basis of the marked zones, or the destination, or delivery, or refused.

In the near future the phases will change and must come via the realisation of the Country Planning. On 24 July 1996 the structural planning in Flanders announced the basis for the inspection of the so named planning decree. The structure planning has therefore stated the whole ground territory of what must occur for the three existing government levels, the Region, the Province and the Community. Following the decree, country structural planning falls into three divisions (one informative, one directive and one for binding the authorities) which together give a communal vision of the SPATIAL future of an area. It is important that they have a direction and do not give up therefore producing no immediate arguments which could inhibit the delivery of the permission. The have one forceful ability to cast over the authorities, and that is that their direction lies fixed in export conclusions.

The project of Country Structural planning in Flanders is working together with the planning decrees of the Flemish Government approved from the 1 December 1996 until 28 February 1997 on a Public Research Submission. The plan is for the intended spatial structure of Flanders containing the vision of this structure over a period of 10 years (till the year 2007). The basic principles are :

- concentrated bundling, this is selectively concentrated on the growth of living, working and social functions in the cities and centres.
- the protection of open spaces
- the revaluation/preservation of the city texture/fabric

One essential difference between the four structural components is the definition of the city areas, the outer areas, the areas for economic activity and the line infrastructure. For each of these components there is a basic target which is aimed to consistently achieve durability and quality:

- First and foremost is the striving towards a selective *out building* in city areas. This means that the optimal use is made of the existing city structures.
- Secondly the outer areas are strengthened against further subdivision through the combination of living and working in the villages.
- Thirdly is the aim to selectively concentrate economic activity
- And finally the existing traffic and transport infrastructure should be optimized so that the use of community transport can be maximized and increased

In September 18, 1991, a decision on minimal requirements on thermal insulation for habitations and Flemish public buildings was taken. This regulation is based on the specification NBN B62-301(table 3).

Real estate	*New construction*	*Transformation of a construction with a change of use*	*Transformation of a construction without a change of use*
Houses and dwelling buildings	K55 k_{max} values	k_{max} values	k_{max} values

Table 3: Thermal isolation and ventilation in Flanders (since 1992)

(K value indicates the global thermal insulation quality of buildings as defined in NBN B62-301, k_{max} must be calculated following NBN B62-002)

3.2 Mobility and infrastructure

The high population density and a dense road network, especially in Flanders and Brussels, did put mobility to a high priority for public authorities. In Flanders, this resulted in the start of a mobility policy. The Brussels region is, in mobility matters dependent on Flanders, as Brussels is completely surrounded by Flanders. An important part of the Brussels ring is situated in Flanders.

April 96, a mobility agreement was approved by the Flemish government. From that moment, Flanders possess a framework for a mobility policy, where the responsibility is shared between the Flemish authority, the community and the exploitation company for buses. This framework concerns the construction of new roads, the improvement of the public transport, etc.

The exit point from the mobility covenant is the planning and multi modal hold of the Flemish mobility problem. Such covenants hinder the financing of particular projects of the Flemish Authorities, where no existing initiative and engagements of the community interfere (for example location, administration, remnants of old past ways, take-over of an old past way, through streaming facilities and so on). For the advantages of modular build-up to be seen, the local authorities are obliged to be held to a particular term after the signing of the “mother covenant”, a proposed mobility plan. The mobility plan, within the set framework, will result in action, and then different “export agreements” can be taken up.

3.3 Quality of dwellings

Outside the isolation and ventilation regimentation in the framework of the city buildings, expert planning exists, and recently initiative has been taken to define a minimal quality for sections of buildings. On 6 April 1995 a decree in Wallonia was created wherein a permission to rent was created and where a number of quality norms were defined, though only applicable to particular types of buildings. In fact, it was envisaged that small units (less than 28 m2) would occur where in the three living functions (cooking, living and sleeping) occur. The decree applies only to buildings older than 20 years and has no reference to student quarters.

Also in Flanders in the beginning of 1997, a design for the Flemish Living Code was created. A few minimal qualities for living were defined, with the intention of giving everyone the chance to have a safe, healthy and affordable dwelling, in decent living surrounds. Dwellings not within the minimal quality norms are declared unsuitable or unliveable. Dwellings for rent will be gradually required to complete a “conformity attest.” This means that the living code will be regulated and a number of social dwellings will be improved. In this framework the Flemish Government has already begun to develop a strategy for addressing abandoned buildings and hovels in 1996.

3.4 Environmental management planning

3.4.1 Wallonia

The Wallonian Region targets sustainable development through a large number of regimentations and laws. A short explanation is given in table 4 below :

Subject	Objectives	Plans	Information
Environment	"Plan d'Environnement pour le Développement Durable (PEDD)"	• Walloon Waste Plan "Horizon 2010" • Water • Nature • Air • Soil	§ 3.4.1. § 3.6.4.2.
Landscaping	"Schéma de développement de l'espace régional (SDER)"	Sectorial plans	§ 3.2.2.1.
Energy	"Programme de réduction des émissions de CO_2"	Political declaration on energy	

Table 4: Planification in Wallonia

The "Plan d'Environnement pour le Développement Durable (PEDD)" is dated 9 March 1995 and is intended to clarify and implement the Action Plan Agenda 21. In June 1992 it was introduced and affirmed by the Conference of the United Nations of Environment and Development. Therefore the PEDD will direct the activities, influencing the quality of the environment.

In the PEDD there is thus a long term vision to carry out the development of environmental politics. The foremost intention of the PEDD is to form on a co-ordinated realisation between the different objectives, actions and mediums that have a relationship with the different environment compartments. Then together, specific action plans can be formulated. The stimulation of a preventative movement is evolving from the concerned parties such as authorities, industry and so on. The polluter pays principle is also emerging.

The PEDD has formulated a number of aims, with over 257 proposed actions. They can be broken down into **sector** dominations (agriculture, industry, transport, energy) and **thematic** dominations (water, waste, etc.).

3.4.2 Flanders

In Flanders, similar plans are being and have been instigated. The first of these was the MINA-plan of 1989, followed by the Environmental Administration Plan and the Nature Development Plan for Flanders, intended for 1990-1995. The 1996 Environmental Projects Administration Plan 1997-2001 (in short MINA-2) undertook to see that a durable sustainable environment and nature administration was developed.

In 1996 it was intended that the Environmental Administration was precisely and unequivocally confirmed in a decree. In particular the Flemish Parliament is involved in the environmental administration in Flanders with three targets : the management of the environment, the protection of the environment, nature preservation and ordering of the biological and landscape diversity. Precise definitions are :

- the management of the environment through the protection of ground cover and nature
- the protection of people and the environment against pollution; and in the special case of the ecosystem which is important for the working of the biosphere and the relationship of food provision, health and other aspects of human life
- the average quality of the environment in the surrounding lands
- loss of nature and environmental damage

Important environmental problems, such as the thinning of the ozone layer and the greenhouse effect, function as themes. Targets are proposed, the administration forms a strategy and intended actions are confirmed and carried out. An important new element in the environmental administration is equal relationships with a specific **target group administration,** that the authorities in the future will work out. The group is one of the 9 target groups where an agenda exists. The agenda point currently being considered which has not be achieved yet is the increase of environmental effects following construction activities.

3.5 Soil remediation

Previously, it was only in **Flanders** who had specific rulings in relation to ground sanitation. The ground sanitation decree of 22 February 1995 and the following detailed conclusion "VLAREBO3 (the Flemish ruling concerned with ground sanitation) have unmistakably had a great impact, also in the construction sector. In many construction enlistments people are frequently confronted with ground resistance, that otherwise only occurs in a risk free situation with ground pollution.

The decree is divided between historical, new and mixed ground pollution. *Historical ground pollution* is that which occurred before 29 October of 1995 , the date of the establishment of the decree. *New pollution* is dated after and the date for mixed pollution is after and before 29 October 1995. The jurisdiction of this authority is most important, as seen from the new ground pollution, automatic sanitation would then become a sanitation norm. Historical ground pollution will continue until sanitation is standard, indeed the pollution is a serious problem formed for the people concerned with the environment and indeed for the authorities. In conclusion it is clear that a definition must be made between sanitation and those answerable for the costs incurred in further sanitation.

In the **Brussels Region** is recent times there has been the intention of creating a specific legal framework for the protection of the soil. Momentarily people here must appeal to the law makers for advancement until the environmental permission (Ordinance of 30 July 1992 and within a short time the ordinance of 5 July 1997) is instigated. This will state that the permission borrowing authority has the absolute power to return the terrain in the city back to its original state. The Brussel's Waste Law has this power also in a particular number of cases, for example in the disposal of contaminated ground.

Like in Brussels, the people in **Wallonia** have recently begun with defining law establishment. Until now they worked very much with clauses from the regimentation concerning the exploitation permission (see ARAB-RGPT, an integrated environment permission not yet standing in Wallonia; awaiting work with apart exploitation and dump permission) and out of the waste disposal law establishment. Important to mention is the existence of a law concerning "la renovation des sites d'activité économique désaffectés." This law establishment is in fact a fill in under CWATUP (See §3.2.2.1.) and consists of a number of rules concerning sanitation of almost collapsing or abandoned industrial buildings. The sanitation is here greater defined to the sanitation of the ground only, and meaning the possible later use of the reintegration of the site in the built area.

3.6 Energy

Energy troubles are more related nowadays with environmental aspects than the economical arguments of the 70's and 80's. The European CO_2 guiding principal forces all countries to go ahead with further measures in the area of rational energy use. This is a more applicable form of energy use winning more and more thought as an alternative. In Belgium, the European agreements were made concrete in the "Nationaal Belgisch Programma ter Vermindering van de CO_2 -uitstoot-Programme National Belge de réduction des émissions de CO_2" , that was approved in June 1994 by the federal and the regional authorities. The goal was to reduce the national CO_2-emissions in 2000 by 5% compared with 1990.

The Interministerial Environment Conference of June 1996 decided it acceptable to extend the goal also after the year 2000 under the same conditions and proposed that before the end of 1999 a national leading program with additional measures should be started.

3.7 Construction and demolition waste : State of the art

3.7.1 Introduction

The first construction and demolition waste recycling plant in Belgium started to operate in the 50's. However, the recycling industry was only developed on a broader scale from the seventies onward amongst others due to scientific and technical research. This lead in the beginning of the eighties to one of the most important pilot projects in Belgium, i.e. the construction of the "Berendrecht" lock nearby the Antwerp harbour with recycled concrete produced with recycled aggregates coming from the demolition of the old "Zandvliet" lock (2).

Since then, recycling became more and more a "hot" topic. Nowadays about 90 recycling plants are operating all over the country and can be classified into fixed plants, mobile installations with a fixed location and mobile installations. About 75 % of all the installations belong to the two first categories. The most advanced installations are generally composed of the following elements: a weighing bridge, equipment's for pre-processing (bull, crane, ...), a preliminary sieve to eliminate earth, sand and gypsum (finest materials), a primary crusher, electrical magnet systems, a sieve installation to separate the materials in accordance with the size of the obtained materials, an air sieve or a washing installation and a secondary crusher and sieve installation.

Far the largest part of the recycled aggregates are used in road construction. In addition to the re-use of crushed asphalt this sector takes the crushed concrete and mixed aggregates for use as unbound base-course and sub-base material. The mix material, and to a lesser degree the sieve and crusher sand, is also used in earthworks and raising. These materials are already for some years used as aggregates for treated or stabilised sand and lean concrete produced at mixing installations situated besides the recycling plant. Albeit the processing of masonry rubble is relatively cheap, the market for crushed masonry aggregates remains limited. Therefore, recycling plants may refuse to accept masonry rubble, which leads to the inevitable low-grade, unprocessed application of this inert material.

3.7.2 Amounts of waste materials and recycled products (3)

The production of C&D waste in Belgium is estimated at 8 million tons per year of which about 3.6 million tons/year are processed (i.e. 45 % recovery of C&D waste). This represents approximately 6 % of primary aggregate consumption. However, there are some slight differences between the regions in terms of composition of C&D waste and recycling level (4)(5)(6).

3.7.2.1 Flanders Region (3)(4)

In Flanders, the production of C&D waste was estimated in 1990 at 4.6 million tons per year. A study has shown that approximately 41 % of the waste consists of concrete, about 40 % of masonry and the remaining 20 % is a mixture of bituminous materials (12 %), ceramics (3.4 %) and various other types of waste. In 1990 it was estimated that about 2 million tons C&D waste (43 %) were being recycled a year. At the moment, the level of recycling increased already up to 65 % which represents 3 million tons a year. For 2000, 75 % recycling is expected.

These relatively high figures can be expected taking into account the lack of natural resources. For the moment there are about 80 recycling installations (crushing facilities) for C&D waste in operation in Flanders with a total capacity estimated at 5 million tons per year. At the same time, the high population density, i.e. 425 inhabitants per km^2, limits the capacity for dumpsites.

3.7.2.2 Brussels Capital Region (3)(7)

In Brussels, the production of C&D waste was estimated at 850,000 tons per year. In comparison with Flanders, a larger part of masonry rubble is present in the stony materials fraction. Selective demolition has the priority in the Capital Region since there is no landfilling capacities or recycling plants. Although the purpose was to reach a recycling level of 70 % back in 1996, currently only 50 % is processed in Flemish recycling plants in the neighbourhood of Brussels. The remaining 50 % is reused without processing as on-site fill or for landfill engineering.

Private investors are however planning to start up a brand new recycling facility on the Brussels Capital territory. This should in the near future lead to higher quantities of "real" recycling.

3.7.2.3 Walloon Region (3)(5)

In Wallonia, the production of C&D waste is estimated at 2.6 million tons per year. As the Walloon Region has a relatively low population density of 190 inhabitants per km² and a large number of quarries, the interest for recycling was until recently rather limited. However the environmental concerns motivated the Walloon Government to take some initiatives in the beginning of the nineties in order to develop the recycling industry. At the moment this has resulted in the creation of 30 special dumping sites, called "Centres d'Enfouissement Techniques" or CET, and 10 recycling plants, which process about 650.000 tonnes of C&D waste a year.

3.7.3 Information about the recycling industry

The average cost for a demolition contractor for waste disposal at class III dumpsites varies from about 5.75 to 16 ECU/ton, this is excluding transportation costs (see Table 5).

- In Flanders tipping costs for construction and demolition waste are 6.5 ECU/ton upon which an environmental tax of 9.5 ECU per ton has to be added.
- For the evacuation of its waste Brussels has for the moment to rely totally on the recycling and dumping possibilities offered in Flanders and in Wallonia. As already indicated, the Brussels Region doesn't dump the mineral C&D rubble anymore.
- In Wallonia tipping costs are typically in the range of 2 to 7.5 ECU per ton. An environmental tax of 3.75 ECU per ton adds on to this.

In contrast with this, the recycling plants try to promote selective demolition by using different delivery tariff's for mixed and clean material. Average prices for delivery at recycling plants are given in following Table 6.

Tax for landfill			
	Flanders (1995)	*Brussels*	*Wallonia (1994)*
Tipping costs class III (1995)	6.5 ECU/ton		2-7.5 ECU/ton
Environmental tax (1995)	9.5 ECU/ton	no dumpsites	3.75 ECU/ton
Sum	***16 ECU/ton***		***5.75-11.25 ECU/ton***

These prices are transportation excluded

Table 5: Tax for landfill in the three Belgian Regions

Average prices for delivery at recycling plants	
concrete	free of charge
reinforced concrete	1.25 - 2.5 ECU/ton
heavily reinforced concrete	6.25 - 12.5 ECU/ton
masonry	2.5 - 6.25 ECU/ton
mixed rubble containing plastics, wood	2.5 - 12.5 ECU/ton

Table 6: Average prices for delivery of C&D waste in recycling plants

Most of the C&D waste is processed by the recycling companies into secondary aggregates. The market for secondary aggregates can be summarised as follows:

- Concrete aggregates 80/200 find their application in hydraulic works as filling material for river embankment protection (limited market).
- Concrete aggregates 0/80, 0/56, 0/40, (4/32) with a continuous particle size distribution are the bulk of the production and are mainly used in road construction applications (as sub-base and base material). They are also used for landfilling and for the realisation of unhardened parking areas. In some instances, the material is split in a 0/20 and a 20/40 fraction for example and may be recycled as aggregates in lean concrete. A limited number of recycling plants have a concrete mixing installation using typically a 4/32 fraction for their concrete production (a 100 % substitution of the coarse aggregates by recycled aggregates is in this case of application). The market price of this kind of aggregates is about 5.75 to 6.5 ECU/ton (i.e. about 2.5 ECU/ton below the price of natural aggregates).
- Sieve and crushed sand is mainly sold as sand for pavement sub-bases or for the construction of embankments. Recycling plants having their own mixing installation produce also cement treated or stabilised sand with these products. The market price for this product ranges from about 1.25 to 2.5 ECU/ton.
- In some areas, crushed masonry 0/56 can be used in the private sector for landfilling and unhardened parking areas. The market price lies then around 3.75 ECU/ton. In most cases, however, mixed aggregates consisting of crushed masonry and concrete are used in unbound or bound applications as sub base or base materials. The

market price for these mixed aggregates is slightly lower than the price for crushed concrete and amounts to 5.25 ECU/ton.
- Recycled asphalt aggregates are recycled as base materials for roads and parking areas and reused in new asphalt. The market price is in the range of 3.75 to 5.75 ECU/ton.

As clearly illustrated, it is at the moment the road sector who gives the greatest outlet for recycled aggregates. However, as Belgium has already one of the most developed road infrastructures in the world, roads are mainly renovated and none are constructed. As a result of this the consumption of recycled aggregates in this market is stagnating. Therefore, the recycling industry has a clear need to develop new products or applications for the recycled aggregates in general.

3.7.4 Policy

As a result of the constitutional changes in the three regions, Flanders, Wallonia and Brussels, are taking into account some exceptions, entirely responsible for the formulation of the waste disposal policy. In particular the responsibility to draw up waste management plans has fallen under the authority of the regional administrations "Openbare Vlaamse Afvalstoffen Maatschappij (OVAM)" for Flanders, "Institut Bruxellois pour la Gestion de l'Environnement/Brussels Instituut voor Milieubeheer (IBGE/BIM)" for Brussels and "Office Wallon des Déchets (OWAD)" for Wallonia.

3.7.4.1 Flanders

The Flemish public institute OVAM was founded in 1981 and is responsible for the stimulation of prevention and recycling of waste. The management of C&D waste is based upon:
- the Waste Decree of April, 20th, 1994, in particular article 11 in which the definition of a clear regulation for the utilisation of secondary materials is made possible;
- the application order of this decree concerning hazardous waste for the hazardous fraction of C&D waste;
- the application order of the waste decree “VLAREA” concerning the prevention and the management of waste, approved in June 1997 by the Flemish Government and regulating the use of waste as secondary materials (8). This document is particularly relevant for the construction industry, as it contains a list of waste materials (C&D rubble, etc.) which are recognised as secondary aggregates if they fulfil certain requirements in terms of composition, lixiviation and conditions of use.
- the “Flemish Strategic Waste Action Plan 1991-1995”, which is completed by the “Implementation Strategy Plan of Construction and Demolition Waste”. The main objective of the latter plan is to realise a level of 75 % recycling of C&D waste for the year 2000. The remaining 25 % should be landfilled within effective and environmental by hygienic conditions.

- the decree of January, 21st, 1997, which approves the inter-regional collaboration agreement for the prevention and management of packaging;
- the technical specifications for public works, developed by the technical services of the Flemish Government. These documents, although not having a regulating character, have a particularly important example function. Since the beginning of the nineties amendments have been published in the form of circulars, which cover the use of recycled concrete and masonry aggregates for the construction of road sub-bases and bases, the use of secondary materials for embankment protection, the use of broken asphalt in lower road layers and the use of "hot recycled" asphalt in upper road layers. These circulars have been recently (January 1997) integrated in the Standard Specifications 250 ("Standaardbestek 250") of the Flemish Government.
  A draft proposal in relation to the use of concrete and masonry rubble aggregates in recycled concrete in buildings and civil engineering works (foundations, inner walls,...) was under discussion in 1993, but was not accepted, this was mainly due to the uncertainty about the alkali aggregate reaction with recycled aggregates.

3.7.4.2 Wallonia

The OWAD which was founded in 1991 is the responsible organism for the management of waste in general. The management of C&D waste is based on the following legislative acts and documents:

- the Waste Decree of July, 5th, 1985 and the different application orders;
- the Decree of July, 25th, 1991 relating to the waste taxation in Wallonia and the application orders;
- the Waste Decree of June, 27th, 1996 of which one of the main purposes is to regulate the production of secondary products from waste (9). At the same time, the establishment and exploitation of special dumping sites (CET) is defined.
- the Walloon Waste Management Plan 1991-1995 which considered the prevention of waste and tried at the same time to limit the burden caused by the treatment or disposal of waste. The plan considered all existing technologies such as recycling, waste minimisation, incineration, pre-treatment and landfilling, but didn't specify a clear target level of recycling for C&D waste.
  In accordance with this plan and in order to realise a better control of the C&D waste stream, the following initiatives were undertaken by the Government :
  - ◊ about 30 special class III dumpsites, called "Centres d'Enfouissement Techniques", were created and managed by the company *Tradecowall* (in which the Government and the construction and demolition sector are represented).
  - ◊ Following the conclusions of a study realised by *Tradecowall*, the Walloon Government decided on July, 7th, 1994 to invest through the public company *Spaque* 140 million BEF in the creation of 7 recycling plants.
  - ◊ Besides this financial participation, a collaboration agreement between the Government and the Walloon Construction Confederation was signed on July, 14th, 1994 in order to improve the recovery of C&D waste. The main

tools identified were to sensitise and to inform the public and private sector about ways to prevent the arising of waste and to orient the C&D waste stream towards C.E.T.'s and recycling plants.

- The new Walloon Waste Management Plan, called "Horizon 2010" published in June 1997 and at the moment under public inquiry. C&D waste targets for recycling are defined, i.e. 60 % of recycling in 2000, 65 % in 2005 and 75 % in 2010. At the same time disposal of C&D waste at C.E.T.'s should be decreased to a level of 10 % in 2010.
- With respect to the technical specifications for public works, reference can be made to the circular AWA/178-95/150 which deals with the reuse of secondary materials within road works. This circular has already been integrated in the General Technical Specifications CCT 300 of the Walloon Government. In future, the circular will also be integrated in the Technical Specification Document W10 for road infrastructure (9).
- The last important initiative relates to the circular of February, 23rd, 1995 concerning the management and disposal of C&D waste at public works. This circular was published to stimulate the Walloon Administration to dispose of C&D waste in appropriate dumpsites or recycling plants and to promote the recycling efforts in general at public works. Amongst other issues, the Walloon Administration is forced to use transport forms on which the type and quantity of all the waste materials leaving the construction or demolition site must be specified.

3.7.4.3 Brussels

In the Brussels Region, environmental issues in general, and therefore also the waste problem, fall under the competence of the IBGE/BIM, which was created in 1989. The waste management rests on the following documents :

- the Decree of March, 7th, 1991, regarding the prevention and management of waste,
- the Brussels Waste Management Plan of 1992-1995 of which the aim was to realise 70 % recycling of C&D waste by 1996. In order to achieve this goal, major attention was directed towards the promotion of selective demolition.
- the order of March, 16th, 1995 regarding the obligatory recycling of certain types of construction and demolition waste (representing some 95 % of the C&D waste arisings in Brussels) in private and public works. This order forces the contractors to bring this particular waste to appropriate recycling plants situated in the neighbourhood of Brussels.
- the circular of May, 9th, 1995 regarding the reuse of C&D waste in public road and infrastructure works, which is in fact an annex to the General Technical Specification Document 150.

3.7.5 Development of recommendations and regulations

In relation to the initiative of the recycling association V.V.S. and the regional government technical authorities, a voluntary certification scheme for recycled aggregates for use in unbound applications, cement treated sand and gravel and lean concrete was developed. COPRO is the responsible party for the certification of these aggregates.

At the moment a technical prescription for recycled concrete, masonry and mixed aggregates is being drafted in order to enable to grant a BENOR quality label to these aggregates. It is made by a CRIC[1]-working group reporting towards the National Management Committee for the Certification of Aggregates.

3.7.6 References

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3.8 RTD initiatives

3.8.1 Use of energy

In December 1991 the Flemish Government started an impulse program for Energy Technology between 1992 and 1995, the VLIET-program. For this there was 800 million Belgian Francs available. Before the continuation of this program there was more than 277 million Belgian francs extra available, so that further support could be given to research programs in the subject of energy and energy economy and renewable energy sources.

Interesting to mention is that the previous VLIET-program spent about 20% of the resources concerning heating and ventilation of buildings. About 35% of the support

[1] CRIC : Certification organism for cement, aggregates, concrete, fly ash and additives.

was orientated with research concerning renewable energy forms, for example wind, water, solar cells, bio-mass, storage and management.

During this year the Flemish Institution for Rational Energy Use will be opened, which, in the future, will play a co-ordinated role in the area of rational energy use.

3.8.2 Environmental programmes

In 1990, the Flemish government also started a 4 year impulse programme for research in the environmental field "VLIM" (Vlaams Impulsprogramma Milieutechnologie). In this programme, feasibility studies, research programmes and demonstration programmes were granted as well as more sociological studies.

3.8.3 Other

The Belgian construction industry has it's collective research centre, the Belgian Building Research Institute (BBRI). Research was carried-out on several environmental themes, such as:

- the inner climate of buildings
- the recycling of construction and demolition waste
- new recycled materials for construction
- isolation (thermic and acoustic)

3.9 Information and training

3.9.1 Technological guidance

Within the BBRI, new technological developments are transferred to the industry by technological guidance. The task of technological guidance is to inform and train professionals in the construction industry to deal with new developments.

New guidance was created in 1994 in order to stimulate recycling and to help companies to minimise waste generation.

3.9.2 Presti-Projects : Programs for waste disposal in business

In 1994 the first subsidy program was started for the prevention of rubbish in Flemish businesses - the PRESTI-programme. Due to such great demand the Flemish government has the PRESTI-2 and PRESTI-3 programs approved. They shall both run until the end of 1998.

The PRESTI-2 program has the goal of encouraging the federation to work together with a minimum of two businesses from the sector testing prevention. Following this will be the application in business of the expansion campaign, specially directed towards middle sized businesses. The goal is of course to achieve results as examples to give in this manner to other businesses, and to continue until the adaptation of the same measures. The PRESTI-3 program encourages businesses to take on the available existing knowledge in waste prevention to try out and therefore to begin a prevention plan.

4. DEMONSTRATION PROJECTS / CASE STUDIES

4.1 The centre for Sustainable Construction (Heusden-Zolder)

The new project Centre for sustainable construction, is planned for a renovated ancient mine building. The renovation will be carried-out as a large demonstration project in the field. It will contain conference- and meeting rooms, demonstration facilities, space for starting companies a child museum etc. In the neighbourhood of the centre, there is space for demonstration buildings and for new companies, operating within the framework of sustainable construction.

The centre is a joint initiative between the Construction sector (BBRI, Federation of construction industry, ...), the Energy sector and Public authorities (Flemish Waste Administration, Water supply administration ,...)

The centre will co-ordinate different initiatives in Belgium and in the Euregio in the field of sustainable construction, stimulate application, demonstrate new technologies and show concrete products and services.

The development of vision will be the task of the "creative cell", an autonomous think-tank, steered by an independent scientific committee.

The information for the public will be organised by answering services, exhibitions, conferences, special demonstrations, etc. These will be organised within 6 monthly themes, such as "the circle of construction materials", "energy a limited resource", "the man and the water", "Made from recycled".

4.2 The mobility plan of the city of Hasselt

Several cities have implemented a mobility plan within the framework, described in § 3.2. Examples are the public transport plan in Brugge (parkings around the city and busses, bringing visitors into the centre) and the traffic plan of Gent (a channelling of the car traffic).

An interesting case study is the city of Hasselt, where an overall mobility plan is implemented. Elements of this plan are:

- traffic black points were inventarised and as much as possible adapted
- a "speed reduction plan": 30 and 50km/hr in inhabited areas; 70 and 90 for other roads
- the inner ring of the city is completely reorganized:
    - ◊ reduction of a 4 lane-road to a 2 lane one
    - ◊ traffic is only admited in 1 direction

  - ◊ the new space is used for "slow traffic" (walking and biking) and trees
- a complete network of bike-lanes
- public traffic:
  - ◊ increase of the bus traffic by a factor 4
  - ◊ all buses are free within the city
- large parking areas outside town, free bus-shuttles to the centre

The first monitored results of this plan are expected in December '97, however, the first months of the new public transport plan showed an increase of the use of buses by a factor 10 and a considerable decrease of car traffic within the centre of town.

4.3 Pleiade

The PLEIADE (Passive Low Energy Innovative Architectural DEsign) dwelling is the Belgian contribution in the framework of the Task XIII project of the International Energy Agency (IEA). IEA Task XIII started in 1989. In total, 12 countries participate in the project : Austria, Belgium, Canada, Denmark, Finland, Germany, Japan, The Netherlands, Norway, Sweden, Switzerland, and the United States. The aim is to build in all participating countries a dwelling which should be for the period 2000-2010 a realistic low energy solar dwelling. It means that an important boundary condition is that the techniques to be used should be cost effective within 5 to 10 years.

For Belgium, the Belgian Building Research Institute together with Architecture et Climat of the University of Louvain-La-Neuve take part in IEA Task XIII. The Belgian participation is financed by the Walloon Region. Besides these 2 teams, a large number of other organisations are involved in the project :

- Electrabel which is the Belgian electricity and gas company. Electrabel acts as owner of the dwelling. Moreover, two of its laboratories, Laborelec (for all electrical applications) and A.R.G.B. (for all gas applications) are fully involved in the project and are responsible for the heating systems to be used in the dwelling. A gas system as well as an electrical heating system are installed in order to allow a comparison between different systems;
- a professional architectural office, leaded by Ph. Jaspard;
- COMITA which is the association of all Belgian thermal insulation associations. The major role of COMITA is related to the choice and installation related aspects of the thermal insulation and glazing systems;
- Belgian Centre for Domotics (BCD), which is the Belgian association of organisations involved in domotics;
- a whole range of sponsors.

The "Pleiade" building is in fact a two-storey row house of about 240m² net floor area (including the attic which is part of the inhabited space) located in the new city of Louvain-la-Neuve. Special attention is given to the integration of the bioclimatic architectural concepts, the achievement of good thermal comfort in winter and summer, and good indoor air quality. Accordingly the design of the envelope was important. Daylighting the central part of this 10 m deep row house was another objective.

A balanced ventilation system with heat recovery supplies fresh air to the bedrooms and recirculated air to the living rooms. During hot periods shading of the south-facing glazing and night-time natural ventilation reduces or eliminates overheating. Two heating systems, a gas air heating system with a four-zone control system, and an electrical heating system were installed for experimental purposes. A home control system ensures optimal energy use and thermal comfort. The system is also used for other functions, such as home security.

Other interesting technical aspects of the dwelling can be summarised as follows :
- the concrete blocks internal walls constitute the dwelling structure while the facades are made of light prefabricated highly insulated panels (up to 25 cm insulation). This option consequently guarantee a high thermal inertia which plays an important role in the prevention of overheating;
- the dwelling is equipped with improved double glazing (Argon filling and double low-emissivity coating);

4.4 The recycled house

This demonstration project concerns the construction of a demonstration building incorporating a significant proportion of new materials derived from recycling building debris and from the reuse of waste or by-products from other industrial sectors. The goal is to demonstrate that it is possible in the construction sector to make use of a high proportion of recycled materials without harming in any way the functional properties of the building or without increasing the construction costs. The project covers all the traditional phases of construction. It begins with the planning stage and includes materials selection, specifications, etc. until completion of the building and the access routes. It will be built on CSTC's experimental station site at Limelette (Ottignies - Louvain-la-Neuve) and will consequently be accessible at all times.

5. THE HORIZON OF THE YEAR 2000 : THE CONSEQUENCES FOR THE CONSTRUCTION INDUSTRY BY 2010

5.1 City planners and the built environment

Belgium is a very fragmented country, with a lot of construction along roads ("ribbon construction"). This results in a lack of open space. There is a high population and road density. As a consequence, tendencies in city and country planning are
- the use of the space is more and more regulated with
    - ◊ respect for open space and green areas

  - ◊ discourage fragmentation
- stimulation of renovation
- other type of city planning (better planning of mobility, traffic reduction etc.)

5.2 Initiating, designing, constructing and demolishing

The main points of attention in these fields are:

- prevention of waste
  - ◊ separation during demolition
  - ◊ stimulation of the use of recycled material
  - ◊ stimulation of renovation
  - ◊ more standardisation
- energy saving
- water saving
- acoustic insulation

5.3 Components, materials, services and assembly

As in Belgium most construction of houses is carried-out for private families, tendencies are strongly initiated in a "market pull" situation. Therefore sensibilisation is extremely important. However sustainability and environmental soundness is more and more a commercial issue.
On the level of technical and scientific development, following issues are important :

- Combination of characteristics
  - ◊ energy (insulation & energy content)
  - ◊ waste
  - ◊ impact on environment
- Life-cycle analysis
- Environmental standards
  - ◊ Composition
  - ◊ Leaching

5.4 Human resources and skills

On the level of human resources and skills to be developed, there are tendencies toward

- More specialisation in the environmental field
- But also the need for more multidisciplinary skills
- Sensibilisation and information of the public (see § 5.3) is done by different instruments:
  - ◊ Changing economic environment : environmental costs are put on products. An example is the tipping fees on waste. (see § 3.7)
  - ◊ "Presti" projects are an instrument to promote sensibilisation actions, organised by industrial sectors
  - ◊ Sensibilisation campaigns are organised by the public authorities

6. CONCLUSIONS

As in other countries, quite some initiatives are taken in Belgium to implement principles of sustainable construction.

Specific to Belgium is:

- the regionalization of the country gave authonomy to the regions, which develop there own policy and put their own accents in issues, related to sustainable construction
- the importance of construction by private people requires an own approach of sensibilisation actions.
- the high population density and fragmentation of the space

For the future (horizon 2010), this means:

- an increased regulation on the use of land with more respect for open space and green areas
- stimulation of renovation of existing buildings
- more mobility planning and new concepts for city planning within these frameworks
- more waste prevention and recycling and
- increasing environmental costs (waste treatment, emissions, ...)
- attention for saving resources (energy, water, primary materials)
- on the scientific level: higher importance on global studies such as:
    - ◊ life cycle analysis
    - ◊ multi-criteria evaluation of materials, services, constructions,...

REPORT 2

SUSTAINABLE CONSTRUCTION IN FINLAND IN 2010

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION

This is the Finnish national report of the CIBW82 project: Sustainable Development and the Future of Construction. The report is based on brainstorming discussions within an informal scenario group (see Annex 1.) that was temporarily called for that purpose. Remarkable contribution has also been received from other sources, such as relevant ongoing research and development projects [1], the cluster-based working groups [2] of the Ministry of Trade and Industry and the sustainable construction committee [3] by the Association of Finnish Civil Engineers RIL.

1.1 Construction and Environment

Building sector presents 44 % of the total energy consumption in Finland: 34 % for heating of buildings and electricity used in households and 10 % for building production (out of which 70 % comes from manufacturing of products and 30 % from transportation and building sites). In addition, 3 % of the total energy is consumed by production of building materials and products for exportation (see Figures 1 and 2).

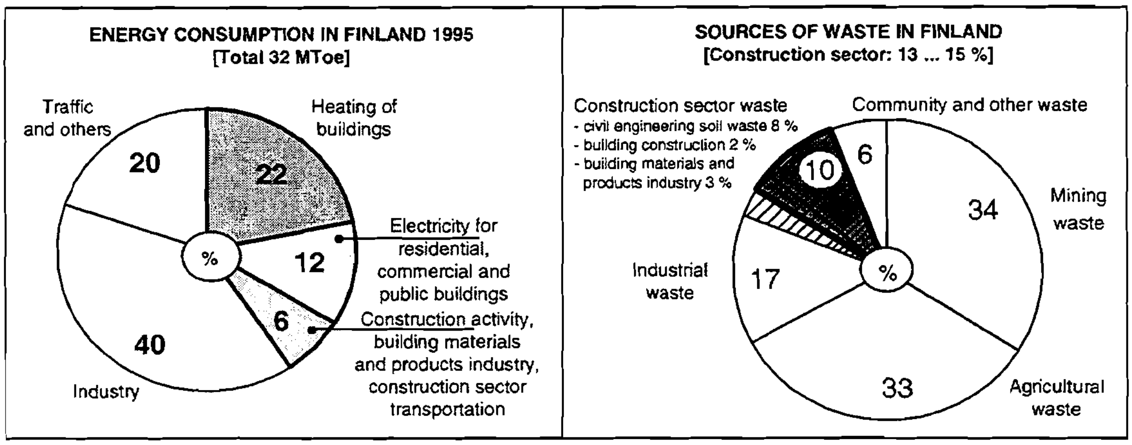

Figure 1. Energy consumption and sources of waste.

About 13 % of the total waste is estimated to come from building sector: 8 % from civil works (soil construction), 2 % from construction of buildings and 3 % from manufacturing of building products. 15-30 % of the building waste is estimated to be now recycled. [4]

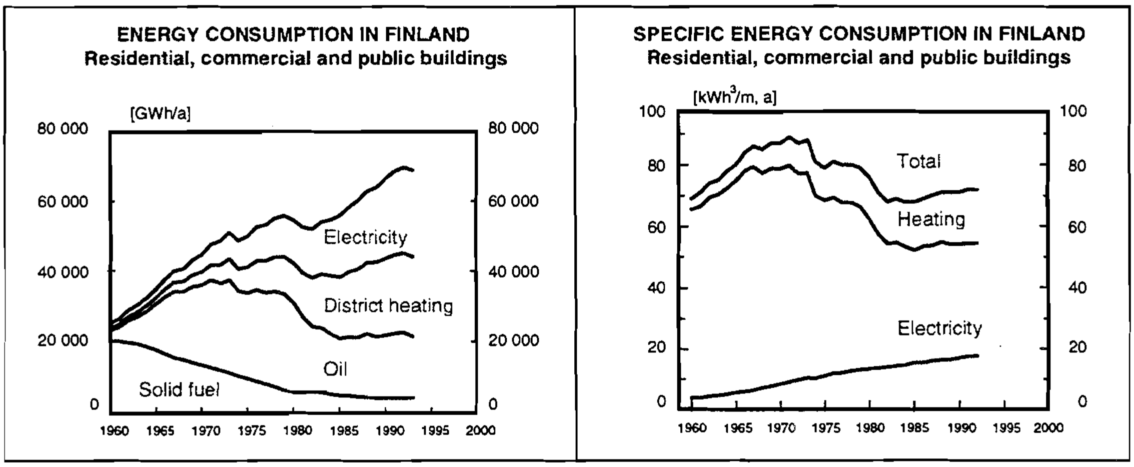

Figure 2. Energy consumption in buildings.

The most important ongoing environment-related research and development effort in our country is the technology program: Environmental Technology in Construction (1995-99) [5], that is coordinated by the Technology Development Centre. It has an estimated budget of 20 million USD to be covered by about 50 % by the participating companies. It aims at developing of methods and technics for environmentally sound construction to be implemented in enterprises. It covers the fields of ecobalance and life cycle, design guides and procedures, environmental geotechnics, products and production technologies, and demonstration projects.

1.2 Environmental Concerns

The main environmental concerns of our society are environmental burdens of the industry, energy economy and emissions in the use of buildings, and environmental impacts of traffic. The important issues related to the building sector are, besides energy and emissions, the service life of building systems and products, and maintenance and refurbishment of the existing building stock. One hot topic of today in Finland is management of indoor air quality, including the mould issues.

The Council of State of Finland has in December 1995 made a policy decision concerning the realization of energy saving. According to it, the energy consumption in 2010 should be 10-15 per cent lower compared to the development without a change in the energy policy (estimates based on energy economy and prices). The saving policy is economically based on taxes, elimination of subventions which may prevent savings, building refurbishment, research and development for energy saving technology, and a new third party financial system. The influence of the European Union policy has been taken into account. According to the decision, all measures should be initiated during years 1996-97.

The preparation of Agenda 21 programmes is based on the UN Rio Conference on Environment and Development which was held in 1992. One chapter of the work programme Agenda 21 recommends the preparation of Local Agenda 21 programmes.

In Finland, around 50 municipalities (or cities) are now involved in Local Agenda 21 projects. In spite of the fact that they are around one tenth of Finland's municipalities, they cover more than 40 per cent of the Finnish population. The Agenda process is going on in practically all bigger cities but there are also minor municipalities like Kumlinge in Åland. A regional perspective is still rare. The few exceptions are Mikkeli, Oulu, and the capital areas. Each municipality makes its own local programme for sustainable development. The programme is made in cooperation between the municipality, organizations of citizens, industry and commerce, and residential organizations. The municipal administration acts as a coordinator. Central issues have been land use, traffic, energy, environmental attitudes and education, nature conservation. Social issues include i.e. employment and local democracy. Less attention has been paid to consumer habits and the problems of rural development. The Ministry of Environment has been subsidizing the most prominent Local Agenda projects.

One of our major challenges for the future will be setting of growth objectives to qualitative level instead of quantitative. Sustainable growth may be interpreted as increase in efficiency of production and increase of consumption of services instead of consumption of goods.

1.3 Objectives of the Study

Long term objective is to improve the quality of our life (see Figure 3) by promoting environmentally sound construction – or, to ensure its present level for future generations.

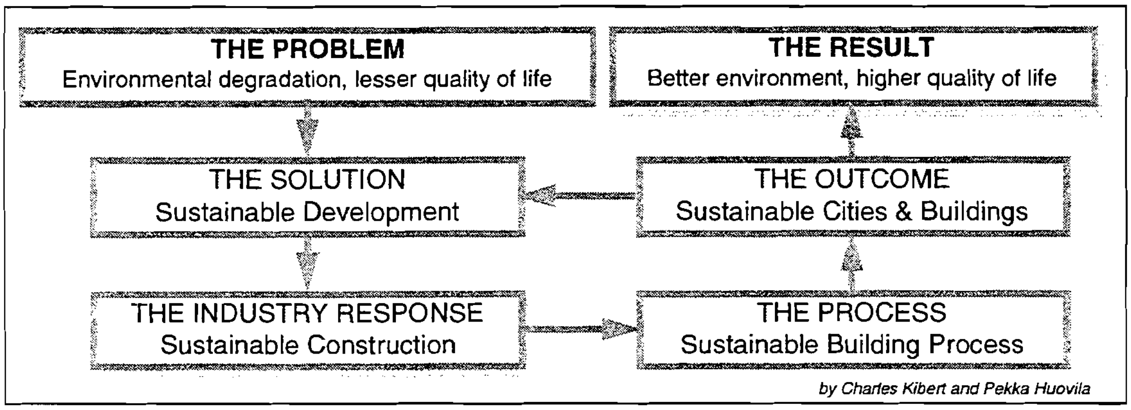

Figure 3. Improving the quality of life by sustainable construction.

The research objective is to study which will be the consequences of sustainable development to construction by the year 2010 [6]. National research results are planned to serve for managing the construction industry and its research and development to consider the identified main consequences of sustainable development to the building and operating process. The planned time schedule of the international study is presented in Figure 4.

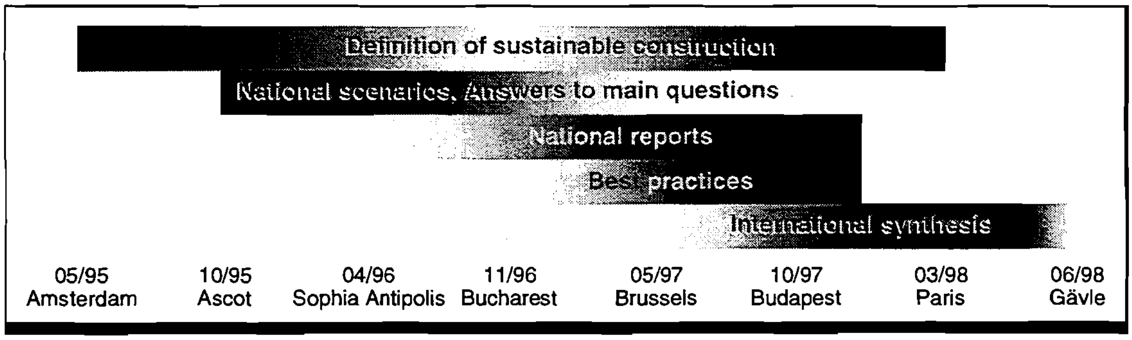

Figure 4. The planned time schedule of the international study.

2. METHODOLOGY

The methodological structure (Figure 5) consists of the following steps [7]:

- definition of what is meant by sustainable construction
- description of national constraints, special issues and future scenarios for 2010
- answers to defined questions concerning the building sector
- analysis of the main consequences of expected sustainable development to the building and operating process (Figure 6)
- presentation of selected success stories to serve as examples for companies, organizations and countries to encourage them towards implementation of environmentally sound procedures and products
- an international synthesis, based on national reports, will be produced following a common methodology and format
- recommendations to the building sector based on the discussed main changes.

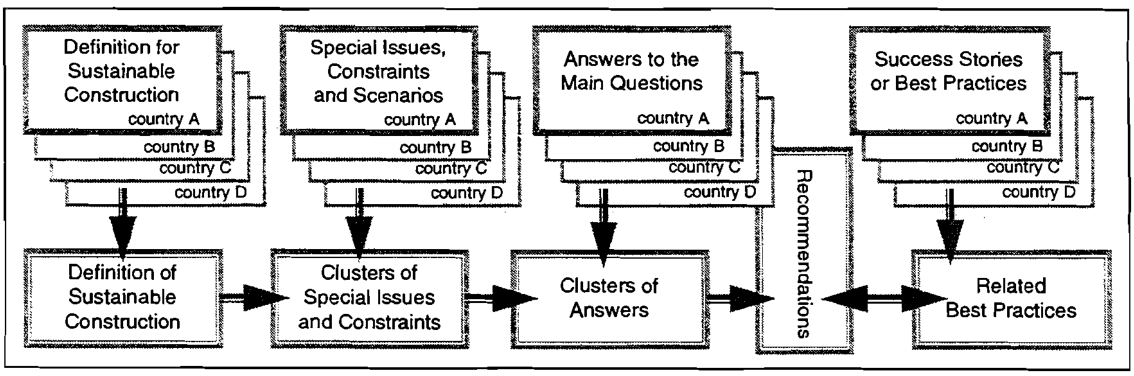

Figure 5. Different steps of the project.

Resources / Process	LAND	ENERGY	WATER	MATERIALS
Urban planning Product development & Design Manufacturing & Construction Operation Deconstruction				

Figure 6. Structure of the consequences to the building and operating process.

2.1 Definition of Sustainable Construction

Sustainable development has been defined by the World Commission on Environment and Development in 1987 as: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable construction was defined in the First International Conference on Sustainable Construction in 1994 as: "The creation and responsible maintenance of a healthy built environment, based on ecological principles, and by means of an efficient use of resources."

In Finland, sustainable development is often treated in three areas: ecological and economical, social, and cultural. In this context, the sustainable construction discussion is emphasized at ecologically sustainable construction, which means essentially management of biodiversity, tolerance of the nature, and saving use of resources. Achievement of ecologically and economically sustainable construction enables socially and culturally sustainable construction.

According to our current definition [8], sustainable construction: "In its own processes and products during their service life, aims at minimizing the use of energy and emissions that are harmful for environment and health, and produces relevant information to customers for their decision making." To building construction this means:

- intensified energy-efficiency and extensive utilization of renewable energy sources
- prolonged service life as a target
- saving of the natural resources and promotion of the use of by-products
- reducing of waste and emissions
- recycling of building materials
- supporting of the use of local resources
- implementation of quality assurance and environmental management systems.

The desired state prevails environmentally responsible industry and building owners together with environmentally conscious consumers.

2.2 National Constraints, Special Issues and Future Scenarios

In Finland, the availability of free space, and air and water of good quality, is not seen as a problem to be solved. That reality is not striving us for environment-saving solutions (like it maybe has in some other countries). The climatic conditions in the North of Europe are cold, leading us to energy saving thinking and acting as a self-evident matter. Large share of our population lives in scattered areas and we are depending on imported energy. In general, the education standard is high, and means for co-operation and large-scale responsibility exist. All that gives us a good starting point for developing and implementing sustainable construction both within our borders, and abroad.

Although construction is mainly a home market activity, the market requirements in Central Europe act as a driving force to a larger extent than just to our manufacturing industry, that is already actively exporting their building products. Our risen interest towards environment-conscious thinking risks to stagnate if no clear signs of its practical implementation is seen in the European market. The driving force for sustainable development in our building sector may be based on competitive factors (quality and environmental control), and image considerations to amplify the picture of the pure nature in the North. These success factors are, and certainly will be, associated with competition circumstances in Finland and in Europe.

Definition of our sustainable development scenarios was started by looking at applicable existing scenario works. Three recent ones (Figure 7) were selected: four Dutch [9] national sustainable development scenarios for 2030, four French [10] national future scenarios for 2030, and five Finnish [11] global future scenarios for 2005 and on.

Our scenario discussion commenced with treatment of the Dutch scenarios Strong Together and Strong Alone combined with the Finnish scenario Master Plan. The chosen working procedure, that was judged most profitable for this occasion, was first to set sustainable future objectives, then start to accomplish them. Therefore our efforts were focused on describing one desired and realistic future, instead of comparing different alternative scenarios. The mission of the group was understood as not to discuss unsustainable futures.

The methodical idea of the Dutch framework Duurzame Ontwikkelingscenario is interesting. The method is based on the idea of four kinds of capital which are environmental, manufactured, human, and social capital. Different weights are given to them in the four scenarios. In the background there are assumptions about how far the environmental capital can be substituted by other kinds of capital. In the first two scenarios (Strong Together, Strong Alone) there is no substitution available. The third scenario (Considered Sustainment) allows limited and the fourth one (Weak Sustainment) practically unlimited substitution. Other differences between the scenarios concern i.e. the international role of the Netherlands, international development of environmental policies, some social considerations, and the role of technology in the society.

Duurzame Ontwikkeling-scenario (The NL 1996) *Span*: 2030 *Scope*: "Extended economy" forms of capital and their interchangeability	**Bâtiment 2030 / Club Bâtiville** (France 1992) *Span*: 2030 *Scope*: National & European socio-economic variables	**Finland an the possible worlds / SITRA** (Finland 1995) *Span*: 2005 – ? *Scope*: Global development "macro level phenomena"
A1 **Strong Together** Global dominance of environmental values	B1 **Laisser-faire** Strong liberalism + economy in crisis	C1 **Master Plan** Multinational cooperation + political stability + sustainable development
A2 **Strong Alone** National dominance of environmental values	B2 **Croissance duale** "Intermediate scenario": liberalism + fordism + modest economic development	C2 **Mercyless Business** Dominance of the market and free capital + economic and political instability
A3 **Considered Sustainment** "Intermediate scenario": modest regulation + technological optimism	B3 **Productivisme** Dominance of the EU level + modest regulation + technological optimism + strong economy	C3 **Conflicting Cultures** Cultural blocs + national separatism + economy-driven conflicts
A4 **Weak Sustainment** Market dominance, liberalism + technological optimism + strong economy	B4 **Développement durable** Dominating environmental values on the global and the EU level	C4 **Beyond the End** A fast and severe crisis invoked by competition and economic growth + global disorder + new localism and regionalism
		C5 **Competing Power Blocs** International spheres of influence + hegemony of power blocs + power politics

Figure 7. Future scenarios.

The French Bâtiment 2030 stays on the national level but runs a respectable apparatus of structural components (14) and variables (27 in total). The components are: population, economic growth, housing policy, role of Europe, urban policy and land use, environment, lifestyles and dwelling, energy, traffic, economic market and cost level, building design and functionality, quality of building, building research and technical development, and greenhouse effect. The resulting four scenarios describe different causal patterns of development of these elements. The international level is included as external conditions in the framework. The overall approach seems quite consistent and logical. A relatively strong emphasis is given to (positive) impacts of technological progress and independent (not industry-driven) research in building and construction.

Finland and the possible worlds is interested in general global development and the respectively invoked national issues. The scale is larger and less accurate than in other frameworks. Each of the five scenarios is based on a dominating single factor. These are: international politics and supranational institutions, the power of the free capital market, cultural issues, ecological problems, and international spheres of power. The strength of this approach is its ability to delineate (national) risks and opportunities. However, the work is a somewhat problematic combination of realistic conclusions and creative causal imagination. The latter is needed to cope with multivariable uncertainty of global development without a strict method. However, this is the only approach which tries to derive the consequences of both political, economic, and cultural development outside the European Union.

The frameworks are not directly comparable because of crucial differences in their objectives and orientation. Duurzame Ontwikkelingscenario is the most environmentally oriented on a general level. However, building and construction do not have any special role in it.

On the contrary, Bâtiment 2030 is, as also its name indicates, specially aimed at the preconditions of favourable development of building and construction (including their social and ecologic aspects). This goal naturally reflects the national role of CSTB, the producer of the scenarios.

In Finland and the possible worlds the environment is only one theme and nothing is said of building. There is a clear emphasis of international politics and national decision-making.

2.3 Answers to the Main Questions

The following five questions were to be answered:

① What kind of buildings will be built in 2010, and how will we adapt existing buildings?

② How will we design and construct them?

③ What kind of materials, services and components will be used there?

④ What kind of skills and standards will be required?

⑤ What kind of cities and settlements will we have then?

The applied methodology [12] was to analyze data that was collected from simple questionnaires, which were filled by experts. The objective was to get a range of expectations of possible sustainable futures. A short questionnaire consisted of a definition for sustainable construction and the five main questions with the following assumptions and instructions:

- the fulfillment of a sustainable development (whatever it means)
- the future to be rather favorable than probable
- profound reasons for the answers are not needed, short answers are adequate
- the differences between today and year 2010 are especially interesting
- questions that don't make sense to be ignored.

27 people were chosen as experts among those who work on the field and/or who should (based on their position) have a vision of the future of sustainable construction.

The final sample consisted of 22 people with various backgrounds. Among varying answers at least the following themes could be identified:

① BUILDINGS (Figure 8):

- flexibility, multiple use, functionality of buildings
- small energy consumption, energy conservation, autonomous energy production, energy-economic construction, new energy sources, energy storage
- small amount of new buildings, utilization, economic renovation, and modification of existent buildings
- high and good quality, no quality defects
- long/short service life, life cycle costs.
- the speed and amount of the development was a minor question.

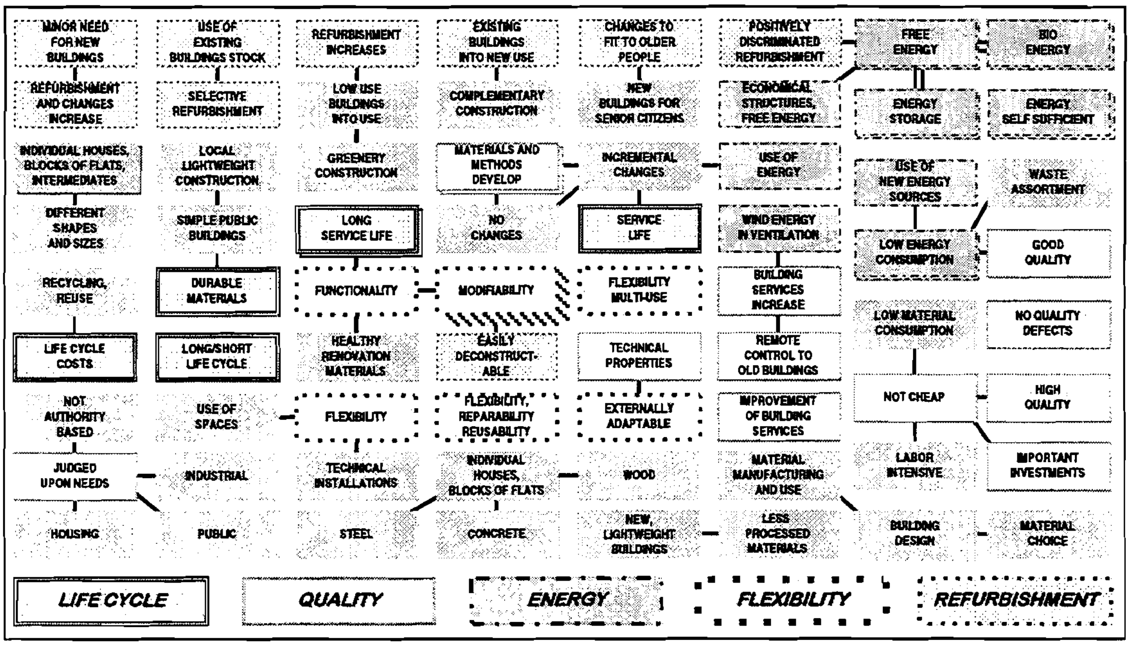

Figure 8. A map of answers regarding to sustainable buildings of the future.

② DESIGN AND CONSTRUCTION (Figure 9):

- the needs of the user, the participation of the client/user
- the increasing amount of design work, more demands for design, more investments to design work
- the importance of ecological knowledge, life-cycle analysis, environmental and ecology databases or other information systems, ecological profile data
- the increase of construction on-site, specialized on-site constructors
- the importance of local (natural) conditions and environment.

③ MATERIALS, SERVICES, COMPONENTS (Figure 10):

- recycling and re-use of materials, products, and equipment;
- recyclableness of materials, the ease of demolition

- easy repairs and service of equipment, little need of repairs, durability, long service life
- economic use of resources, renewable natural resources (like wood), small energy content of materials
- healthy, non-poisonous and non-allergenic materials, low emissions of hazardous substances
- new and 'high-tech' materials, glass products.

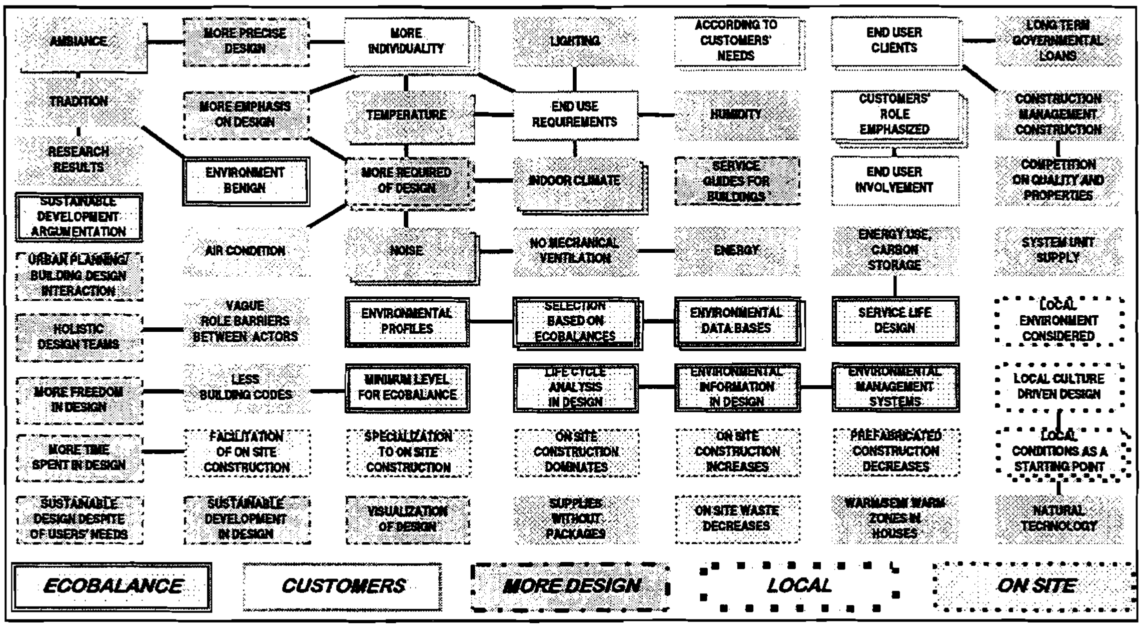

Figure 9. Design and construction.

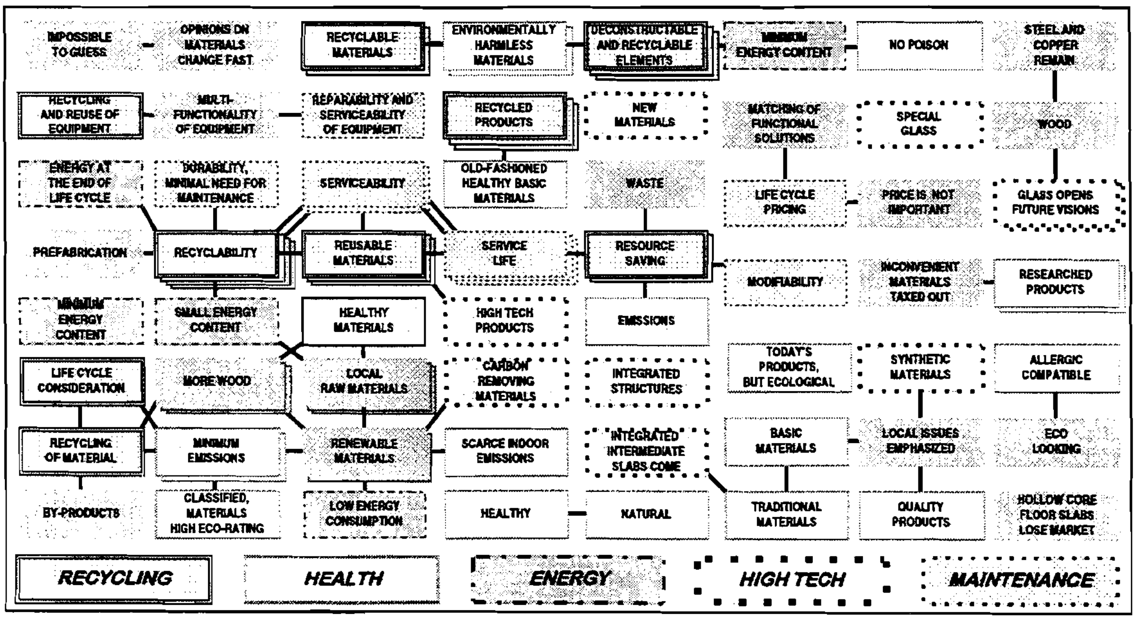

Figure 10. Materials, services and components.

④ SKILLS AND STANDARDS (Figure 11):

- skills, qualified labour, expertise;
- autonomy and responsibility of labour, quality production
- (on the contrary?) general skills, non-specialization, less important professional limits
- the ability to handle both new and old materials
- flexibility of regulations, non-descriptive regulations
- the importance of the life-cycle and overall performance, mutual coordination of the regulations.

No clear opinion existed about the importance of regulations.

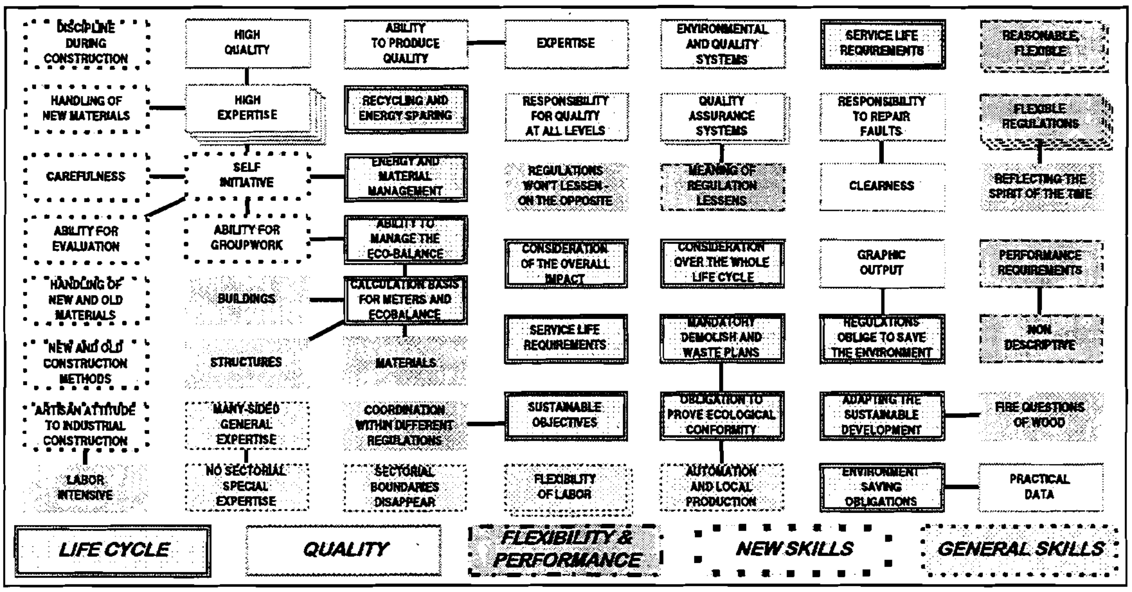

Figure 11. Skills and standards.

⑤ CITIES AND SETTLEMENTS (Figure 12):

- denser cities, dense urban structure (high or low)
- lower suburban structure, less apartment houses (or smaller ones), smaller scale, village-like environment;
- demolition of inferior suburban housing, no new suburbs
- more greenery and greener urban areas, well-planned natural areas, careful planning of non-built land;
- rural milieu will be conserved and utilized for food production
- telework will be more common and the workers may live in less urban or in rural areas;
- autonomous (satellite) districts of cities, functionally more integrated and more heterogeneous cities
- increased use of light traffic and public traffic, the separation of light and car traffic, central pedestrian areas;
- greater importance of traffic systems and traffic planning;

- more efficient utilization of networks and technical infrastructure.

But also opinions that no great changes will occur were given, or that sparse structure is still possible in Finland, or that the nature will not be conserved in time.

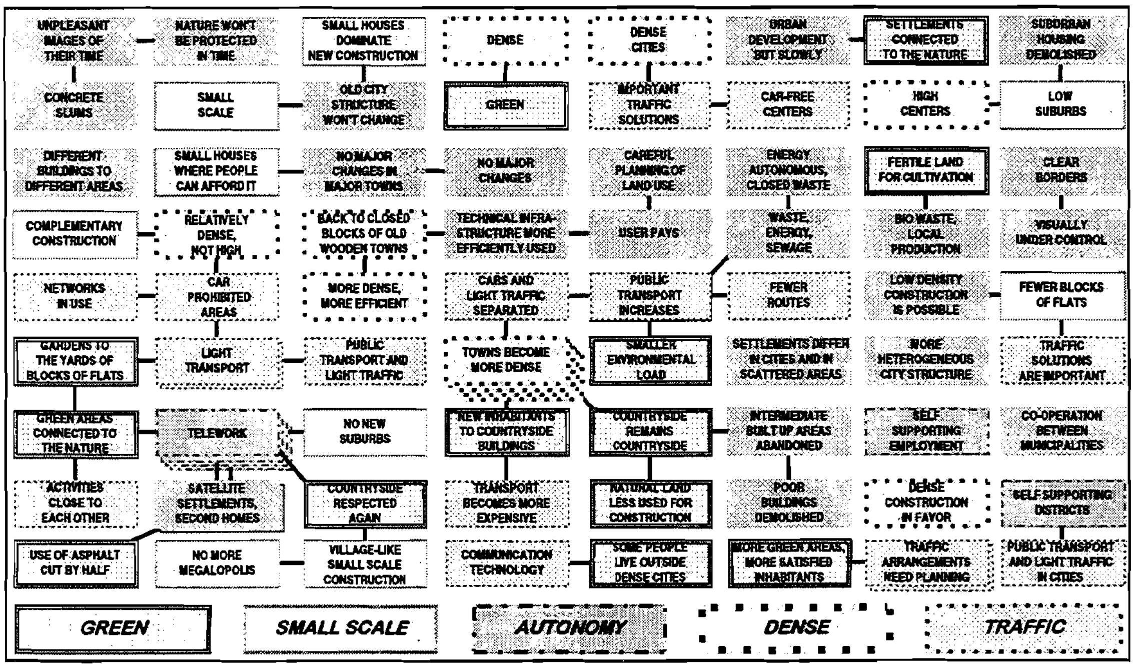

Figure 12. Cities and settlements.

3. CONSEQUENCES TO THE BUILDING AND OPERATING PROCESS

General consideration in Finland is, that our infrastructure (roads, schools etc.) could serve considerably greater population than the present. The national policy is to develop out networks further to support the industrial competitiveness and an overall logistics optimum. Electronic infrastructure is formed above the physical infrastructure.

Increasing share of aged (and disabled) people and the lifestyle in 2010 (values and consumption habits) will have a crucial influence in the housing requirements. A radical minority is expected to remain, regardless to the general trends, to act as our ecological conscience. Individual motivation towards environment-saving solutions may as well be ecological consciousness, optimization of life cycle costs or desire for high tech -gadgets.

The share of immigration in Finland is minor and the possibility of its remarkable increasing in the near future is occasionally discussed. (There are more people living around St. Petersburg, less than 500 km from our capital, Helsinki, than in Finland altogether.) That kind of future is not, however, considered to be likely.

In spite of the Nordic climatic conditions the level of our energy consumption (Figure 13) in buildings is in the same order than in the South of Europe. The share of low energy buildings will remain minor – most likely less than 1 % of the population will live in such dwellings in a fifteen-year time span, unless that will be supported through a conscious policy. In the 2010 horizon, 20 % of our buildings at the most, will be built after 1996.

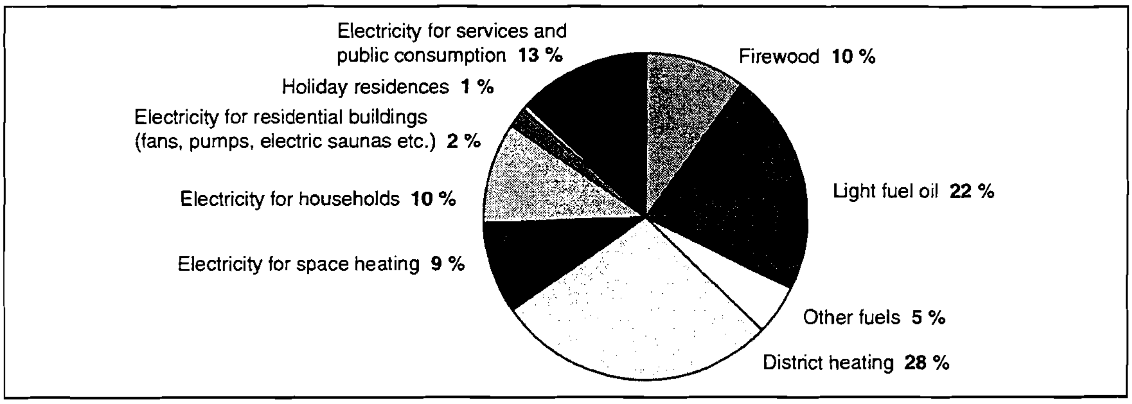

Figure 13. Energy consumption in residential, commercial and public buildings, total 7.1 Mtoe.

If 20 % of our buildings constructed after 1996 were, what is today concerned as low energy buildings (e.g. consuming half the energy that corresponding buildings do on the average), the total share of low energy buildings would reach 4 %, but even that can not be achieved without taking subsidizing measures. In fact, there isn't any common definition for low energy buildings. Such aspects as use of renewable energy sources, functionality, flexibility and service life should also be considered when judging the sustainability issues.

Refurbishment has also potential to affect considerably on energy saving. The share of our building stock constructed in the 1960's and 1970's is 30-40 % (Figures 14 and 15). If replacing of windows were done in 80 % of them the energy saving, together with other improvements, could be 15 % of the total energy consumption in each dwelling – summing up to 4-5 % decrease in total.

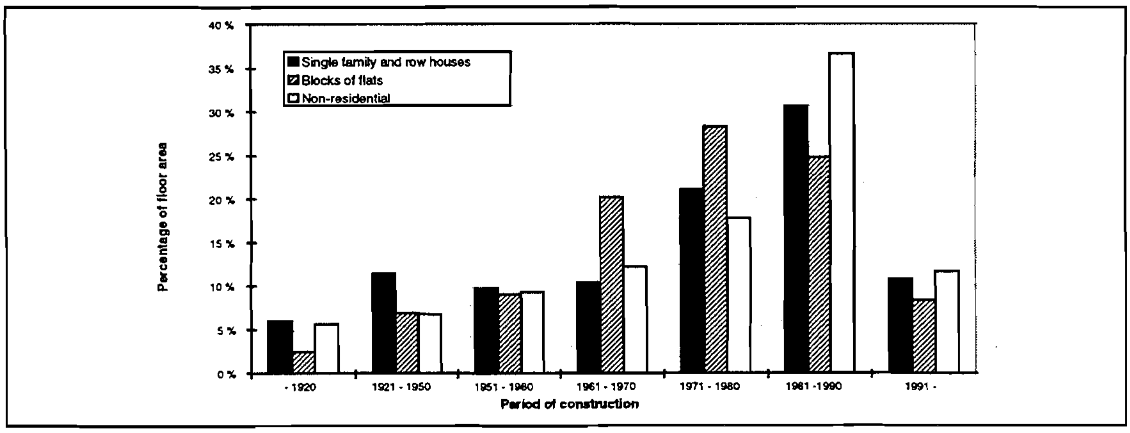

Figure 14. Age profile of the Finnish building stock as a percentage of the total stock floor area.

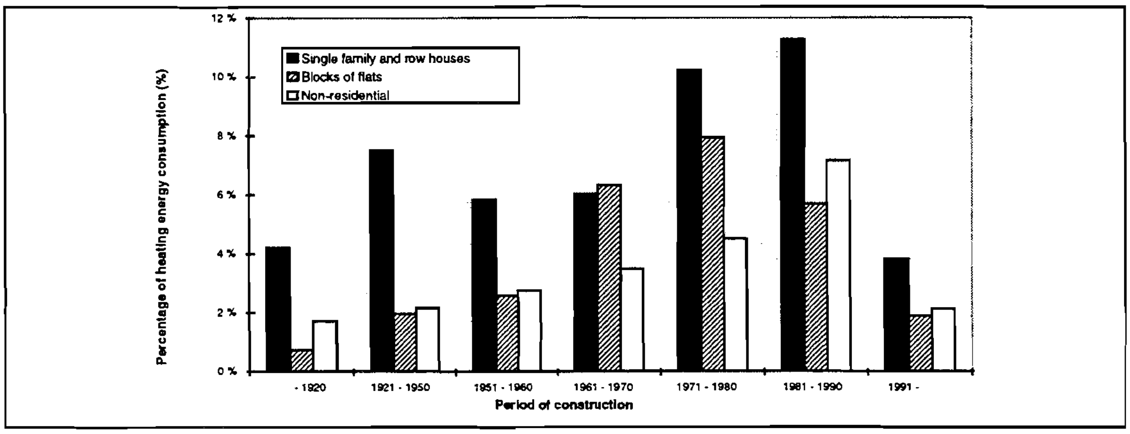

Figure 15. Calculated estimate of heating energy consumption related to the period of construction (influence of refurbishment is not counted).

The situation where the price that environment pays, can be changed to money, will affect all phases of the building and operating process.

3.1 Urban Planning

The growth of environmental-responsible thinking and possible public subsidies in energy saving affect on refurbishment. Increasing knowledge about greener solutions is expected to create new demand. A minor share of population will go teleworking as a result of improved electronic highways, but that doesn't necessarily affect on the development of the infrastructure. Ecological indicators are hard to define, density of habitation being one of the possible ones. That can, however, not be taken as the only measure, especially if it conflicts with the living comfort requirements of the individuals. A certain "minimum" level of sparse space must be maintained, although it would be in contradiction with environmental objectives. The know-how in the future will be harnessed to improve the quality of the neighboring environment.

LAND

The former industrial land use released for other purposes rises construction needs and speeds implementation of soil cleaning technologies. That development is expected to be accomplished by 2010, which means, that the market for that technology has then to be then found outside our borders.

ENERGY

Energy questions in communities will be answered from the point of view of technical solutions in the urban infrastructure, traffic arrangements, placing of buildings on site etc. District heating will remain the solution for big communities. In the countryside, flexible, wood-based – or other renewable – solutions, have potential. Combined heat and power production is still, and natural gas as a new alternative in the future, appreciated in large scale solutions.

WATER

Ground water protection will be our main challenge. Other possible issues will be local use of storm water, double drainage systems etc. Overestimated water consumption in our water supply network has created new problems. Low consumption and slow flow in ducts results in lessening quality of drinking water. We don't have water shortage and water saving is not our primary objective.

MATERIALS AND PRODUCTS

Local use of materials and products is prioritized because it reduces energy consumption in transport influences also positively in waste management opportunities. The overall impact of transport remains, however, small.

3.2 Product Development and Design

Most important issue is expected to be the indirect influence of producing of ecobalance by architects and engineers. Once the methodology exists and the tools are available (developed through research), it leads "automatically" to optimization process. (Analogically to the development of cost optimization with cost calculation tools.) Even normal loads for environment can be obtained as normal prices that are used in cost comparison. More design will be done early in the process. Penetration of energy-conscious thinking in architectural design will show. Design for service life is undertaken. Life cycle costs play a key role in trade-offs. Use of passive solar energy and daylighting, development of diagnostics and regulation systems increase energy efficiency.

LAND

The environmental footprint will be considered in design. That concept has a wider content (production, emissions, waste management etc.) than just the constructed land around building foundations.

ENERGY

Energy applications will be developed upstream early in the design process. The judgment develops from U-value to building entities. In the energy use, fuel switching may become important. That means choice opportunities in the energy sources in the real estates. Heat transfer systems that are not tied on one energy source will be favored. The objective is to use renewable energy sources. The cost level of new technologies is expected to change remarkably in the near future.

WATER

The essential objective is reducing of sewage water. Improved measurement for individual water consumption and waste water consumption is also needed. (Today, waste water is charged according to consumption of drinking water – even if not lead to drainage.) Water saving water and sanitary fittings are promoted.

MATERIALS AND PRODUCTS

In the proper use of materials it is important that the characteristics of waste materials are known and adopted in design. Selection of materials will be done according to users' needs and material properties, and individual service lives. Recycling becomes a reality. Products and systems of a shorter service life have tighter recycling requirements! It is also discussed whether some parts, like the envelope of building or heating and ventilation systems, should be designed for a shorter service life, when new products with new technology will be launched in the near future. (Sometimes it is better for the environment to replace old solutions with new ones.) Despite of the objective of minimizing of transport, for some components even a very long transport can be feasible. It is hard to predict how things, like modularity or easy replacement, should be considered in the ecobalance calculations.

3.3 Manufacturing and Construction

In the supervision, public approval of designs and follow-up of construction will be emphasized towards assurance of conformity to the plans, and technical supervision may be bought as a private service in the future. Developed technology enables flexible solutions. On-site emission of waste, noise and dust will decrease. Environmental management systems affect to the development, they are seen as means to increase the productivity and profit. The influence of a certain image is also important. Emissions of our own industry are important, because it has an effects on environment still after the year 2010. Environmental taxation is one of the possible means to influence in the future development.

LAND

In the future, the building site needs not to be blown up first, and leveled flat next. Instead, environmental sensible construction methods will be developed. Access roads that are needed during construction, can be used afterwards without reconstructing them. Construction waste management will be developed together with secure and neat sites.

ENERGY

Minimizing of transportation cuts down energy consumption. Increase of the price of energy will directly lead to energy-saving refurbishment.

WATER

Closed water circuits will be implemented in the manufacturing industry.

MATERIALS AND PRODUCTS

Improved and completely new processes will be introduced. Open building systems are be implemented with modularity and mecano clips in building services systems. Use of local materials is prioritized. Recycling technologies and renewable materials will be developed in the manufacturing industry. The producers' environmental (life cycle) responsibility covers also production processes. Product information includes also description of the conditions for the proper use. Reliable quality, durability and service life information of building products are required to be produced by their manufacturers.

3.4 Operation

Professionalism in facilities management spreads. Service guides of buildings will be common. Cost management together with indoor air quality and energy management will be important. Efficient use of resources hasn't been until now really been carefully planned.

ENERGY

Management of operation costs, energy and water consumption, and the indoor air quality are, by 2010, developed in thinking, tools and technical systems. Complementary energy systems are needed side by side with electric heating (there is half a million dwellings equipped with only direct electric heating). That, together with extended use of daylighting, economizes the use of electricity.

3.5 Deconstruction

Buildings constructed after 1996 will not be demolished by 2010. Deconstruction methods will still be traditional then, but new buildings are already designed to be reused and recycled. The key issues will be

- assorted demolition
- reuse of building parts
- stone-based waste directed to soil construction
- waste utilization for energy production (everything that burns should be burned)
- quality requirements for waste
- raw material base may need to be reconsidered also for image reasons.

Management of hazardous waste in demolition of old buildings is under control. Demolition permits and demolition plans are required. New business opportunities rise in recycling of building materials, such as service leasing. Our suburbs need environmental impact analysis for their life cycle; are all of them good enough to be refurbished – or should some of them be demolished?

MATERIALS AND PRODUCTS

Maximal share of serviceable components will be collected unbroken to be reused when its economically feasible. Demolished parts, such as doors, windows, roof tiles, blocks, logs, floor planks etc. must be assorted to enable their reasonable reuse.

4. BEST PRACTICES FOR SUSTAINABLE CONSTRUCTION

4.1 Ecological Single-Family House (Marjala)

The aim was to develop and build a house which during its life cycle disturbs the processes of nature as little as possible, e.g. exists in harmony with nature. The house should be a simple and cheap basic house for everyone, still having good architectural quality and providing occupants good quality and flexible living spaces.

The Marjala house [13] is built largely of wood and wood products. Other keywords are local products, simple technical solutions, repetition of same details and components, thus decreasing the number of different components. The inner surfaces are coated with so called ecological materials from nature, such as wall paper, paintings and waxes. The outer paints are cooked on site or made of skimmed milk as a base material.

It gets its energy for heating and hot water from firewood and sun. There's one stove in the house and 10 m^2 solar heating panels on the roof. Heat from firewood and sun is collected and stored in a 1.500 liter hot water tank. Standby heating is provided by a 6 kW electric heater at the bottom of the tank.

The heating energy of the Marjala house is 42-50 % of that of eight reference houses. It is supplied with an owner's manual and service instructions for the next 50 years.

4.2 CFC-Free Low-Energy Office Building (METOP)

The building module prototype METOP for a low-energy office building was built for testing the performance of new structural, electrotechnical and HVAC solutions developed in different development projects of different companies. The main objective was to put into practice good indoor air quality, thermal comfort and low energy consumption simultaneously and economically.

Its heating energy consumption was measured 13 kWh/m^3 (55 kWh/m^2), which is 60 % lower than the average consumption in Finnish office buildings. The consumption of electricity was 16 kWh/m^3 (72 kWh/m^2), which is equal to average consumption. According to the measurements, there was no problems with the indoor air quality. Concentration of odors, radon, particles, microbes, volatile organic (VOC) and other chemical compounds were low. Thermal indoor climate was pleasant in winter and in summer. The satisfaction index was over 90 %.

The ground slabs were heat insulated with 120 mm thick polyurethane without CFC. The roof was insulated with a 350 mm thick layer of loose-fill insulation. Quality of construction was good and the air tightness of the building envelope was 0,8 air change per hour. The calculated U-value of the windows was 0,5 W/m^2K.

Contrary to the public opinion, this project showed that it is possible to improve the indoor air quality and energy economy and at the same time to improve the quality of the construction process and to reduce costs. METOP office building is heated with the energy produced by its own operations, almost throughout the year. In the hot summer periods, the building can be cooled with outdoor air and with the aid of a heat recovery device without refrigerators operating on CFC-refrigerants.

4.3 Energy-Conscious Dwelling (Soidintie)

The purpose was to find out the actual influence of structural and technical systems on construction costs and comfortable dwelling when ecological alternatives are favored. The goal was a 30 per cent reduction of annual heating energy without significantly increasing construction costs. First, performance and costs of various exterior walls and windows were calculated. A trade-off comparison between a better thermal insulation of exterior walls and windows and, on the other hand, building costs and dwelling comfort was performed. The results indicated the fact that a better insulation gives an opportunity of using floor and air heating based on low temperature technique.

An experimental apartment was constructed, based on the results obtained. This was Kiinteistö Oy Malmin Soidintie 10, a block of flats containing 15 apartments in Malmi, Helsinki. Eleven of the apartments were equipped with air heating and four with floor heating. All of them had individual ventilation and a heat recovery unit. In humid rooms there was an additional floor heating facility (integrated in the heating system).

Room temperatures and dwelling comfort were studied in two air heated and two floor heated apartments. Energy consumption was measured from November 1995 to October 1996. The results were reassuring: The energy consumption of the heating system was 59,1 % lower than in the reference building and 30,4 % lower than the original goal. The energy consumption (hot water included) of the experimental building was 49,7 % lower than in the reference building. The annual temperature efficiency of the heat recovery systems was 42,7 % in air heated apartments and 40,8 % in floor heated apartments.

Due to the good indoor climate the apartments are suitable for allergic persons. Some additional research on air conditioning and water systems would still be needed.

4.4 Ecological elevator concept (Kone MonoSpace)

The Kone MonoSpace elevator concept with the EcoDisc hoisting machine is innovative in many respect. Compared to present hoisting machine technologies, it:

- increases the efficiency of the space use, because no machine room is needed due to the integrated slim design
- saves energy 40-60 % in operation due to elimination of power losses
- cuts down material consumption derived from slim shape of the elevator and elimination of the machine room
- eliminates waste oil production from elevator service and related spillage hazards, because it includes no oil
- has a longer expected service life, because there is only one moving part, and the rotation speed is only 95 rpm compared to 1500 rpm of traditional technologies
- facilitates elevator construction to existing buildings.

The hoisting machine applies permanent magnet technology in the axial synchronous motor. The variable frequency and voltage converter drive together with the new electric motor enable the elimination of a reduction gear and minimize related energy losses. The traction sheave and the motor form one single part that is the only moving part in the machine.

The integrated structure with the axial magnetic flux enables so flat design that it fits between the wall of the hoistway and the guiderail and no separate machine room is needed. The machine is fixed to the guiderail and all forces are lead to the pit instead of hoistway structures.

The environmentally-sound concept is applicable to both new developments and existing buildings. The machineroom-free solution gives more freedom to architects and savings in construction time for contractors.

4.5 Ecological criteria for experimental construction (Viikki)

The City of Helsinki and the Eco-Community Project organized a design competition for experimental building in a rural area including ecologically sensitive and valuable protected waterfronts at Viikki near the centre of Helsinki. The competition aimed to save nature and natural resources, to have a high quality with regards to their architecture and functionality of the dwellings, and to be feasible to construct. The competition also was a means for a search for solutions which follow the principles of sustainable development and which could be more generally applicable. A group of building consultants devised a tool for the ecological assessment of building plans.

Viikki's ecological criteria for ecological construction [14] is a method that defines minimum ecological levels for building and estimates the ecological degree of various development projects. Minimum ecological levels for building have been dimensioned to enable their implementation in residential construction to be carried out at a reasonable additional cost. The fulfilling of ecological criteria will also achieve cost savings during the use period. These criteria, whose purpose is to serve as a guide for design and implementation, shall be appended to regulations concerning building practices at city cites.

In Viikki, increasingly ecologically conscious building will progress as a four-step process: a minimum level of ecological criteria applied to all projects, supportive PIMWAG points for significant trial projects with a high expectation value, experimental image buildings representing radical ecological construction, and follow-up studies for mapping information about projects under construction. Examples of the required minimum levels are as follows (difference from reference building):

- CO_2 3.200 kg/grm^2, 50 years (- 20 %)
- waste water 125 l/resident/day (- 22 %)
- construction site waste from building 18 kg/grm^2 (- 10%)
- waste produced by residents 160 kg/residence/year (- 20 %).

4.6 Electric and District Heating Energy Plant (Vuosaari B)

The new energy plant, Vuosaari B, of Helsinki City is starting its operation in September 1997. The plant uses natural gas as its fuel and produces a nominal electric power of ca. 450 MW. The fuel is fossil but offers the advantage of practically no particle and sulfur emissions. The NO_x emissions are low: for NO_2 only 35 mg /MJ of fuel. In comparison, modern coal-fueled plants emit ca. 50 mg/MJ, and 10 years ago typical emissions for coal were above 200 mg/MJ. Also carbon dioxide emissions are low, only 56 g/MJ (more than 90 g/MJ for coal).

The power plant produces both electric energy and district heating energy. The electric energy is produced in two stages by gas and steam turbines. The remaining useful energy (about half of the yield) is then available for district heating. The amount of unused heat (e.g. outside the heating period) is cooled by seawater. When all available energy is used the total efficiency of the plant is about 90 per cent.

About 50 % of district heat is used in the densely built area of Helsinki. The heat from Vuosaari B is lead outside of this area, to North and East parts of the city, via a new 20 km long district heat tunnel (an investment of ca. 500 million FIM). About 90 % of the building volume in Helsinki is covered by district heating.

4.7 Business based on recycling of wastes (SKJ Companies)

Steel industry of the world produces approximately 700 million tonnes of steel annually. At the same time it produces approximately 400 million tonnes of by-products, solid residues and sludges.

In addition to the reduction of waste and emissions, the efforts towards a waste-free steel industry, has created business activities based on the useful application of by-products. Recycling in the steel industry means primarily either returning by-products into metallurgical processes or utilisation of the by-products elsewhere.

In Finland there are two steelworks based on blast furnace hot metal production in Raahe and in Koverhar. In addition there are two steelworks with electric arc furnace technology in Tornio and Imatra. The integrated steelworks in Raahe and Koverhar produced a total of 2.6 million tonnes of steel, and 0.8 million tonnes of blast furnace and steel slags. Besides this, approximately 0.15 million tonnes of dust and mill scale were formed as process by-products. In Tornio approximately 0.3 million tonnes of ferro chromium slag and 0.16 million tonnes of electric arc furnace slag were formed.

SKJ Companies, a subsidiary of the Finnish steel group, Rautaruukki Oy, is responsible for utilising the by-products of steel industry. Activities cover the whole range of the by-product business from by-product treatment to product development, marketing and export. SKJ has developed into products and is marketing approximately 90% of the above mentioned by-products of Finnish steel industry totalling about 1.4 million tonnes. Slags are the largest product group by volume, and they are marketed to road construction, agriculture and the building materials industry.

SKJ companies have activities in the fields of by-product treatment, product development and technology know-how. With regard to the technology know-how SKJ also has activities within export. The primary export countries have been Russia and East European countries.

5. CONCLUSIONS

The following recommendations to the buildings sector are given:

BUILDING OWNERS
to set concrete environmental demands to the parties involved in the design process, as well as to the final product, during the initial design phase

- to set concrete goals regarding building maintenance that are based on environmentally friendly methods and include these goals in, for example, the building maintenance agreements
- assure of the productivity of one's own business by emphasizing environmental issues, quality and preservation of property values.

BUILDING USERS

- to act as a demanding customer when selecting spaces and considering the environmental qualities of the building over it's life span as one selection criteria
- to see the environmental issues as one aspect of comfort and consequently as one factor that affects the productivity of the use of the spaces
- to develop one's own activities to be more environmentally friendly in the occupied building.

CLIENTS

- to inform and analyze the owner's environmental demands regarding the construction project, as well as make sure they are adhered to
- to select the parties involved in the building project based on their expertise on environmental issues
- make sure that environmental goals are part of the owner's demands and implementation plans and, if needed, set them together with the owner.

DESIGNERS

- to consider the environmental qualities of construction materials as a starting point of the design and to develop design solutions from the point of view of environmental goals of the final product
- (one can also set goals, even if the owner is not yet doing it)
- to develop the design process together with other professionals in order to achieve the optimal situation
- to develop methods and tools which will enable the designers to control not just the statistics and cost but many other variables, such as life span and maintenance intervals, pollutants and health factors, heating and moisture technology etc.

MANUFACTURERS OF BUILDING PRODUCTS

- to see the life cycle considerations (environmental impact, life span) as the basis of product development
- to explain in the product information the environmental qualities based on life cycle analysis, together with information regarding use and conditions of use, recycling and – and stick to this
- to minimize actively the environmental harms of one's own production processes.

CONTRACTORS

- to see environmental consciousness as a factor of competitiveness and to develop one's own services to be environmentally sound
- to reduce the environmental impact of one's own business processes regarding, for example site operations, logistics and material selections

- to require readiness from the other parties (sub-contractors, material and product suppliers) to work in cooperation towards environmentally sound goals.

BUILDING MAINTENANCE ORGANIZATIONS
- to see environmental consciousness as a factor of competitiveness and to develop one's own services to be environmentally sound
- to correct one's own processes so that they are based on sound environmental thinking, show initiative and give feedback to the building owners regarding environmental issues
- to expect cooperation from suppliers and partners regarding environmental issues.

OFFICIALS
- to confirm the creation and existence of mechanisms that lead to life cycle thinking
- to consider environmentally sound construction as one criteria in all building
- to use appropriate guidance (regulations, supervision and sanctions) in order to achieve environmental goals.

RESEARCHERS
- to produce, together with other parties in the construction business, environmental qualities for entire buildings and building parts as well as methods and means to calculate them, to be used by owners, builders, designers and contractors
- to aim in one's own activities to introduce life cycle thinking as the guiding principle of design and construction process and actively implement research results in, for example, experimental construction projects
- to produce research based information to contribute to the ethical discussion on environmentally sound construction.

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7. APPENDIX 1 : MEMBERS OF THE SCENARIO GROUP

Technology Development Centre:

- Osmo Koskisto

Ministry for the Environment:

- Aila Korpivaara

Finnmap Partners:

- Harto Räty — coordinator of the national Technology Programme: Environmental Technology in Construction

VTT Building Technology:

- Ilari Aho — energy issues, building services
- Pekka Huovila — construction process, chairperson of the group, responsible for the report
- Tarja Häkkinen — building materials, sustainable construction coordination
- Markku Norvasuo — architect, secretary of the group.

8. APPENDIX 2 : FIVE MAIN THEMES

A preliminary definition for sustainable construction was given:

the creation and responsible maintenance of a healthy built environment, based on ecological principles, and by means of an efficient use of resources

five main questions were asked (using short, mailed questionnaires):

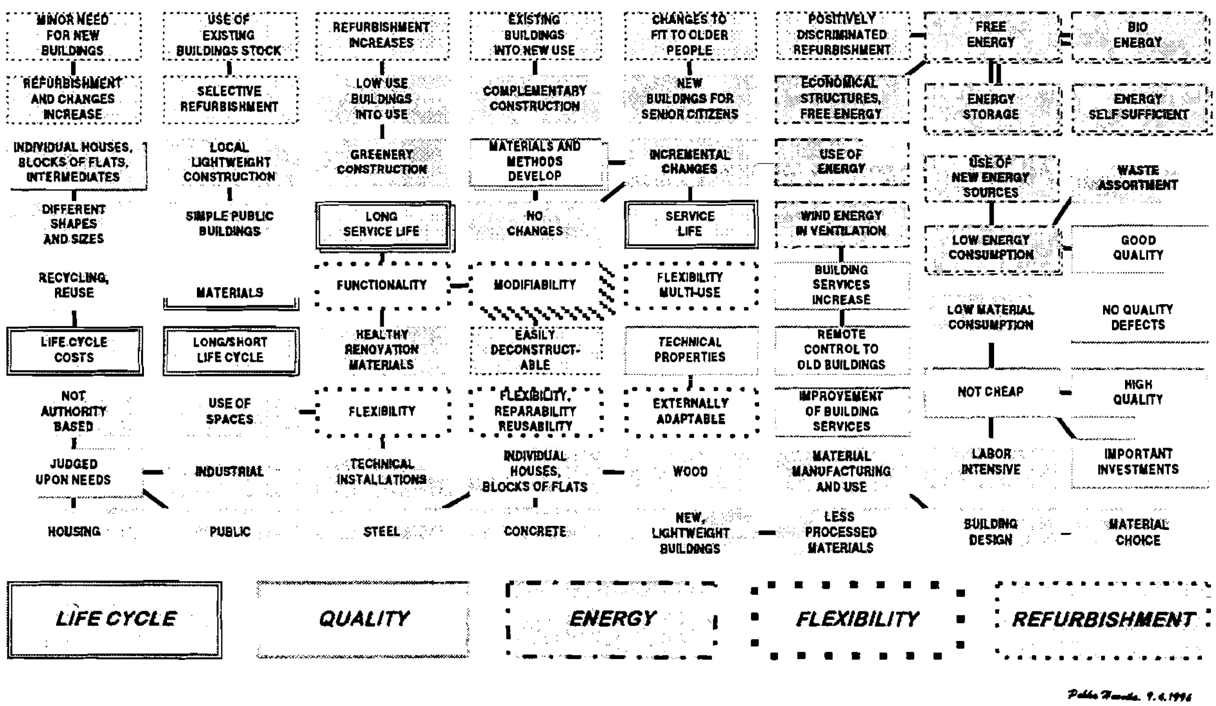
- **what kind of buildings will be built in 2010, and how will we adapt existing buildings?**
- **how will we design and construct them?**
- **what kind of materials, services and components will be used there?**
- **what kind of skills and standards will be required?**
- **what kind of cities and settlements will we have then?**

by 22 experts of different backgrounds answered:

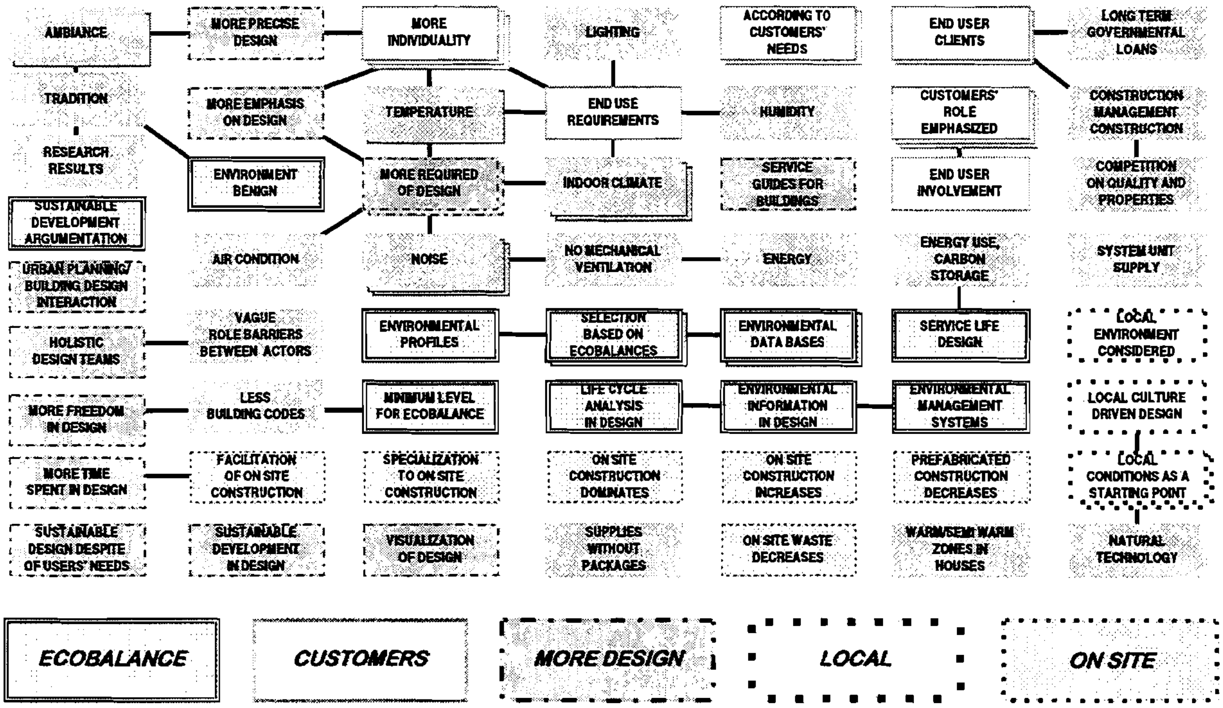
VTT building research (5 engineers & 1 architect)	**6**
VTT urban planning research (1 engineer & 1 architect)	**2**
coordinators of sustainable construction programs	**2**
building material producers (3 from the same company)	**4**
building material research organizations	**1**
engineering practice	**2**
architectural practice	**1**
contractors	**1**
professional owners	**1**
professional interest groups	**1**
nature conservation organizations	**1.**

and different "maps" of answers were obtained:

BUILDINGS

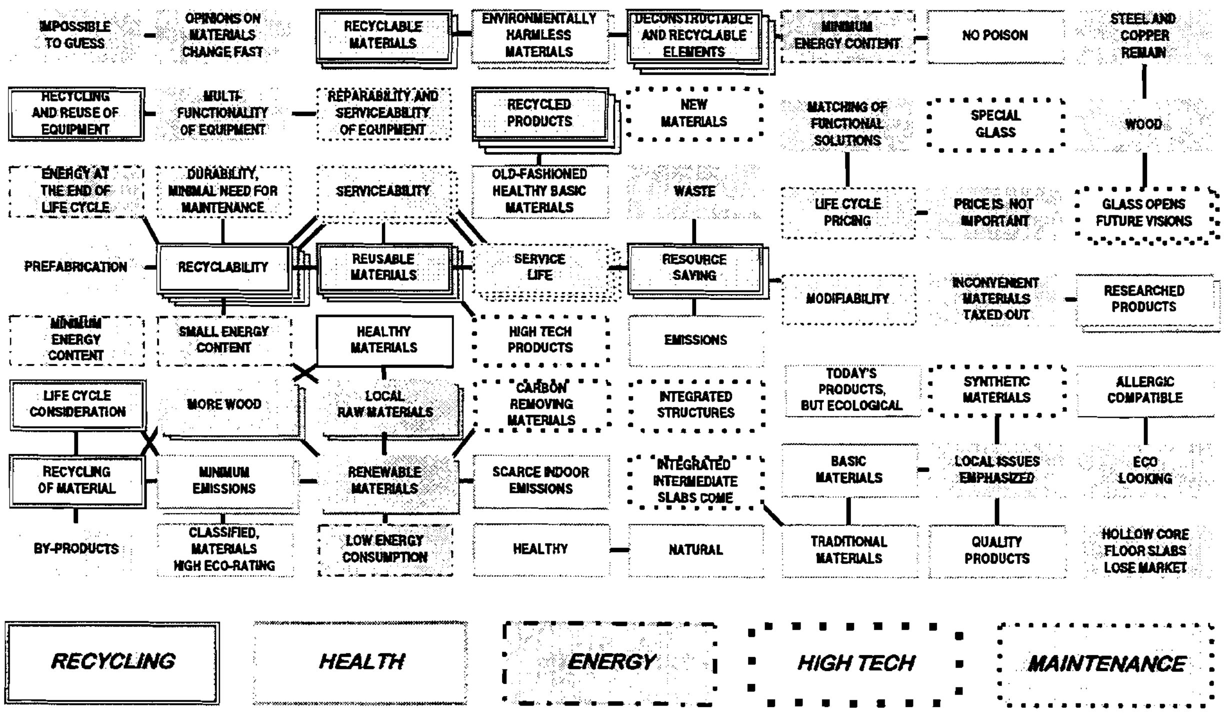


DESIGN & CONSTRUCTION



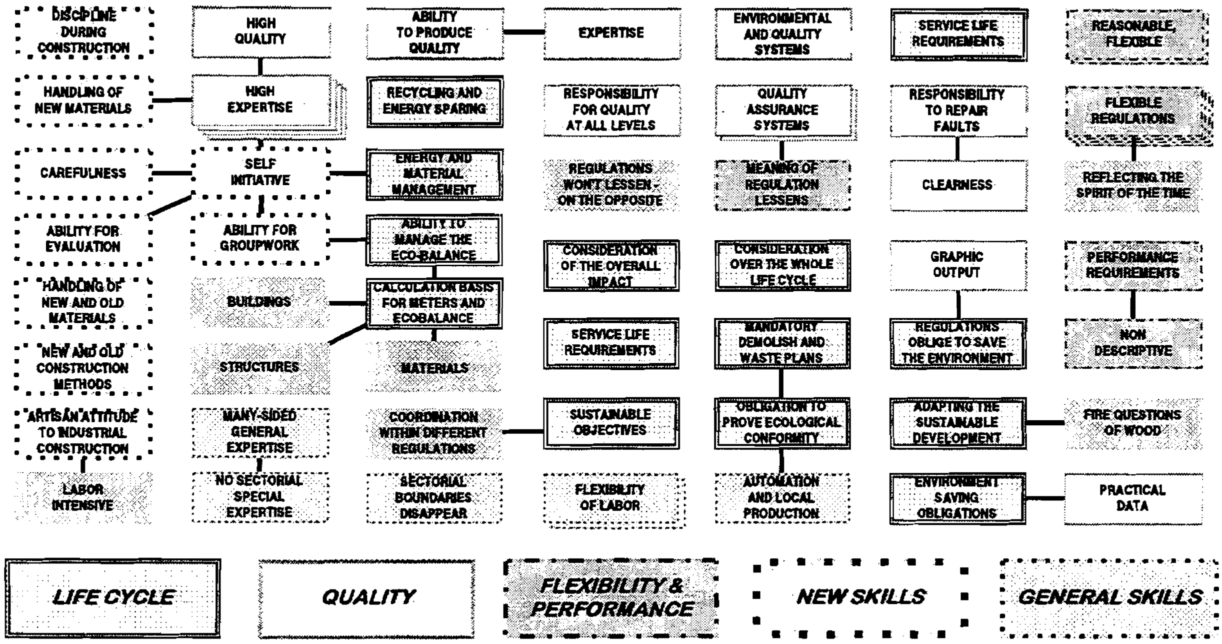
Pekka Huovila 9.4.1996

MATERIALS & COMPONENTS

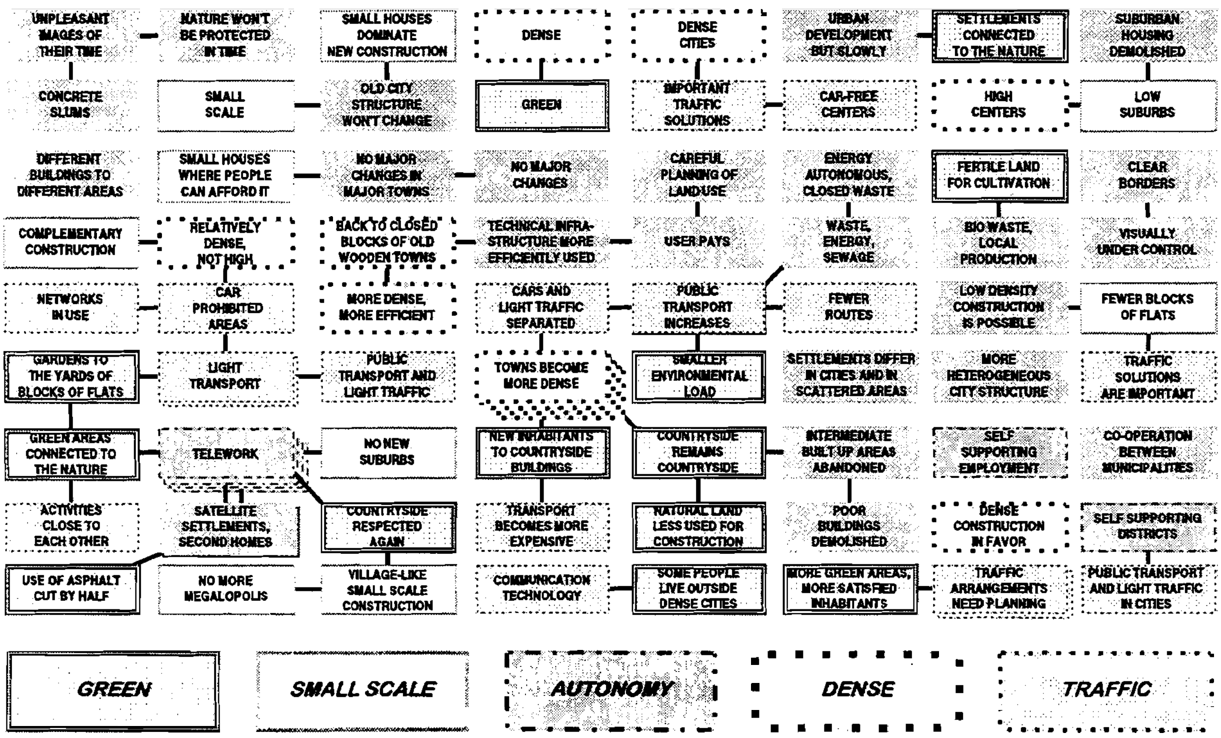


Pekka Huovila 9.4.1996

SKILLS & STANDARDS



CITIES & SETTLEMENTS



These results present a range (of clusters) of answers concerning possible (desired) sustainable futures. The focus was not to describe that future and its boundaries in detail, or to explain how it could and should be realized.

REPORT 3

SUSTAINABLE DEVELOPMENT AND FUTURE OF CONSTRUCTION IN FRANCE

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION

1.1 'Sustainable Development' : a new concept about what?

'Sustainable development' is today about to join the 'charts ' of spread out phrases such as 'society of consumers', 'zero growth' or 'the thirty happy years', without clear ideas about the real meaning of this concept or the deep changes that will be derived in our day-to-day practices.

This concept was defined in 1987 by Mrs Gro Harlem BRUNTLAND, in her report to the World Committee on Environment and Development, as « a development which meets the present needs without endangering the capacity of the future generations to meet their own needs ».

Another author has proposed to define the sustainable *urban* development as « a process leading to changes in the built environment, which will favour the economic development while preserving resources and saving human, community and ecosystem integrity ».

As a matter of fact, even if the phrase 'sustainable development' carries along a lot of ambiguities and is a source of confusing - particularly in the French building sector where the word 'durabilité', which is close to the translation of 'sustainable development', i.e. 'développement durable', often refers to the life span of a construction or its components -, it is sure however that it is a paramount stake for the future of our world, our society model, and, to a smaller extent of course, the professionals of the building sector.

1.2 How buildings are concerned ?

The concept of 'sustainable development' often refers to the notion of product life cycle. In that sense, since a building must be seen as a product, it is obvious that we have to look at the environmental constraints from an industrial point of view. But, this is not sufficient.

As a matter of fact, the builder of a building, a quarter or a city modifies the *physical*, but also the *socio-economic* tissue on which he operates, not in a lasting way but definitively, without any real possibility to go 'back' to erase the causes of the damages which can appear later. The challenge we are facing today is not only to find the best balance between the present various constraints of the building process - technical, architectural, social or cost constraints -, but also to try to favour 'without regret' decisions and, consequently, to strengthen the importance given to *long term* aspects in the choices that the building process requires permanently.

Moreover, the operation of the built environment has every day, a great influence on the immediate surroundings, and therefore on the global urban life environment.

It can be concluded that the management of the built environment should only be envisaged with a global approach, i.e. integrating the life span of building much further than its production alone and even further than its life cycle. The manoeuvring capabilities in this domain are so far unknown and a priori depend on numerous factors linked to the complexity of relations and the rarity of the 'raw material' which is available and usable on a individual plan.

1.3 State of the Art and Specific Issues

In France, interest on environmental problems appears only in the late 70's which were marked by some major ecological accidents. The Ministry of Environment was created at that time. The Rio Conference, which was given a high media coverage, speeded up this trend. The "contaminated blood" and "mad cow" affairs have, more recently, strongly affected the population, but have also revealed the complexity of an anticipation and a control of the risks in the absence of scientific certainty. At last, the first circulation constraints in Paris were decided last year for air quality.

The practices of the consumers are still not very ecological and, even if one can note a real acceleration of the innovations in the eco-industry, those do not have spectacular effects on consumption. However, the on-going changes in the country are much more important than the changes of the behaviours can show it today. The awakening of the environmental stakes seems right now to have major effects in the society.

In France the concepts of sustainable development, and of "sustainable construction" are quite new. It is only at the end of the 80's that the problem of the links between environment and buildings is really raised. However, the problem of energy savings in buildings has been the topic of a lot of development in France since the oil crisis (and even before). Several energy standards were set up in France since the 70's and the last one in 1989 introduced an advanced approach taking into account all energy consumption factors in the dwelling sector.

The main other environmental preoccupation factors in the construction sector were so far the problems of lead and asbestos, the problem of community wastes, the problem of CFC substitutes in building products and equipments (insulation products and cooling systems), the saving of water in flush systems, and the development of the use of recycled materials for road construction.

However in the early 90's the CSTB initiated a large research program on this topic, and in 1993 the French Equipment Department "Plan Construction et Architecture (PCA)" launched a call for proposals to develop experimental building projects with a High Environmental Quality ("Bâtiments HQE"). Thirteen operations have been launched and supported so far and are being monitored and analyzed by the PCA and the CSTB. The five main aspects considered in these operations are: environmental quality of the construction products, water management, visual comfort, site integration, and environmental management.

This Departement launched also in 1993 with the "Agence de l'Environnement et de la Maîtrise de l'Energie" of the Industry Department a research and demonstration call for proposals on "Environmentally Friendly Products, Techniques and Methods". The goal of the Program was to reduce the nuisances susceptible to be caused by a building site, while being concerned by keeping the technico-economic profitability of the building sector. A total of 11 specific construction projects were completed. They deal with one or several kinds of nuisances susceptible to be caused by a building site: waste management, acoustic nuisances, traffic and parking problems, ground and water pollution.

Some "ecological" schools were built (Maximilien Perret, Calais) and some others (Limoges) are under construction.

1.4 The French BâtiVille Club

The BâtiVille Club is a future studies group created by the 'Centre Scientifique et Technique du Bâtiment', the 'Agence de l'Environnement et de la Maîtrise de l'Energie' and the 'Centre de Prospective et de Veille Stratégique' (Direction de la Recherche et des Affaires Scientifiques et Techniques - Ministère de l'Equipement) in 1993 to gather actors of the building sector who are interested in carrying out collective studies in the future domain.

After a preliminary future study called "Bâtiment 2030" which allowed to propose four scenarios of the built environment, the club launched in 1995 a subgroup in charge of thinking over the concept of 'bâtiments durables ' (sustainable buildings), with the collaboration of the Dumez company.

The objective of the subgroup is to try to define this concept by identifying and listing the elements to be clarified to stabilise the concept. The subgroup also seeks to determine the research orientations needed for the design and the construction of buildings in a view of sustainable development.

This activity is complementary to the scientific and technical analyses of ATEQUE. It is a future study since it looks at what we will build and retrofit by using the findings of the upcoming studies.

2. DEFINITION OF 24 CRITERIA FOR SUSTAINABLE BUILDING DESIGN

2.1 Scope and methodology

The concept 'to build without regret' means that the builder has explicitly taken into account the future, i.e. in some way the life cycle of the building which is to evolve during its operation and get value till its destruction. The purpose of the approach is therefore :

- to identify and to precise how short-term, mid-term and long-term interests can converge,
- to see how to integrate into the pre-design phase the know-how, the methods and the experience gained during the other phases of the building life (Figure 1).

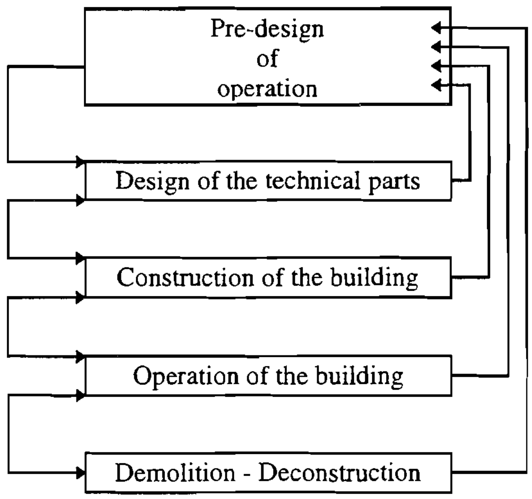

Figure 1 : Two ways principle between the pre-design practice and the life cycle of a building

In order to analyze the whole process, the BâtiVille Club has elaborated a set of 24 criteria which concern the totality of the life cycle of the building from its birth (design stage) to its death (demolition phase). Starting from this set of criteria, it would then be possible:

- to identify appropriate research and development orientations on the entirety of the technical and socio-economic sub-sectors and domains of the building sector,
- to develop pertinent design tools taking account of all the relevant factors.

Different kinds of buildings could be analyzed through the set of criteria. The analysis method which was used is based on a functional analysis, element by element, of all the components of the building, from foundations and substructure to achievement and finishing.

Therefore three steps can be identified in the progress of the study:

- definition of a typology of buildings, based on constructive methods and volumes,
- definition of a functional and time based breaking up of buildings, from the construction phase to the retrofit and demolition phases, leading to a definition of a set of sustainability criteria,
- close examination of each family of buildings through the set of criteria.

The results obtained so far and presented here deal with the second step.

2.2 The 24 sustainability criteria

Following the methology described above, a list of 24 criteria has been defined. Only two kinds of buildings have been selected : dwellings (diffuse houses, intermediate grouped houses and blocks of flats), and two kinds of buildings of the tertiary sector : office buildings and large commercial buildings. The time based analysis has been carried out from three phases of the life cycle of buildings : construction, operation and retrofit / demolition.

This led to the set of criteria presented in Figure 2.

- The first phase involves the technico-economic optimization of the project, the site activities and the resources subtraction.
- The operation phase also implies the resources subtraction, complemented by the maintaining of the use functions during the life of the building, the management of the interfaces with the surrounding tissue (utilities), and the contribution to the social and urban life (links inside the city, communications, access to the city, security,...).
- At last, the retrofit / demolition phase includes, on one side, retrofit and refurbishment, and, on another side, demolition and deconstruction.

The criteria have been classified in two families: direct criteria and indirect criteria. The direct criteria involve impact factors in terms of physical pollution and have effects on resources depletion, area degradation and pollution growth. The indirect criteria are all the other criteria, expressly those with a socio-economic character. They have only an indirect influence on the life environment and the human relations.

The close examination of a building through the set of criteria is done one element after each other. The notion of 'sustainable development' applied to each element of a building is in fact a dangerous exercise mixing various impacts on the environment, which can be either measured quantitatively or just assessed on a qualitative way. In order to carry out this exercise in a pertinent way, the subgroup has also decided that he could say that he is not able to give a appraisal in the actual state of the art in a given domain. In such a case, it is said that the criterion is either 'without object' or needs additional studies.

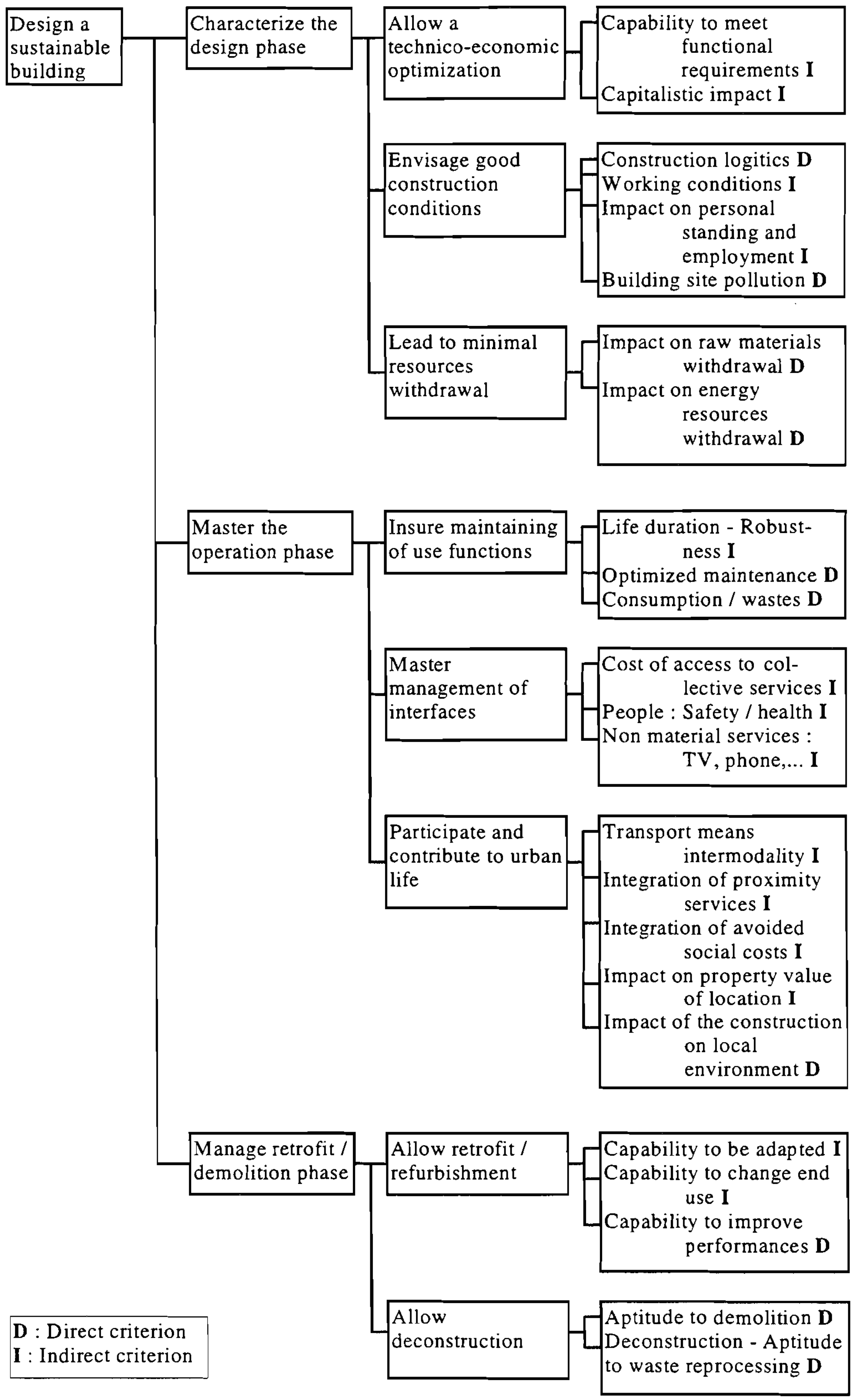

Figure 2 : Treelike outline of the analysis of a sustainable building

3. ANSWER ON MAIN QUESTION AND 5 SUBQUESTIONS

3.1 Introduction

3.1.1 Applied Methodology

The methodology applied in the framework of the French participation to Phase II of the CIB W82 Project was to organise a brainstorming meeting with experts from the building sector in order to collect answers to the five questions defined in the CIB Project.

About fifteen experts[1] from the BâtiVille Club participated in this brainstorming meeting which took place in the CSTB premises in Paris on the morning of 8 February 1996. The five questions were presented "on a wall" to the experts who were free to answer without following any order. The leader of the group was just put in charge to launch again the reflections when he felt that a topic had been enough discussed.

After the meeting, the recording of the discussions was analyzed in order to edit the report with a dispatching of the results into five chapters corresponding to the five questions of the CIB project.

3.1.2 Time Horizon

Taking into account that things are moving rather slowly in the building sector, due to, on one side, the inertia of the built environment which makes any innovation in the new buildings to take a long time before spreading into the built environment, and, on the other side, the large number of actors and the stability of the sector, the group of experts considers that the time horizon which has been chosen (2010) can be seen as a short/mid term horizon. The changes mentioned by the group are to be considered as only a step towards more important changes which could take place later, always if the assumption of a sustainable development occurs.

3.1.3 Reflection Scope

The group has considered that its reflections cannot be reasonably focused only on the concept of environmental quality but have to be enlarged definitely towards the larger notion of "sustainable building", which is supposed to contain in particular the notion of affordable costs. Therefore the purpose is to consider the assumption of a

[1] The author wishes to acknowledge the experts who participated in the brainstorming session organised in the framework of the Club BâtiVille : Messrs Angioletti (Ademe), Blachère (Auxirbat), Blondy (Ateque), Boudjouher (Edf), Collet (Graph), Mrs Coudret (CSTB), Messrs Coulon (Edf), Gobin (Dumez), Henderieckx (CSTC), Lajouanie (Ademe), Lepoivre (CERIB), Moch (Ademe), Mrs Setbon (Ademe), Mr Weckstein (CSTB).

development without compromising the future (develop "without regret"), and not only the assumption of a protection of the environment independently of the general context of the sector.

3.1.4 Macro-economic Context

The group has wished defining some elements of the macro-economic context in which it could put its reflections. As a matter of fact, this context is very important when defining future scenarios (see the study "Building 2030").

The initial framework of the project of CIB W82 does not define this context, excepted for the time horizon (10-15 years) and for the assumption of sustainable development. The other factors are not detailed ; in particular, do we assume a low, moderate or high economic growth ?

Since some of the answers can depend on this context, the group has decided to assume present trends such as : a low demographic context, an economic growth between 0 and 2 %, an unemployment rate rather high, and no large migration flows. The group will give if necessary in its answers some details if some sensitivity to the macro-economic context is identified. The group will also precise if, taking account of these assumptions, the changes it foresees must be seen as heavy trends or if they should show some uncertainties.

3.1.5 Need for a More General Debate

While agreeing on the interest of the five posed questions - which indeed deal with technical aspects - the group wonders, since everybody is in fact convinced that we have to "go towards a sustainable construction", if the question should not be more focused on the need for organizing a debate on the topic "how to go there". Should this CIB action not be widely taken over by the specialized press in order to pose the real questions as those about environment and costs ? Should the changes not be suggested by scientists rather than by professionals, whose immediate interests, in a logical way, do not go generally towards these aspects ?

3.1.6 Need for Reflections about Stakes

Reflections about present and foreseen stakes are also necessary in particular order to push to the birth of a regulation body able to take account, in a neutral and non partial way, of the different aspects of the problem.

3.2 The answers

3.2.1 What Kind of Buildings will be Built in 2010 and How will we Adapt Existing Buildings ?

3.2.1.1 Will an "Environmental Demand" Really Emerge ?

3.2.1.1.1 The "environmental demand" cannot be disassociated from the other aspects of the demand

Everything will depend on the **emerging of a demand** : will we build or will we not build any more ? will dwelling get unchanging or modernized ?

3.2.1.1.2 The demand will be stimulated by a growth of "immaterial" aspects

We can imagine a decrease of the domination of the offer and a growth of the demand, particularly under the effect of the **influence of information and communication.** When the questions are well defined and the demand well expressed, the offer will get adapted to the demand and not the demand to the offer. This outburst of information will deal of course with the way of living, but also with the quality of life both inside and outside the building. The power of information will be the generator of the power of response.

3.2.1.1.3 The demand could remain ambiguous

However this **demand** could prove to be **ambiguous** (demand for quality of life but also for consumption) and ask for making choices.

3.2.1.1.4 The looming sensitivity of users could be not lasting

In Some countries, an approach is to set up a **series of rules** which lead to a sustainable dwelling and a **series of concepts** which can be related to them. Some experimental operations are planned following these rules and concepts. How will occupants feel their effects and will the **sensitivity** be still present in 2010.

3.2.1.1.5 The influence of changes in the desires of users is uncertain

There will be certainly some **changes in the desires of users**, but they cannot be precisely predicted today (individual houses, houses close to working places,...?) particularly because of the large influence of the economic context.

3.2.1.1.6 The lack of an economic pushing factor is unfavourable

The current context is not the same as the context which led to energy savings because of the **lack of an economic pushing factor**. The payback of investment does not exist or practically not here. The slow progress of changes in the new construction sector could lead to a demand coming from the only "ecological people".

3.2.1.1.7 The influence of external factors can be poorly defined

A lot of questioning relates to the evolution of **external factors**. However, **some general trends** can be brought out which are mentioned hereafter. As a matter of fact, due to heavy influences for example at the European level, it is likely that several aspects must be evolving.

3.2.1.1.8 A need for pragmatic design and construction tools

Following the Netherlands which have developed and diffused about 160 practical rules for environmental design and construction, it is through **pragmatic and didactic tools** developed with professionals that the goal will be favoured ; it is the only way in order that people realize the need for adapting the construction practice to sustainable concepts. These tools should however avoid the pitfall of the "red lists" or putting miraculous materials forward.

3.2.1.2 New or Retrofit ?

3.2.1.2.1 More results in the retrofit sector than in the new buildings sector

As a matter of fact, the two sectors have to be clearly distinguished. In the **new buildings sector**, 2005/2010 is only a **step**, without a lot of sure results. The assessment of new constructed buildings can be done only after a large period of time. Consequently, results in terms of impacts on the building stock, which can be obtained only after the spreading of technologies firstly tested, then validated, will be observed only after a large period of time. On another hand, in the retrofit sector, in which paradoxically there are today only very few studies and works, but which is already a large demand market, much more results are expected and should be observed.

Operations will be dominated firstly by **retrofit then**, after an upper limit of the number of possible operations (and a change in mind of people which today in some countries do not accept any longer that old buildings are destroyed to build new ones), we should observe a "**come back**" to new construction (after 2010 ?).

3.2.1.2.2 Experimental operations and criticism in the new construction sector

A lot of experimental operations will be carried out (pilot operations) and these will lead to **a lot of criticism**. For example, it must be known that the few experimental operations which are carried out today (ecological villages) do not meet the present quality standards, just because this is not possible. It must be feared that these operations may have a negative effect.

3.2.1.3 Role of Public Authorities

3.2.1.3.1 A possible mid/long term program in the construction sector

There will be possibly a mid/long term program (20 years) in the construction field.

3.2.1.4 Tertiary Sector and Flexibility

3.2.1.4.1 The tertiary sector modified by teleworking

The tertiary sector will be submitted to the **influence of "teleworking"** and Information Technologies : decrease of areas, office sharing, reallocation of spaces,... (examples of IBM applications). The IT evolution should go faster in the tertiary sector than in the dwelling sector. The link with the decrease of the travelling needs is not obvious, taking into account the demand for meeting that should last in spite of it.

3.2.1.4.2 Taking account of spaces flexibility

"Spaces flexibility" will be probably taken into account.

3.2.2 How will we Design and Construct them ?

3.2.2.1 Other Main Constraints

3.2.2.1.1 Importance of the user

There will have been diffusion of the **importance of the user** from the urban problems towards the building aspects.

3.2.2.1.2 Importance of the financial aspect

A major problem will be the problem of the **payback of the investment** necessary to construct sustainable buildings.

3.2.2.1.3 Resources savings

Though these aspects are today relatively a little considered in France, unlike some other countries, there will be probably a search for **capitalistic and human resources savings**, together with a **decrease of the part of the costs of non quality**.

3.2.2.1.4 Possible decrease of costs

There will be probably a very strong influence of **a search for decreasing building costs** ("affordable housing"). But who or what will have been the driving force : political action, "keys on the door" suppliers,...? As a matter of fact, the problems of construction costs, insolvent demand, overcosts, have been mentioned for several years, without any real evolution. The absence of the final user, who is the only real interested actor, in the construction process explains this fact probably. The development of "keys on the door" process could increase the power of the final user.

3.2.2.2 Major Modifications

3.2.2.2.1 Aspects health/environment

Taking into account the permanent questions asked to industrialists on the **potential impacts** of their products or their manufacturing **on environment and health**, there will be inevitably consideration of these impacts on the various components of buildings.

3.2.2.2.2 Home waste management

There will be **modifications in the building design** due to taking account of the **management of home waste.**

3.2.2.2.3 Emerging of the life duration mastering

There will be an emerging of the concept of "**life duration mastering**".

3.2.2.2.4 Strengthening of energy savings

Energy savings will be strengthened (goal : -25%) : new facade components with a positive energy balance, ventilation management, energy control management,... However, with regards to facade components, it must be kept in mind that their performance will, on one side, strongly depend on building location and use, and, on the other side, have a direct link with the comfort conditions created in the spaces. Consequently, the way these components will be integrated in the buildings will be much more important than their own characteristics.

3.2.3 What Kind of Materials, Services and Components will be Used Then ?

3.2.3.1 What Basic Technologies

3.2.3.1.1 Uncertainty about basic technologies

With **which basic technologies** will buildings be constructed ? Will the "rules" already established in some countries such as the Netherlands have drastically modified technologies or will they have just led to select some of them ?

3.2.3.2 Adapted Materials

3.2.3.2.1 An uncertain emerging of sustainable materials

Sustainable materials will have emerged only if a **real debate** is given rise to.

3.2.3.2.2 *Today materials but adapted*

Will we observed the birth of new materials or a rebirth of forgotten traditional materials ? Will there be a spreading of the application of LCA concepts ? Probably we will observe the **same materials as today but** these materials will have been adapted, with new properties, new performances,... In particular, their environmental harmlessness will have been increased (materials which can be easily separated, materials without toxic fumes,...). On another side, a recycling economy will have been organized, even if the low added value which characterizes building materials, and therefore their high sensitivity to the costs of inputs, will have made difficult the use of recycled products.

3.2.3.2.3 *Asbestos problem will have been solved*

Considering the consequences for health and the scale of the problem in most of European countries, it is almost certain that solutions, of course maybe costly, will have been developed and that the **asbestos problem** will have been **fully solved**.

3.2.3.2.4 *The "black lists" danger*

It must be mentioned the important risk of having - **black scenario** - **"black lists" of materials, solutions,...** in case of lack of available training and scientific tools.

3.2.3.2.5 *Regionalization of construction*

It will be probably observed a larger use of **local materials and technologies**.

3.2.3.3 *New Equipment and Components*

3.2.3.3.1 *Facades with a high interface role*

It will be observed an emerging of the concept of **interface facade** at the inside and outside. From an architectural point of view, we could thus have a framework based on the notion of plates and mixed supports (wall-posts) which leaves a high freedom at the facade level. However, the outside facade will be mainly determined by the necessary continuity with the urban environment in which the building will be integrated. Only the inside facade will have more freedom and will enable a high flexibility to be adapted to various internal requirements.

3.2.3.3.2 *Priority to comfort aspects*

The **comfort aspects** will have taken a large importance, but the consequences on buildings can be hardly identified today.

3.2.3.3.3 Waste and effluent reduction

The aspects **waste and effluent reduction (including domestic waste)** will have also taken a high importance. However consequences cannot be foreseen today.

3.2.3.3.4 Environmentally free building sites

This is the same situation for "**green building sites**".

Particularly with regard to building site waste, we can wonder about what will constitute the driving force which will perpetuate reprocessing. The development of new taxes is a priori today highly unlikely, and the only public pressure on the local authorities with a refusal to have a degradation of environment could maintain the impulse. It must also be noted the non toxic feature of building waste and consequently the low criticity of the reprocessing. Added to the difficulty of carrying out controls and enforcement actions on a very diffuse profession (craft industry), this low criticity could delay the development of the reprocessing of this kind of waste.

3.2.3.3.5 Equipment for saving water

The cost of water will have largely increased (an average increase of 10 to 15% per year until 2005 is foreseen today) due to the necessary connecting of the biggest part of the cities and therefore of the population to draining networks, which will lead to strong impacts on the uses and probably to an **unavoidable adapting of buildings and equipment**.

3.2.3.3.6 Likely development of indoor cooling

Under the effect of an always higher demand for comfort and under the driving effect of office and car cooling, it is likely that **cooling** will also have been **largely developed in dwellings** (some experts estimate that 20% of the building stock could be equipped within some years). The only design of ventilation, shading protections, facades and thermal inertia will not be able to solve, with passive or hybrid means (see the example of cooling floors), all the summer comfort problems.

3.2.3.3.7 A ventilation for a high air quality

We will observe **modifications in ventilation and indoor air quality systems**. The current sensitivity to outdoor air quality will indeed spread to indoor air aspects. This sensitivity will lead to new technical solutions (confining, filtering,...?).

3.2.3.3.8 From immovable to movable

We will observe a **decrease of the cabling** and a trend **from immovable to movable objects** (equipment which is taken with him by the user when moving).

3.2.4 What Kind of Skills and Standards will be Required ?

3.2.4.1 A very weak regulations driving force

Taking into account the political and economic context in which we are today (deregulation, budget deficit reduction,...), it is likely that we will not observe the evolution which occurred in the context of the French energy savings regulation in buildings, that is to say with a very voluntarist policy, even if it would be desirable to follow the same approach (research, experiments, labels, regulations). This approach can however **be envisaged for aspects** where there is a strong social demand **such as health**.

3.2.4.2 Technologies in continuous progress

Technologies are **neither ready nor well defined**, contrary to the situation, generally speaking, after the energy crisis (a comparison could be made with bioclimatic technologies).

3.2.4.3 New skills

There will be a development of activities linked to **co-ordination and management of projects** in a view of **performance and inconsistencies management**. This performance management will have been well understood by actors and will have contributed to the emerging of a demand for sustainable performances.

3.2.5 What Kind of Cities and Settlements will we Have Then ?

3.2.5.1 Less acute suburbs problems

Urban and social dysfunction will be **decreasing**, as the problem is today emerging and will be the subject of a lot of particular attentions, with, for example, heavy retrofits of buildings and urban quarters.

3.2.5.2 Lots of unknowns

But **which town planning** ? **Which country planning** ? **Which** material and non material **networks ?**

3.2.5.3 No major disruptions

Towns and villages will have the **same** general features **as today**. Industrial activities will be still concentrated in urban poles, even if it can be envisaged a certain transfer towards middle size towns. The development of a settlement mainly trending towards individual houses in the country side seems therefore very unlikely.

3.2.5.4 No "ecological villages or settlements"

There will **not** be "**ecological villages or settlements**", excepted in some very particular cases.

3.2.5.5 A regional country planning

It can be envisaged a rather large **country dissemination of activity poles**, in spite of an uncertain economic viability, due to a "political listening" regarding regional "cases", which will be favoured for example by tax breaks. But this would not of course constitute a large percentage of the economic activity of the country.

3.2.5.6 A taking account of urban transport in building design

The possibility of having cities without cars must not be rejected. **Other transport means** (public transports, one-person transports, electric cars,...) could have appeared with some consequences for buildings for example at the levels of parking means, power supply systems or even the building geometry.

4. MAIN GENERAL CONSEQUENCES FOR THE WHOLE CONSTRUCTION INDUSTRY

4.1 Introduction

At the Sophia Antipolis Meeting it was agreed to use a common format to present the various national results. This format is based on a multi-dimension analysis of the problem such as described in the minutes of the meeting. Three dimensions were introduced :

- ecological principles (six principles are defined in the construction field in order to meet the three basic goals of a Sustainable Development: to eliminate resource depletion, to eliminate environmental degradation, and to create a healthy interior and exterior environment),
- resources (four resources are concerned: land, energy, water and materials)
- life-cycle phases of the construction process (five phases are defined: develop and plan, design, construct, operate, deconstruct).

The various aspects introduced in the 24 domain based definition of Sustainable Construction have been dispatched and detailed in five tables which correspond to the five life-cycle phases of the construction process (APPENDIX 1). It can be seen that several aspects cannot be associated to any of the resources and principles defined in this approach. These aspects deal generally with human, social or financial topics. However a global approach of Sustainable Construction cannot be envisaged without taking account of these aspects. Therefore the various aspects of the 24 criteria are presented below through a simple listing.

4.2 Consequences per phase

4.2.1 Development and Planning

- Optimize impacts on property value of the place : image, comfort, vacancy rate,...
- Limit space occupation impacts on green spaces,...
- Protect flora and wildlife (trees, protection areas,...)
- Limit space occupation impacts on ground water and run-off
- Optimize costs of access to collective services : costs of connections (water, gas, electricity, highways, services), costs of evacuation (water, gas, domestic waste), costs of operation
- Master traveling needs : access to transport means (nearness to collective transport means, parking optimization,...), safety of traveling (parking, pedestrian ways, outside spaces,...)
- Accommodate proximity services : meeting room (space and management), services (shops, city representation,...)
- Optimize space design and social costs : stairwells, housing blocks, quarters,...
- Respect residents and surrounding buildings (shading masks, view obstruction, noise,...)
- Calibrate impacts on capital (technical costs, put off costs, housing subsidy costs)

4.2.2 Design

- Choose products with low energy content (local products, reduce transports)
- Reduce component weight
- Use innovative or natural technologies
- Optimize building weight
- Use recycled products
- Insure use functionalities : space, climate, protection, equipments, relation mastering, site integration, sense bearing
- Insure no health risks
- Increase durability
- Increase robustness
- Optimize maintainability (easiness, accessibility, modularity,...)
- Optimize internal flexibility (spaces, indoor climates, equipment connections,...)
- Optimize use changes capabilities (structures, equipments,...)
- Optimize performance improvements capabilities (indoor climates and protections, equipments
- Optimize abilities to be deconstructed (site accessibility, nuisances,...)

4.2.3 Construct

- Reduce squandering (plan right quantities, re-use offcuts,...)
- Insure flora and wildlife protection
- Increase waste management

- Insure ground water protection
- No air pollution
- No soil pollution
- Building site without noise
- Limit traffic needs
- Decrease task hardness (definition of tasks and operating methods, adapted tools,...)
- Secure tasks
- Pleasure at work (good living conditions at site, site cleanness,...)
- Impact on self-actualization (interest at work, image,...)
- Optimize building site logistics : supplying, delivering, executing, controlling

4.2.4 Operate

- Optimize energy consumption
- Optimize water consumption
- Recycle gray water
- Use rain and run-off
- Master fluid waste
- Master gaseous waste
- Master domestic waste
- Optimize consumptions (in operation loads equivalents)
- Mastery of communications (access to networks)
- Insure no health risks

4.2.5 Deconstruct

- Marking of products to increase selecting abilities
- Collection on building or specialized site
- New assembling methods
- New connections
- Operating manuals
- Waste treatment
- Final waste treatment

5. MAIN RECOMMENDATIONS TO THE ACTORS

5.1 Focus on Important Recognized Aspects

Behind the phrase "sustainable development", which is often today hackneyed and also more and more used as a "suitcase concept" into which a lot of various and diversified questions can be put, it can be distinguished in fact a certain amount of issues that the building sector cannot ignore.

In order to avoid overdiversification in a sector for which innovation is not the main consideration of every day, it seems important to focus attention on some specific but important aspects on which consensus and appropriation could be reached certainly.

These aspects should be clearly linked to the general concept of Sustainable Development. The Bruntland approach has initiated a large concept, but it turns out today that 4 main simple issues can be used to define the concept.

5.2 Fit Sustainable Development on Four Simple Issues

Four main simple issues can be used to define Sustainable Development for non-expert people :

1. SD encompasses the idea of development with an economic growth, but...
2. SD must take place without signing mankind's life away,
3. by taking also account of natural and cultural heritage,
4. and trying to ensure an inter- and intra-generation solidarity.

These four issues are still very large, but can be easily accepted and memorized, even if they can lead to numerous constraints and incompatibilities.

As far as the building sector is concerned, and if the first issue is put apart since followed for many years by the sector, the three last issues give birth to numerous problems which have been detailed above but which, generally speaking, can be classified into three main categories : physical (or "environmental") problems, biological (or "health") problems and sociological problems.

5.3 Approach Sustainable Construction through Three Problem Categories

Three categories of problems can be identified behind the notion of Sustainable Construction. These three categories are the following :

1. Physical problems : these problems come from the issue of taking account of natural heritage, that is to say, on one side, the management of resources shortage (essentially energy and water), and, on another side, the management of damage caused to the earth (essentially greenhouse effect). These problems will lead to recommendations that aim at decreasing the impacts of the building industry and activities on environment.

2. Biological problems : these problems come from the issue of not signing mankind's life away. These problems will lead to recommendations aiming at avoiding any damage which could be caused to the mankind's health, either in the outside environment, or in the inside environment of the buildings.

3. Sociological problems : these problems come from the issue of ensuring an inter- and intra-generation solidarity. These problems have several facets which are sociopolitical, socioeconomic or sociocultural (preservation of cultural heritage for instance) facets.

If the first category seems to encompass very rational problems, the second and above all the third ones introduce some irrationality. As a matter of fact, a lot of uncertainties still remain on the knowledge of the effects on health due to many factors. However, it is sure that these effects cannot be put apart and that these problems must be tackled with the same priority as the problems of the first category. Only the third category could be treated at a different level with a lower priority, at least in the "Sustainable Construction" problematics, as far as the major risks linked to the previous issues are not totally eliminated.

5.4 Main Technical Recommendations

The basic mission of a building has ever been to protect man against natural elements. The main efforts so far have been focused on the improvement of the ways necessary to fulfill this mission, that is to say on the improvements of the global quality of the building and the mastery of the corresponding costs.

Today, the notion of sustainable development introduces an additional constraint which is to fulfill this mission without compromising the possibilities of future generations to meet their needs.

As a matter of fact, a building has an environment impact which goes far beyond the classical notion of investment. On another hand, the internal environment created by a building must satisfy higher and higher requirements linked to indoor climate and health.

The 24 criteria described above lead to a lot of consequences for the building sector, which have been listed in the previous chapter per phase of the building process. To try to define priorities between these different aspects is not possible so far in a scientific way. However the protection of environment and health should be in the hearth of the strategic choices of the actors of the building sector.

After reviewing all the aspects which have been identified in the study and taking account of the prioritisation principles mentioned above, it turns out that the following main recommendations can be made, as far as the French context is considered.

5.4.1 Going on with Energy Savings Policy

A lot of efforts have already been done in the building sector to decrease energy consumptions. Some additional ones can be done at short term for example in the tertiary sector. New thermal standards have to be issued shortly, which will increase the level of requirements and make uniform the approaches in the domestic and tertiary sectors.

Several new developments have to be looked for in the domains of renewable energy (new materials, cost reduction of solar photovoltaïc cells, network connected systems, facade and roof integrated systems, solar active and passive heating and cooling systems), advanced glazing and insulation materials, natural, artificial and mixed lighting, boilers, energy control systems,...

Cooling equipments should be studied in particular since comfort requirements will lead to a heavy development of this kind of systems.

Mastery of electricity demand should also be looked for through the improvement of the knowledge on the electricity demand for each use (at home or in the offices), the energy and environment performance of domestic appliances (such as lighting devices, washing machines or refrigerators), information, and awareness and consciousness-raising campaigns.

5.4.2 Improving Air Quality

The air quality must be ensured inside buildings. The causes of bad quality can come both from the outside environment and from occupants or the building itself.

The improvement of air quality in indoor spaces should be a global objective of research, study and technical evaluation projects. The indoor environments which should be considered are office buildings, dwellings, public or private collective use buildings (nurseries, schools, swimming pools, theaters,...), underground spaces (subways, parking, railway stations,...), as well as transport vehicles (cars, trains,...). Hospitals, workshops and other spaces with specific pollution sources should also be considered.

Some examples of activities which are to be carried out in this domain are the following :

- characterizing pollution sources and air contamination elements,
- optimizing ventilation systems,
- clarifying sociological aspects linked to air quality,
- measuring air contamination elements and assessing exposures,
- developing standardization in the domain.

5.4.3 Decreasing Health Risks

The building and construction sector, as the other industrial sectors directly linked to the collective life, is the subject for a tougher and tougher social demand for risk management. In the domains of health and safety, society gives often the authorities the responsibility of maintaining a certain amount of hazards at a "zero risk" level.

Recent examples in the domain of health (lead in paintings, asbestos) depict this fact very well.

The theme "health and construction" is very vast and asks for various experiences and disciplines. Furthermore, the object is both to treat problems coming from the past and to deal with tomorrow risks, with regard to work design as well as to construction products put on the market.

Recommendations in this domain would be :

- to identify and analyze the current state of the art in this domain in order to anticipate future problems,
- to develop progressively sanitary criteria in the technical evaluation procedures, in accordance with conditions and practices which are still to be invented and in co-operation with health experts,
- to help building professionals to take account of this preoccupation,
- to develop information dissemination on these health problems.

5.4.4 Bettering Waste Management

If a specific attention should be essentially given to ultimate waste problems (what can we do with asbestos taken out from buildings ?), waste management should also be bettered both at the level of the work sites and at the level of the communities.

5.4.4.1 Work Sites

Developments in the domain of the work sites should aim at favoring the changes that this preoccupation implies :

- new organizations of demolition work sites : the objective is to help professionals to develop deconstruction and selection processes which will facilitate material recycling;
- an offer of materials, products and adapted construction methods.

Among the numerous actions which can take here, the following themes can be mentioned :

- the development of administrative and contractual documents (call for proposals, specification documents,...),
- the amendment of technical standards in order to avoid discrimination of products manufactured with secondary raw materials,
- procedures of selecting waste (on work sites or outside work sites) at acceptable economical conditions,
- valorization chains for mineral materials, polymeric materials, wood, heating systems,...
- work site noise reduction.

5.4.4.2 Communities

At the level of the community waste management, improvements should be obtained through :

- R&D on waste characterization (particularly heavy metals in domestic waste), domestic selective precollecting (with new systems in the field of flat buildings), specific materials (aluminium, steel, plastics and glass) in the waste collection process, organic waste management and biological treatments, thermal treatments, temporarily storage, incineration optimizing, new process assessment, ultimate waste, waste site closing or retrofitting, improvement of the energy performance of waste incinerators, domestic waste treatment procedures, specific waste such as commercial waste, hospitals and building site waste.
- Development of a technical and financial support to local communities to elaborate plans for domestic waste management and to select equipment investment depending on a multi-criteria approach.
- Activities (waste studies, research an development, consciousness-raising campaigns and training) in the field of domestic packaging.
- Development of regulation and standards essentially in the domains of waste sites and container collecting.

5.4.5 Foreseeing Fresh Water Shortage

It is clear that hydrological cycle is more and more modified by human activities and it is likely that some "desertification" problems will appear late or soon in the southern part of France. This implies to launch a program for rationalizing the utilization of fresh water including water saving and recycling systems in buildings.

5.4.6 Developing Construction Materials Saving

The main objective here is not using non renewable materials (such as river aggregates) but more and more renewable ones (such as wood). The development and use of recycled materials should also be favoured.

5.4.7 Developing Assessment Methods

To help professionals to take into account this new preoccupation in their actual activities, it is necessary to develop methods and tools which will aims at :

- increasing knowledge on the integration of building products and buildings into the eco-system and on their effects on health,
- clarifying the debate by identifying the real problems and proposing well-established and scientifically argued answers,
- allowing professionals to improve products, processes, construction and deconstruction technologies, together with the global design of buildings, in order to make them more favorable to environment and health,

- looking for innovation which could lead to a revolutionary progress in construction and deconstruction technologies,
- diffusing information towards professionals in real time of evolution.

From a practical point of view, two main objectives must be followed : incorparating ecological criteria into the product technical assessment procedures and developing tools for assessing the environmental quality of buildings.

5.4.7.1 Environmental Assessment of Building Products - Life Cycle Analysis of Products

The aim is to incorporate ecological criteria into technical assessment procedures. Studies should be pursued to develop an assessment method which will allow industrialists to know and to improve the environmental quality of their products and construction process on a highly pertinent ground. Based on an analysis of the different steps of the life cycle of products, this method of assessment of the environmental quality of products is today available. However the basic assumptions of LCA are not all valid when considering the specificity of the products and actors of the building sector. The necessary validation of the method has to be pursued.

5.4.7.2 Environmental Quality of Buildings

All along their life, buildings have a strong impact on environment as well as on health and comfort of occupants. In order to help city planners, decision-makers and professionals to design, construct, maintain and renovate buildings while protecting environment at best, a method is needed for assessing the global environmental quality of buildings.

The requirement of global environmental quality of a construction project which includes together the considered building, its surrounding and the operation of the building, aims at reaching the following objectives : a limited utilization of natural resources (raw materials, energy, water, ground), a reduced pollution of air, water and ground, a reduced production of ultimate waste, a decrease of pollution (noise,...), satisfactory relations of the building with the surrounding environment, a satisfactory indoor quality from the point of view of comfort and health.

These requirements apply to the building all along its life cycle (construction, operation, adaptation, deconstruction) and should take into account the manufacturing of the utilized products and the valorization and elimination of produced waste.

5.4.8 Modulating the "Building-to-Last" Concept

If the main idea is to limit material squandering, it must be kept in mind that several life durations should be considered depending on the various elements of a building. The shell is built to last several decades, since a lot of internal parts must last only some years in order to allow for changes. This will facilitate changes of use of the buildings and increase flexibility. Numerous technical systems and construction process approaches should be innovated in that goal.

5.5 Do not Wait and Take Action at Once

It turns out today more and more clearly that to take account of environmental constraints will have heavy consequences on the main options of the building process. This will imply to stress on aspects such as the durability and the evolution of buildings, to reject the idea of considering a building as a "consumable to be thrown away" and to reason in global costs.

Protecting the environment includes also the notion of urban environment. The building is supposed to act as a barrier between it and the occupants, without creating other internal aggressions, coming from indoor air, water, materials,... This aspect must not be forgotten, when looking at the environmental constraints.

Therefore even if the concept of "Sustainable Construction" is not yet stabilized and may still appear a little blurred, it is more an more recognized that construction cannot be ignored when talking about Sustainable Development. All the recommendations mentioned above should be taken into consideration at once for at least two reasons.

First of all, to take appropriate measures preventively to be sure that the consequences which have been foreseen for health and mankind will be as much limited as possible.

Second, to prepare the building sector to changes which are needed in the construction process. Three measures seem to be able to contribute to these evolutions towards the good direction :

- to assign external costs to internal/initial costs, that means, as already said, to reason in global costs,
- to develop R&D along the technical recommendations mentioned above,
- to ensure a global information which must be full and sound without any search for sensationalism.

6. BEST PRACTICE EXAMPLES

6.1 High Environmental Quality Buildings

The French Equipment Department 'Plan Construction et Architecture' has launched in 1993 a call for proposals to develop experimental building projects with a High Environmental Quality ('Bâtiments HQE'). Thirteen operations (called REX for "Réalisations EXpérimentales") have been launched and supported so far and are being monitered and analysed by the PCA and the CSTB.

All these REX HQE had to meet 25 environmental requirements grouped in 4 topics :

- eco-construction requirements,
- eco-management requirements,
- comfort requirements,
- health requirements.

Each REX has additionally to focus on one or two specific requirements. The main aspects considered in these operations are :
- environmental quality of the construction products,
- water management,
- visual comfort,
- site integration,
- environmental management.

Four REX HQE are presented in APPENDIX 2.

6.2 Les Chantiers Verts ("Green Sites")

This program was launched in 1993 by the "Plan Construction et Architecture" of the French Equipment Department and the "Agence de l'Environnement et de la Maîtrise de l'Energie" of the Industry Department through a research and demonstration call for proposals on "Environmentally Friendly Products, Techniques and Methods".

The goal of the Program was to reduce the nuisances susceptible to be caused by a building site, while being concerned by keeping the technico-economic profitability of the building sector. The monitoring was ensured by CSTB.

A total of 11 specific construction projects were completed. They deal with one or several kinds of nuisances susceptible to be caused by a building site: waste management, acoustic nuisances, traffic and parking problems, ground and water pollution.

The list of these projects is given in APPENDIX 2.

6.3 INIES, EQuity and ESCALE: three examples of assessment tools

INIES and EQuity are two complementary tools for assessing the environmental quality of building products and ESCALE is a method for assessing the environmental quality of buildings. These three tools developed by CSTB are presented in APPENDIX 2.

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8. ACKNOWLEDGMENTS

This study was carried out with the financial support of the "Agence De l'Environnement et de la Maîtrise de l'Energie" and the French Department of Equipment.

9. APPENDIX 1: MULTI-DIMENSION ANALYSIS MATRIX

Develop/Plan	Resources			
Principles	Land	Energy	Water	Materials
Conserve	- Optimize impacts on property value of the place : image, comfort, vacancy rate,...			
Re-use				
Renewable/ Recycle				
Protect Nature	- Limit space occu-pation impacts on green spaces,... - Protect flora and wildlife (trees, protection areas,...)		- Limit space occupation impacts on ground water and run-off	
Non-Toxic				
Excellent Quality				
Other aspects (human, finance,...)	- Optimize costs of access to collective services : costs of connections (water, gas, electricity, highways, services), costs of evacuation (water, gas, domestic waste), costs of operation - Master traveling needs : access to transport means (nearness to collective transport means, parking optimization,...), safety of traveling (parking, pedestrian ways, outside spaces,...) - Accommodate proximity services : meeting room (space and management), services (shops, city representation,...) - Optimize space design and social costs : stairwells, housing blocks, quarters,... - Respect residents and surrounding buildings (shading masks, view obstruction, noise,...) - Calibrate impacts on capital (technical costs, put off costs, housing subsidy costs)			

Design	Resources			
Principles	Land	Energy	Water	Materials
Conserve		- Choose products with low energy content (local products, reduce transports) - Reduce component weight - Use innovative or natural technologies		- Optimize building weight
Re-use				
Renewable/ Recycle				- Use recycled products
Protect Nature				
Non-Toxic				
Excellent Quality				
Other aspects (human, finance,...)	- Insure use functionalities : space, climate, protection, equipments, relation mastering, site integration, sense bearing - Insure no health risks - Increase durability - Increase robustness - Optimize maintainability (easiness, accessibility, modularity,...) - Optimize internal flexibility (spaces, indoor climates, equipment connections,...) - Optimize use changes capabilities (structures, equipments,...) - Optimize performance improvements capabilities (indoor climates and protections, equipments - Optimize abilities to be deconstructed (site accessibility, nuisances,...)			

Construct	Resources			
Principles	Land	Energy	Water	Materials
Conserve				- Reduce squandering (plan right quantities, re-use offcuts,...)
Re-use				
Renewable/ Recycle				
Protect Nature	- Insure flora and wildlife protection - Increase waste management		- Insure ground water protection	
Non-Toxic	- No air pollution - No soil pollution			
Excellent Quality				
Other aspects (human, finance,...)	- Building site without noise - Limit traffic needs - Decrease task hardness (definition of tasks and operating methods, adapted tools,...) - Secure tasks - Pleasure at work (good living conditions at site, site cleanness,...) - Impact on self-actualization (interest at work, image,...) - Optimize building site logistics : supplying, delivering, executing, controlling			

Operate	Resources			
Principles	Land	Energy	Water	Materials
Conserve		- Optimize energy consumption	- Optimize water consumption	
Re-use			- Recycle gray water	
Renewable/ Recycle			- Use rain and run-off	
Protect Nature	- Master fluid waste - Master gaseous waste - Master domestic waste			
Non-Toxic				
Excellent Quality				
Other aspects (human, finance,...)	- Optimize consumptions (in operation loads equivalents) - Mastery of communications (access to networks) - Insure no health risks			

Deconstruct	Resources			
Principles	Land	Energy	Water	Materials
Conserve				
Re-use				- Marking of products to increase selecting abilities - Collection on building or specialized site
Renewable/ Recycle				- New assembling methods - New connections - Operating manuals - Waste treatment
Protect Nature				
Non-Toxic				- Final waste treatment
Excellent Quality				
Other aspects (human, finance,...)				

10. APPENDIX 2: BEST PRACTICE EXAMPLES

WATER MANAGEMENT

LE PRE DE LA COUR

One 12 flat building and 5 houses
MEILLONAS (Ain- Eastern France)

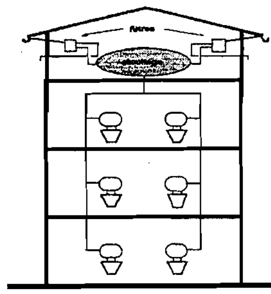
This REX HQE takes place in a small village of 1000 inhabitants. The owner (OPAC HLM de l'Ain) has looked for decreasing the services charges and has given importance to energy and water saving solutions.

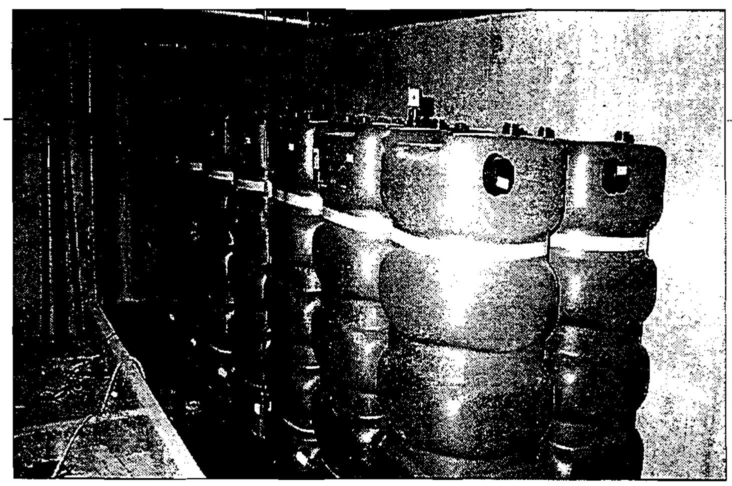
Three technical solutions to collect and store rain water have been envisaged :

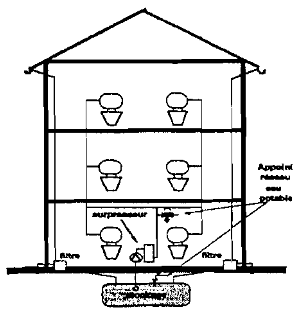
1. A total collecting of rain water above the last floor, with a distribution to all toilets by gravity, which implies overraising the roof.

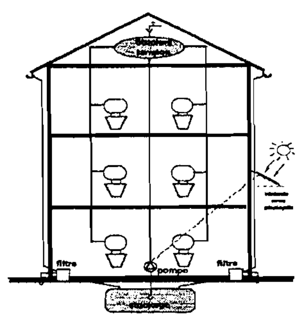
2. A storage under the first floor, which implies a pump and a surpressing device.

3. A solution which is a mix of the two previous ones. This solution allows for an easy collecting and a storage below the first floor, and a distribution by gravity from a buffer storage at the top of the building. A small pump, powered by solar photovoltaïcs cells, ensures the water transfer to the storage. This solution has been chosen, but without the solar cells.









ENVIRONMENTAL QUALITY OF MATERIALS and SITE INTEGRATION

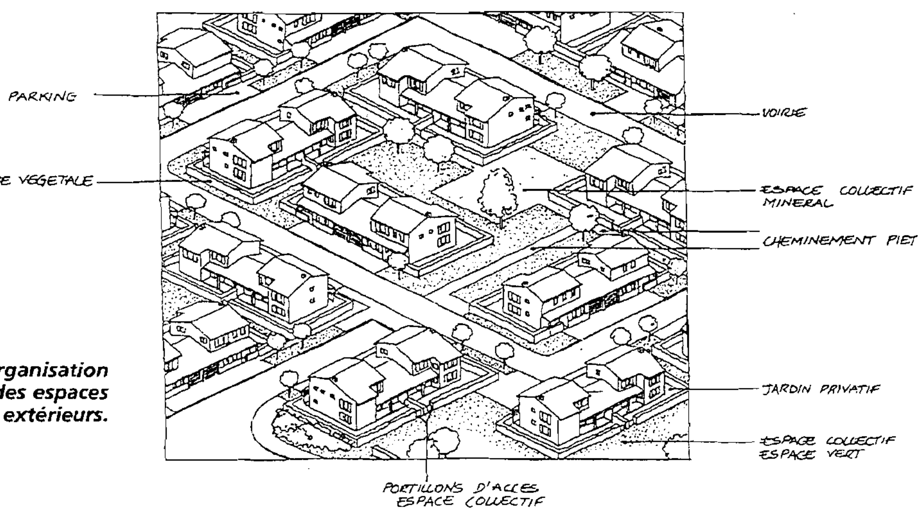
LES JARDINS DE RABAUDY

50 rental houses
CASTANET TOLOSAN (Haute Garonne - West-southern France)

In this REX HQE situated in the hearth of a protected "green zone", a heavy attention has been brought to the integration of the buildings and their neighbourhood into the site. The choice of environmentaly friendly materials has been deeply studied.

The following materials have been chosen :

- baked clay (tiles, 20-cm-hollow bricks, facing bricks, window ledges, cheminey ducts, life cycle studied with an industrialist),
- wood (skeleton, shutters, garage doors, internal doors, plinths, stairs),
- zinc (gutters),
- traditional coating,
- non toxic glue,
- labelled paints.



Organisation des espaces extérieurs.

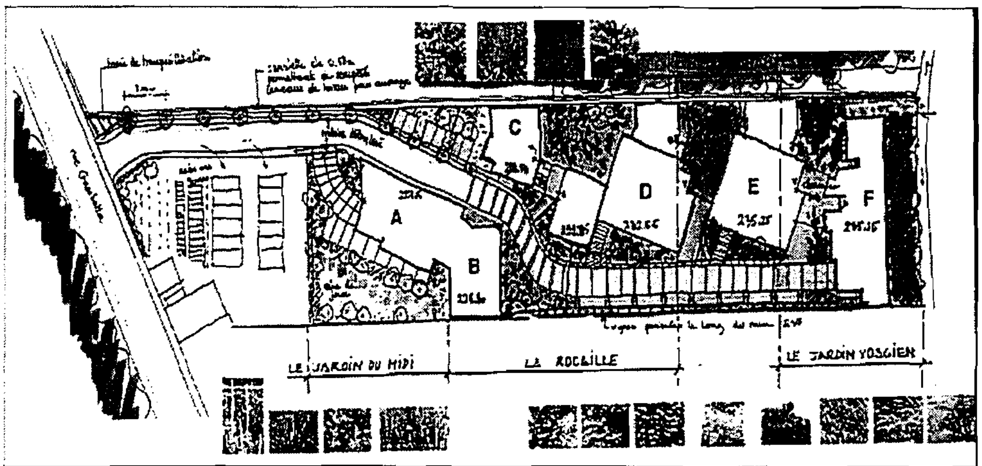
SITE INTEGRATION

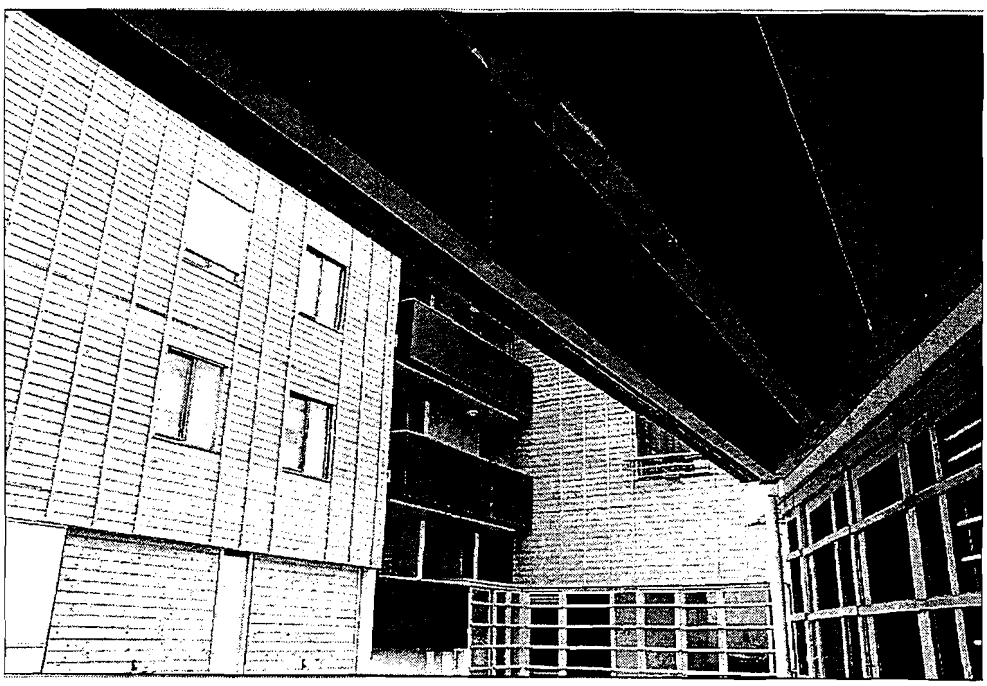
LE CLOS DES VIGNES

56 flats
SAINT MAX (Meurthe et Moselle - Eastern France)

This REX HQE, with 6 flats dedicated to disabled people, has been integrated in a site with specific characteristics from the geographical, cultural and social points of view. Several themes have been considered in this operation, such as the site integration but also water and domestic waste management.

Wood (from the Vosges forests) has been heavily used in this construction, on the façades and inside the common areas. The history and geography of the site have been taken into account for the gardens and surroundings. Various communication actions have also been conducted in order to reach a good appropriation by the inhabitants.





VISUAL COMFORT

PLACE DU VIGNERON

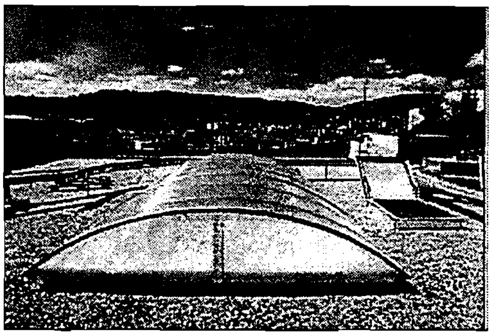
44 flats and stores
UNIEUX (Loire - South-West of Paris)

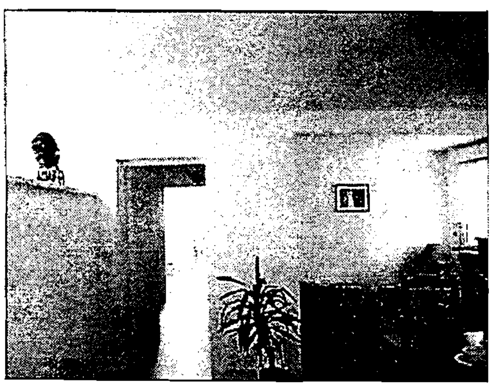
This REX HQE, with three 5-storeys buildings, takes place in a heavy restructuration of the center of a middle-size town. The problem of viual comfort has been studied in particular. A light shaft, located in the middle of each building, brings "second lighting" to landings, bathrooms and livingrooms.

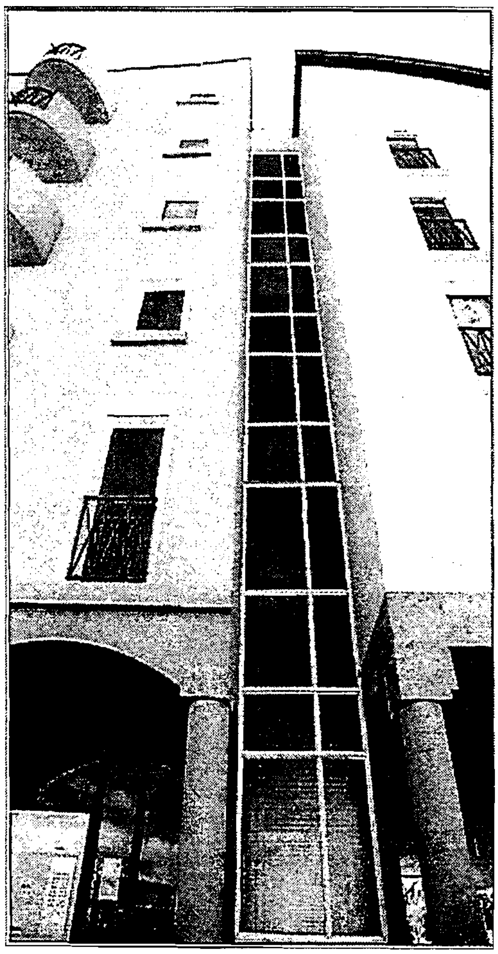
The natural lighting concept includes also :

- larger glazings in the light shaft at the lowest floors in order to balance the lack of light,
- "transparent" lifts to improve natural lighting of landings and lifts,
- appropriate design of the window frames,
- light-coloured cladding and covering,

All these topics have been deeply studied through modelling/simulation and laboratory testing.







LES CHANTIERS VERTS ("GREEN SITES")
Environmental Quality of Building Sites

This program was launched in 1993 by the "Plan Construction et Architecture" of the French Equipment Department and the "Agence de l'Environnement et de la Maîtrise de l'Energie" of the Industry Department through a research and demonstration call for proposals on "Environmentally Friendly Products, Techniques and Methods".

The goal of the Program was to reduce the nuisances susceptible to be caused by a building site, while being concerned by keeping the technico-economic profitability of the building sector.

The monitoring was ensured by CSTB.

A total of 11 specific construction projects were completed. They deal with one or several kinds of nuisances susceptible to be caused by a building site: waste management, acoustic nuisances, traffic and parking problems, ground and water pollution.

The 11 projects and the main themes dealt with are the following:
- BESANCON: all nuisances, communication with neighbours
- BORDEAUX: site noise, waste
- CHAMBERY: waste reduction and enhanced value
- HELLEMMES: site noise, traffic/parking, communication with neighbours
- LILLE: waste reduction and pre-selection
- MONTPELLIER: waste on a retrofit site : pre-selection and enhanced value
- NEVERS: all nuisances on a retrofit site, communication with tenants
- TOURCOING: ground and water pollution by oils
- VILLEURBANNE: all nuisances, in particular waste and noise
- VOGLANS: waste pre-selection
- WAMBRECHIES: waste reduction and pre-selection.

Despite the great progress which has been made, several points need more improvements:
- on materials, equipments (acoustic interest, dust reduction),
- on waste value enhancement paths to go with on-site selection,
- on construction products, by favouring environmentally friendly products and appropriate packages,
- on logistics and organisation, time necessary for changing methods and training of workers.

In order to integrate environmental management aspects into habits, the construction sector should keep in mind three basic principles:
- to define reasonable and well prepared goals before the site launching; these goals should be coherent with the size of the site, the size of the enterprises, the procurement methods and the local context,
- to stress co-ordination, information and training, which appear to run out of steam in the secondary works,
- to plan a control of the environmental actions all along the site duration.

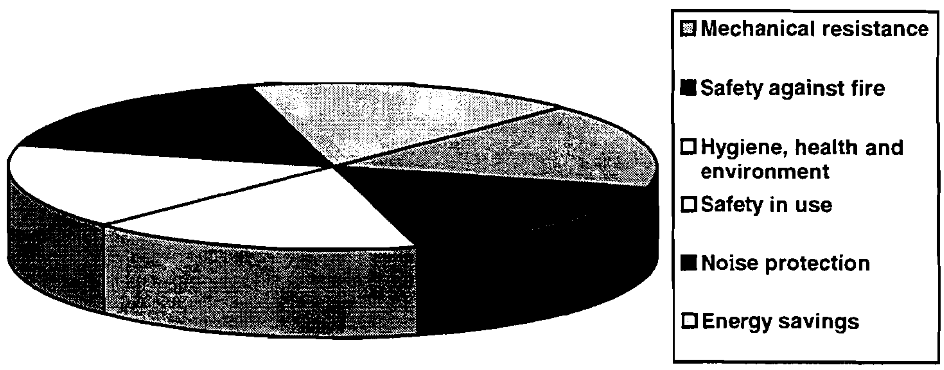
INIES and EQuity
Two Complementary Tools for Assessing the Environmental Quality of Building Products

The notion of Environmental Quality includes the aspects of "cleanness" (lowest quantity of pollutants emitted) and "sobriety" (lowest quantity of new materials and energy resources consumed). This notion comes in addition to more common aspects of the quality of building products - functionality, durability, performance - which it is not disconnected from.

It is important to remind that, as there is no technically good products in the absolute - that depends on what you will do with it - there is no "green products" or "eco-products", but only products which are more or less adapted to a given use from the point of view of the Environmental Quality, and which therefore can be improved or better designed through an approach which will integrate the Environmental Quality.

Experience proved that the improvement of technical performances and manufacturing/installing costs can take place in coherence with an approach of Environmental Quality. For this kind of approach, which needs to look for precise answers to precise questions, CSTB has developed a software, called EQuity and based on the Life Cycle Analysis of products.

If the question is more to select products, which have a good equivalent technical quality, on their environmental qualities, it turns out that the results of a Life Cycle Analysis are generally not clear enough to help taking a decision. It is why CSTB has developed a second tool, called INIES (INformation on Sanitary and Environmental Impacts), which consists of a series of forms to collect and organise existing information on the Environmental Quality of a product.



ESCALE
A Method for Assessing the Environmental Quality of Buildings

Due to the emerging of a demand and the development of High Environmental Quality contruction projects, it gets necessary to help professionnals to design buildings while protecting the environment. In this context, an method for assessing and checking the environmental quality of buildings is under development by CSTB.

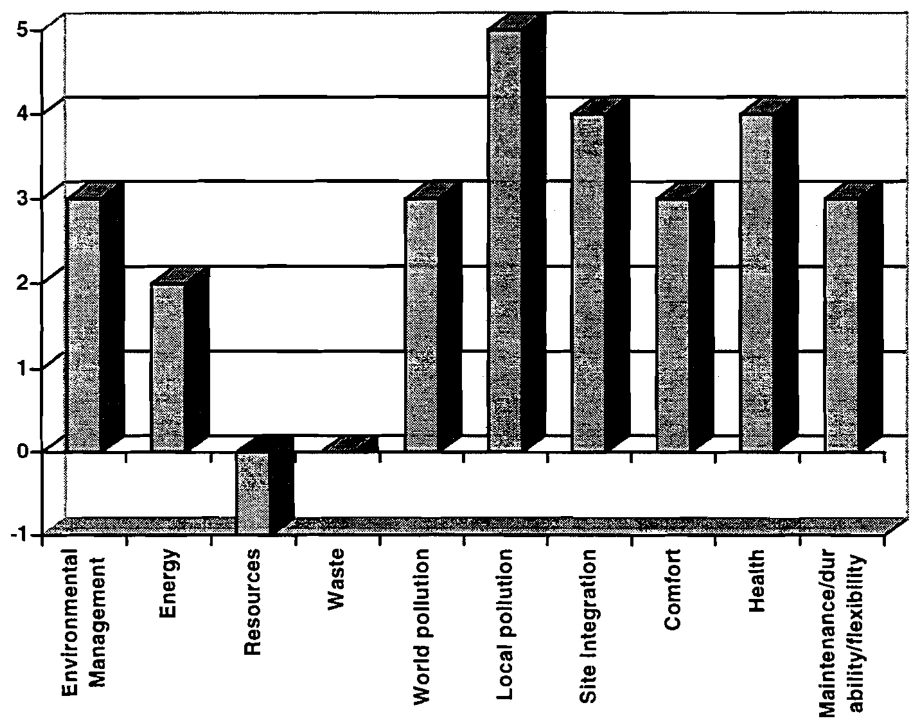
The method follows the design phase. It allows to control and to improve a project from the point of view of the environmental quality all along the design phase.

The assessment criteria are purely environmental ones.

For every criteria, two assessment models are defined, adapted to the level of details of the design data

Every result, expressed by an indicator, is placed on a performance scale from -1 to 5. The lowest level is defined by a standard or commonly reached value. The highest value is defined as the optimal value which could be reached.

The final profile, which represents the performances of the project against the various criteria, can be detailed with "sub-profiles" in order to explain the results obtained.



REPORT 4

SUSTAINABLE DEVELOPMENT AND THE FUTURE OF CONSTRUCTION INDUSTRY IN HUNGARY

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NATIONAL REPORT

CONTENTS

0. PREFACE

The International Council for Building Research and Studies CIB established its Working Commission W82 in order to carry out future studies on building and construction. This Commission started in 1995 a project to deal with prospects of sustainability in the field of construction.

In Phase 1 of this project participants tried to define the notion of "sustainable construction". At the start of Phase 2 the title of the project was fixed as "Sustainable development and the future of the construction industry" and it was decided to take 2010 as the closure of the period to be discussed. The very aim of Phase 2 became to get preliminary national answers to five questions accepted by participants at the beginning of Phase 1. Having discussed these preliminary answers at the end of Phase 2, "Instructions" had been worked out how to prepare detailed national reports in the framework of Phase 3.

The "Instructions" presented a slightly modified set of the original questions and this set was accepted by the participants.

It was accepted too, that the aim of Phase 4 will be to compile an international synthesis of the analyses having been made in Phase 3 on national level.

The present study tries to answer the questions put in the "Instructions", following an Introduction which intends to give a general view of the Hungarian situation; it was accepted by participants at the discussion of the "Instructions" that the national reports should present general surveys of the countries in question, trying to give impressions about the social, economic and environmental constraints prevailing in the given countries.

It was also required to describe the methodology used when elaborating the individual national studies, completed by an appraisal of the study by an organization independent from the team preparing the study.

The authors of the present study had been trying to fulfill all these requirements.

1. INTRODUCTION

1.1 Preliminary remark

People concerned in problems of *sustainable development* may meet serious conceptual difficulties arising from logically incorrect extensions of the original meaning of this expression.

The original meaning of the expression "sustainable development" referred to the fact that certain features of modern economy, certain fascinating achievements e.g. in the industries or in transportation technologies resulted in grave ecological effects. It was concluded that neither any kind, nor any degree of economic, industrial or transport development is sustainable when ecological damages have to be avoided.

This was a conceptually stainless usage of the expression.

Confusion started when the notion of sustainability became used for negative phenomenons having nothing in common with industrial or transport technologies which induce ecological failures. An outstanding example of this is *poverty,* stressed so extremely in so important planetary documents dealing with sustainable development as the Brundtland-report or the "Agenda 21" accepted in Rio.

It is quite clear that certain degrees of poverty should not be tolerated, the negative phenomenon of poverty is, however, not an outcome of development but an outcome of the lack of it. That means that in certain cases the problem is not the *sustainability of development but the tolerability of underdevelopment.* As a consequence of this: should somebody be interested in clearing the full set of the negative features of the situation he (or she) had to deal with both of these aspects of reality, that means with the sustainability of the development just as well as with the tolerability of the underdevelopment.

As a compromise the two aspects might be coined into the unified expression:

sustainable development and underdevelopment

It might be argued that a remark of this type is very informative when preceding the national report of a country struggling with heavy problems of underdevelopment or at least with problems of a socially very unbalanced development.

In the case of the least developed countries not represented so far in the sustainability-project of CIB W82, the problem of underdevelopment is of crucial importance for all aspects of construction activities. The remark done here was made having in mind also the problems of the sustainability issue of the least developed countries.

1.2 Economic, social and environmental constraints of the overall development in Hungary

1.2.1 Economic and social constraints

The economic constraints of Hungarian development are partly an outcome of the more than four decades rule of a political and economic system having a very low efficiency. They are also partly a consequence of a very difficult transition from the formerly planned East-European economy to the market economy of the Western hemisphere including all the other parts of the world which already are extremely significant from the economic point of view.

Before the collapse of the COMECON about 50% of Hungarian exports went to Western and about 50% to Eastern Europe. After the collapse the COMECON market became almost totally lost, because the so called socialist countries became unable to pay for the goods they imported regularly from Hungary. In the same time these goods were not competitive enough on the Western market. All this meant that the overall export decreased in a substantial measure and this induced a serious decline of the GDP.

A further difficulty arose from the fact that - well before the collapse - the Hungarian government took considerable loans from foreign (mainly from private Japanese) sources in order to avoid political disturbances in the country. As the government was not able to repay the loans, the first governments of the transition period inherited a grave foreign debt. As - in the meantime - the GDP decreased seriously and - in the same time - all the imports had been liberalized, the stability of the national economy became extremely threatened.

Fortunately, from the late 80's the Western capital became more-and-more interested in investing in the Hungarian economy and from the early 90's in buying Hungarian firms being near to competitiveness. General Motors, General Electric, IBM, Ford, Philips, Suzuki, Audi, Siemens and others (often even large size construction firms) came in and in some industries exports started to grow definitely.
Other industries became, however, obsolete or even bankrupt and as even in the most profitable privatized firms the number of employees was greatly reduced, a high rate of unemployment followed. A high number of profitable minor and a number of medium size Hungarian firms came into existence but these have been unable to counterbalance unemployment significantly.

In consequence of all these changes the governments were forced to take drastic measures in order to save stability. The basic step was a heavy reduction of the real value of salaries and pensions, followed by strong reductions in the costs of education and health care. Due to these measures the foreign debt was reduced considerably. In the same time incomes in the successful firms and branches (banking, trade, some services, etc.) became fairly high. It was recently published that the average of the economically most successful 20% of the population is seven-times larger than the same value of the economically most helpless 20%. This is an unheard-of ratio in a formerly "socialist" country: there are a few hundred thousand people able to live on a really luxurious level and a few hundred thousand being fairly near to starvation and becoming frozen.

A serious segregation of the Hungarian society is in progress and it is heavily aggravated by the situation of a rapidly propagating ethnic group: the gipsies. For the time being they constitute about 5% of the population of the country; their integration into the society is extremely difficult and the period of political and economic transition is extremely disadvantageous for them: they represent the group the most exposed to unemployment and many of them live under miserable conditions. One of the most serious difficulties of their integration is their cultural backwardness in spite of their talent for music and arts occurring so often among them. Under the given circumstances a relatively high number of gipsies are driven to irregular behaviour, sometimes to crime.

In case of the bulk of the Hungarian Society the birth-rate is very low, one of the lowest in Europe. The aged part of the society is already fairly high and it will be considerably higher in the coming decades. In the last few years the population has already started to decrease, in spite of immigration which has been kept low up to now. This is partly due to the fact that most of the (often illegal) immigrants want to use the country only as a transitory home, as a - rather hopeless - step in coming into the West. Illegal immigrants live mostly in camps. The number of Yugoslavian refugees is still fairly high.

Both Hungarian and foreign experts think that from now on a significant improvement of the Hungarian economy is very likely: the worst of the troubles of transition seems to be over. A substantial, further restructuring of the economy and of the society is, however, even in this case indispensable. This further restructuring will very likely concern industry as well as agriculture and in a very high degree the realm of services.

1.2.2 Environmental constraints

Pollution of the natural environment

The main domestic sources of *air pollution* are vehicular traffic and some industries. The situation is worst in Budapest and in the neighbourhood of thermal power stations scattered in the country. Car density is much too high in the capital lacking parking places and facilities; due to the unfinished highway-ring surrounding Budapest a considerable amount of foreign and domestic lorries must pass through the inner parts of the city when making international or long-distance domestic deliveries, etc. Not all the thermal power stations and portland cement factories are supplied with up-to-date filtering facilities and this causes serious damages in the vegetation and in the settlements nearby. It is a permanent struggle for keeping air pollution values below European standards.

Practically all the rivers of Hungary arrive from foreign countries and consequently a considerable part of the *water pollution* is due to foreign contaminations. The situation is seriously aggravated by Hungarian industries and by Hungarian cities as well. The network of public cleaning plants has to be developed or updated significantly, and further measures inside of industrial plants should be demanded very strictly.

The *pollution of the soil* is in some parts of the country very serious, partly as a consequence of uncontrolled usage of fertilizers, partly as an outcome of the gap between municipal water supply and sewerage. The pollution of the soil induces the pollution of the subsoil water which makes in these regions availability of drinking water very scarce.

As practically the whole area of the country is a lowland having only smaller regions built up of gently sloping hills there is no reasonable possibility of creating hydro power stations. Due to this fact the energy supply of the country had been based on thermal power stations run by using low quality domestic brown coal. As even these coal mines are getting to be exhausted and as also the domestic oil wells give only a very modest contribution and also due to the fact that some uranium was found a few decades earlier, a fairly large nuclear power station was created, which provides roughly half of the energy needed on a national level.

Management of wastes involves the most striking dangers of course in the case of the nuclear power station. The station had been built before the collapse of the Soviet Union and according to the original contract the Soviet partner took upon himself the responsibility of removing the nuclear wastes and burying them in Soviet territories. After their collapse the future of this service became somewhat uncertain, although it has been continued. Nevertheless, for the sake of absolute future safety, the Hungarian nuclear power station decided to build its own cemetery; this was the largest project using reinforced concrete which was realized by Hungarian construction firms in the last years (involving also British subcontractors).

The total amount of solid wastes generated in 1992 had been 84 million tons. From this amount the share of hazardous industrial and agricultural waste was 4 million tons. The amount of municipal solid waste was equally 4 million; the construction and demolition waste came to 8 million tons that time. The waste management is not fully solved: e.g. in 1992 still more than 10% of the municipal solid waste was not treated at all.

The state of the built environment

In 1993 the population of the country was roughly 10 million and it was living in just over 3000 settlements. Almost 2 millions were living m the capital and 1,2 million in cities having 100.000-300000 inhabitants. Almost 2000 settlements had less than 1000 inhabitants and more than 1000 had less than 500. The overall population of these very small villages had been almost 1 million. Due to a fairly dynamic rate of urbanization a considerable proportion of the younger population is abandoning its native settlement and is migrating to the cities; there are villages where the population decreased to some dozen old people. A number of the almost empty villages are occupied by strata of the society which have a high birth-rate and have difficulties in getting integrated into the society as a whole (mainly gipsies). Some abandoned villages are getting to be used by well-to-do groups for recreational purposes.

The dwelling stock is estimated as almost 4 millions dwellings for a population of about 10 millions people, one has to take into account, however, that a high number of houses in abandoned villages are empty and the housing stock of many cities is very old lacking due maintenance and repair for several decades. The situation is especially grave in some districts of Budapest which are getting to become slums; after a few serious catastrophies a growing number of houses had to be evacuated because their structural safety became very dubious. Renovation and reconstruction of the aged part of the housing stock is one of the most pressing challenges of the Hungarian economy.

The neglected renovation and reconstruction of the housing stock is mainly a consequence of smashing its private ownership at the beginning of the Stalinist rule in the country and allocating it to a state which was subjected in that time to the Soviet claims of the cold war. From 1990 the privatization of the housing stock is in progress and is almost finished. Nevertheless, the renovation and reconstruction activity remained in the field of low-cost housing extremely low as a consequence of the economic weakness of the new owners, who mostly are the old inhabitants themselves buying their homes for a low price well below the real market value.

The richest group of the society constructs relatively luxurious new houses for their own purposes. This part of the society is, however, not interested in low-cost housing and the Western capital which supports a vibrant construction activity hardly finds the area profitable. They are attracted mostly by hotels, office buildings, banks, industrial plants, warehouses, garages and even highways, these latter in form of concessions. From time-to-time there is an interest also for abandoned plants of bankrupt industries and agricultural facilities if they may be easily rebuilt and used for new functions. The construction-minded Western capital often uses also Western construction firms in Hungary.

The Hungarian state, the municipalities and the churches support a series of construction works which can not get financed by profit-oriented resources. In Budapest attractive, neomodern, "high-tech" architecture was produced for building a new centre for information technology at the Budapest Technical University, and in the same style a huge national headquarter for the police was erected. This institution became heavily overburdened by corruption scandals and crimes characteristic for a transition society. The "hightech" architecture in Budapest often applies special, imported building materials. In the countryside a relatively high number of medium and small size municipalities created cultural centres and numerous churches have been built to satisfy needs neglected for several decades. Most of the countryside cultural centres and churches have been realized in a newly emerging special style of

Hungarian architecture called "organic" and using often indigenous building materials to considerably reduce costs strongly.

1.2.3 Key-issue of the Hungarian development up to 2010

The most important characteristic of the Hungarian situation is that the country is one of the so-called "transition countries" of Central and Eastern Europe turning from a planned to a market economy. The problems of this transition was analyzed thoroughly in a study titled **"The Market Shock"** - An AGENDA for the Economic and Social Reconstruction of Central and Eastern Europe." The study was published by the Austrian Academy of Sciences/Research Unit for Socio-Economics, Vienna, 1992 and it was prepared by the so-called AGENDA GROUP consisting of 28 experts coming from 16 countries.

According to "The Market Shock" the transformation approach of the countries in question contained three basic measures:

(i) economic liberalization through the abolition of controls over prices and production;

(ii) macro-economic stabilization through control of the money supply and balancing of the government budget;

(iii) the sale of state property to private individuals and corporations*

Hungary, Application of the first measure resulted in 1990 in an inflation of 35% in, 50% in Czechoslovakia and 60% in Poland whereas it came a bit later to about 1000% in Russia and the Ukraine. Further features of the change became a serious decrease of the real value of wages and a serious rate of unemployment. A heavy struggle started in all these countries to manage the task of transition applying all the three measures mentioned and this resulted in the Central European area making progress and promising in Eastern Europe in very slow progress. In a short period of time the Central European countries (including Romania) identified the most important goal of their socio-economic development as to become members of the European Union. To achieve this they have to fulfill a number of crucial requirements stated from the side of the European Union: a low rate of inflation, closely approaching a balance of payments and a balance of the budget, as well as many other (also ecological) preconditions.

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* It has to be remarked that due to the statements of "The Market Shock" these - in order to avoid major disturbances of the transition process - should be accomplished by five other ones as follows:

1. Making the Socio-Economic Context;
2. Creating the Market;
3. From Destruction to Production;
4. From Economic Emergency to Growth;
5. Making the International Context.

As for Hungary there is a chance to become a regular member of the European Union by 2000 or - in a worse case - somewhat later. Anyhow - as it is known also from the example of Spain and Portugal - the correct, or at least an acceptable integration may need even 10 years after the formal declaration of the membership. This means that from now (1997) on even to 2010 the very priority is and remains for Hungary to achieve membership within the European Union and ensure this works well. According to the conviction of the governing and also of the majority of the opposition parties within the parliament all the other problems and tasks of the Hungarian society and economy have to be subjected to this heavy priority. This should be valid - of course - also for the Hungarian construction industry.

2. GENERAL CONSEQUENCES OF THE MAIN ISSUE OF THE HUNGARIAN DEVELOPMENT ON THE SUSTAINABLE CONSTRUCTION IN HUNGARY

As the main issue of the Hungarian development up to 2010 is the achievement and the stabilization of the EU membership, ideas concerning the sustainable construction have also be derived firstly from the views prevailing in the leading member countries of EU often generated originally by American experts.

According to this we accept the definition of sustainable construction given by Charles Kibert in 1994 which says that:

> "*sustainable construction is the creation and responsible maintenance of a healthy built environment, based on ecological principles, and by means of an efficient use of resources*"

In the same time we tried to stress on several occasions that in a high number of countries there are very unhealthy built environments (or at least subenvironments) which can not be abolished and rebuilt in a sustainable way due to the lack of adequate economic resources, and this problem should be taken as a substantial concern for sustainable construction. In spite of our efforts at some meetings of CIB W82 the Kibertian definition remained unchanged, although it is out of question that there are depressing slums and masses of homeless people even in some of the most developed countries.

In a similar way we consider the Kibertian model for surveying ecological principles, resources and phases of the building and operating process as a very productive one, although we think that the human resources and the clearance of miserable urban areas are indispensable.

We think that research efforts done in some EU countries represented in CIB W82 aiming at the development of a system of requirements for sustainable construction gives us an excellent possibility for orientation and save us from making in-depth work on such abstract requirement systems. The work done by the French, the Dutch, the British and the Finnish members of W82 should be valued highly.

So we can concentrate on our special problems of sustainable development and the problems of construction in this development framework. As said our main issue is to achieve and stabilize EU membership for the country; this means that in the construction field those tasks have priority which serve to fulfill this membership goal, and tasks irrelevant from this point of view have not much chance to get substantial priority.

Let us see our special problem areas by trying to answer the "ancillary" questions put by point 2. of the Instructions.

3. SPECIAL CONSEQUENCES

3.1 Cities and transportation networks

As it was described in the part of our INTRODUCTION dealing with the built environment, about 2 million of the population is living in a metropolitan area (Budapest), 1,2 million live in cities having 100 000 – 300 000s inhabitants and almost a million (cca 800 000) lives in villages below 1000 persons. The remaining 60% of the population is living in settlements between 1000 and 100 000 persons; one third of this (a bit less than 1 million) live in cities having a population of 20 000 - 100 000 inhabitants. Should we take 20 000 as the boarderline between the rural, and the urban settlements, we could say that the ratio of the rural and the urban population is about 50-50%. Due to the Hungarian legislation the urban population larger as a number of settlements below 20 000 inhabitants are legally (and often also factually) cities.

Now, a considerable rate of urbanization is characterizing the country's society, with the consequence that a serious decay of the built environment is in progress in some rural areas (especially in villages below 1000 or even below 500 inhabitants) and - in the same time - the pollution problems of the major cities become graver and graver. Some towns having industries which turned to be obsolete in the last few years give special cases of environmental decay.

There is a consensus in the country that the development of the medium-size towns and cities (50 000 - 300 000) would be most preferable, it is, however, accepted also fairly unanimously, that before 2010 there are neither governmental nor municipal means to influence these urbanization processes significantly. Changes depend mostly upon decisions of the foreign and partly the indigenous capital as to the location of new investments. Up to now the western part of the country has been preferred by foreign investors almost exclusively, creating an almost threatening difference between the Western and the Eastern region. A governmental program to counteract this loss of regional equilibrium is under preparation and even foreign aids are foreseen for solving this crucial problem.

As to the positive side of the national consensus concerning the basic construction tasks aiming at the improvement of the built urban environment, it is agreed that the country has to concentrate on the transportation networks connecting us to the neighbouring countries as well as the transportation networks we have within the country and within our major cities, firstly within Budapest. It is agreed that the development of the transportation networks should have the priority both from the economic as well as from the ecological point of view. This development is the crucial prerequisite of the overall economic progress as well as of a decisive reduction of the air and noise pollution in metropolitan and urban areas.

Economically it is of utmost importance for Hungary that it lies at the intersection of the roads connecting Western Europe to the Balkans and West-Southern Europe (Italy e.g.) to Ukraine and Russia.

In the same time it is only the superhighway between Vienna and Budapest which is finished as yet and the construction of the superhighways to Kiev, Bucharest, Beograd and Zagreb reached only the half of the distance from Budapest to the Hungarian border. This work should be finished as quickly as possible.

The most pressing shortcoming of the domestic Hungarian road network is the fact, that the superhighway connection of all the major cities is (or will be in the next phase) running through Budapest which is very disadvantageous: It is a further important construction task to overcome this shortcoming.

As both the international as well as the domestic road network is heavily concentrated to Budapest it is of utmost important to have a superhighway ring encircling the capital city. As a matter of fact: only the southern part of this ring has been already constructed; it is an urgent task to finish the northern part too.

Last but not least also a substantial extension of the underground railway system is indispensible in Budapest. A part of the extension should be finished before 2000, the entire program may run, however, even up to 2010.

As far as the principles of a sustainable urban development are concerned, our experts responsible for planning consider the practical problems arising the most clearly expressed in the *ECE Guidelines on Sustainable Human Settlements Planning and Management* (ECE/HBP/95; ISBN 92-1-116646-2) as follows:

- "How can the use of raw materials and energy be reduced in building and construction? How can construction waste and waste from building demolition be reduced and their recycling increased?
- How can the amount of energy used in buildings and the emissions produced (mainly sewage) be reduced?

- How can the treatment of solid wastes in the human settlements sector be made more efficient and recycling increased?
- How can the consumption of energy in the human settlements sector's transport system and their emissions be reduced?
- How can we preserve the coherence of the landscape in order to consider the ecological, aesthetic aspects, as well as opportunities for outdoor pursuits, and how can we maintain existing ecocycles between urban and rural land?
- How can we conserve, establish and develop the continuity of the green part of the landscape or green corridors?"

Some additional and more concrete tasks are listed in a chapter of the *Transport Policy of the Government of the Republic of Hungary* (Budapest, 1996) titled *Urban and Metropolitan Transport*. Some items of this chapter are the following ones:

- "In urban transport, so as to reduce congestion as well as emission and noise pollution, it is necessary to slow and eventually, to halt, the contraction in public transport;
- various installations, measures are needed in suburban and outlaying areas: parking facilities at railway and bus stations and at transfer points; ... P + R parking with easy access, supplemented by attractive service units ... will have to be provided ... An attractive fee structure in public transport is needed, so as to increase its usage as opposed to private vehicles. At the same time, it should also be accessible and affordable to those most needing it ...
- In densely populated areas of major cities, in zones of protected historic or architectural importance, and those serving rest and recreation, private vehicle traffic should be limited" etc.

In spite of the rather firm national consensus giving first priority to the different types of transportation networks in all regional and urban levels of developing the built environment, also a number of other priorities have been recently redefined. The Ministry for Environmental Protection and Regional Development prepared comprehensive guidelines for both its problem areas in 1996 and in the same year similar guidelines were outlined also by the municipal management of Budapest. Some of the major issues of these documents are as follows:

- The country is divided into 138 minor territorial units and all of them have been valuated according to the EU-norms to identify areas of dynamic progress as well as areas of decay. This valuation has to be used as basic information for governmental and/or municipal decision making;
- About 70% of the interrogated settlements indicated difficulties in managing municipal solid wastes;
- There is a 43% gap between the population of the country connected to municipal water supply and the population connected to public sewers; only one-third of the total waste water piped out is cleared biologically;
- The rehabilitation of a number of abandoned industrial plants and areas in the country not solved as yet;

- Special attention should be given to counties and cities entering into economic and cultural cooperation with counties and cities of neigbbouring countries; some of them are supported by PHARE programs;
- The suburbanization and de-urbanization processes going on around Budapest should be controlled keenly and a comprehensive master plan should be worked out for the whole Budapest agglomeration having a population of about 3 millions (almost one-third of the country);
- The city (the downtown part) of Budapest should be extended in order to give space to the numerous new functions it has to fulfil; in the same time its residential function should not be lost;
- Spread of large-scale suburban shopping centers and shopping malls should not be allowed to destroy fully the traditional urban structure of Budapest;
- Green areas should be maintained resolutely in Budapest and brownfield investments should be offered trying to rehabilitate with these offers the wasteland of abandoned former industrial areas.

3.2 Buildings and the building process

The planned economy decades (characterised by the Soviet domination) drove the almost fully state-owned building industry of that time to operate in the framework of very large governmental construction programs. At the start of this period (in the early 50's) practically the full capacity of the building industry had been used for creating huge plants for the heavy industries; the solution of the serious housing needs of the society - aggravated by World War II - had been neglected almost totally. After the revolution in 1956 the government did not dare any more to neglect these needs of the broad population, and in the late 60's a very large-scale housing program had been initiated which became the dominant task of the construction industry in the 70's. A number of other needs had been neglected in this second - the housing - period again.

One of the most pressing one of these needs had been a very unpleasant shortage of hotels. This shortage was fairly disturbing also on the domestic level, it was, however, keeping back the development of foreign (western) trade and tourism gravely. This shortage gave the first impetus to western capital to take the role of initiation: western investors started to create a number of hotels in Budapest, some of them on a fairly ambitious level (Intercontinental, Hilton, etc.). Although all these hotels have been designed by Hungarian architects, the investors influenced heavily the design process too by determining all the specific functional requirements. In some cases the investors penetrated also into the construction phase bringing foreign construction firms as general contractors.

After 1989 construction became exclusively market-dominated and all the large-scale governmental construction programs got terminated. In some fields the (mostly foreign) market forces resulted in remarkable growth, so e.g. in building office buildings, warehouses, shopping centers and shopping malls. As already mentioned, foreign capital has been taking part also in developing the built infrastructure (parking facilities, highways, etc). In spite of all these developments the total output of the construction industry decreased dramatically, as e.g. the rate of social housing and non-profit public works (schools, hospitals, etc.) fell very low.

The firm BAU-DATA dealing with market information analyzed the distribution of the number of ongoing construction projects between 1991 and 1995 in Hungary and they got the data contained in Table 1.

	1991	*1992*	*1993*	*1994*	*1995*
Industry, trade, agriculture	23%	17%	14%	14%	12%
Civil engineering, infrastructure	14%	25%	33%	34%	38%
Housing	14%	11%	13%	17%	17%
Office, hotel, catering, tourism	40%	30%	14%	13%	12%
Education, health care,sports	9%	17%	26%	22%	21%

Table 1

Looking at the data of Table 1, one can say that at the start of the transition period the market was highly interested in offices, hotels, catering and tourism, it became, however, in this field soon saturated and civil engineering, infrastructure has been clearly taking the leading role.
The same market research firm BAU-DATA prepared a forecast up to 2000 shown in *Table 2.* In this case they used the categories as common in the data-exchange within EUROCONSTRUCT. The values refer to billion Hungarian forints calculated with the prizes in 1995.

construction	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
residential	150	145	160	170	185	205
non-residential private	90	100	100	110	115	118
non-residential public	20	20	20	20	20	20
sum of new construction	260	265	280	300	320	345
renovation residential	60	60	70	80	85	95
renovation non-residential	70	80	80	70	72	74
sum of renovation	130	140	150	150	157	169
civil engineering new	140	140	150	160	170	180
civil engineering renovation	70	70	70	70	72	72
sum of civil engineering	210	210	220	230	242	252
construction output total	600	615	650	680	720	766

Table 2

According to Table 2, civil engineering seems to keep its role gained in the former period as shown in Table 1. Further forecasts up to 2010 are not available, as yet, due to the prevailing conviction of experts, however, the output of the residential renovation should be much higher then now. Should it remain impossible to allocate much higher resources for this task, a catastrophic breakdown of a huge part of the existing housing stock would not be avoided.

Maintenance and renovation is the weakest point, the most critical phase in the overall Hungarian building process.

We touched upon this problem already in our INTRODUCTION dealing with the state of the built environment and we stressed its weight in a number of districts in the capital city.

In order to identify the specific problems of the maintenance and renovation of the residential buildings we have to see first the distribution of the roughly 4 million housing units according to the building material of the walls of the buildings in question. A bit more than one quarter of the total volume (mostly old one-family houses in rural areas) had been built of adobe or have sometimes even simply rammed mud walls. A bit less than a quarter of the total volume consists of multifamily houses produced by using industrialized building systems applying reinforced or sometimes only plain concrete as their basic material; these systems had been valuated as very progressive solutions for social housing in the 60's everywhere in Europe. The other half of the housing stock has been built by using bricks for the load-bearing walls.

Now, in case of the old adobe houses (often very valuable as remarkable pieces of folklore in architecture) one has not to face serious problems of thermal insulation, they are, however, in many cases gravely damaged by moisture coming from rainfall and wind, or from the groundwater. Due to very small windows the ventilation is never acceptable. In the same time it is practically impossible to eliminate these shortcomings in course of a reasonable renovation; in most cases demolition would be the single way of getting rid of these unhealthy buildings, adequate resources for replacing them by healthy ones, are, however, rarely available. In some cases technologies for artificial drying may be used with advantage and demolition may be avoided or at least postponed.

In the case of the system-built social housing stock poor thermal insulation and the need for replacing the aged, built - in network of pipes feeding the used building services produce the crucial tasks of renovation. According to recent calculations 600 000 - 800 000 Hungarian forints are needed for a correct new subsequent thermal insulation in case of an average-size apartment. This sum is larger than the net average yearly income of the population.

In case of the older buildings made of brick the most dangerous structural parts are the chimneys. This comes most often from the fact that these chimneys had been made for heating with coal, the heating was changed, however, to apply natural (sometimes artificial) gas. The combustion product moving off leaves, however, sulphuric acid on the inner surface of the chimney and this devours the chimney just up to collapse if not observed earlier. The trouble caused by this corrosion is often the phenomenon that the corrosion product blocks up the smoke channel, the smoke turns up and intoxicates the room it is coming from: this may be lethal for the inhabitant(s).

Apart from the adobe houses and the oldest set of the residential buildings made of bricks with very thick walls, the heat transmission coefficient U-value of the entire existing housing stock made of bricks is very bad, 1,1-1,3 W/m2 Kelvin in contrast to the value of 0,6 required nowadays in Hungary; in some highly developed countries even more lower values are very common. As we have seen subsequent individual insulation of apartments is very expensive. In case of the reconstruction of whole neighbourhoods of system-built reinforced concrete houses the average cost may be much lower. The heat transmission of the windows is very often much worse than that of the walls; since the 70-es better ones are also produced.

At the end of 1996 a comprehensive study dealing with the problems of the built environment and of the construction industry had been submitted to the Houses of Parliament. This document dealt with the renovation problem of the residential building stock in very grave terms. It stated that for a balanced situation at least 40 000 housing units (one-family houses or apartments respectively) should be built yearly (4 units per 1000 inhabitants), whereas since 1992 we build yearly only 20 000 - 25 000 units. The neglected renovation of the stock of multi-family residential buildings alone needed a sum of at least 400 billion forints which would be almost 10 % of the GDP as a whole and almost 50% of the value of all the investments (data from 1995). This value is extremely high and with time passing it is increasing likely in an exponential character.

There are a few neighbourhoods in Budapest where comprehensive, full renovation-programs had been successfully realized. Their lessons should be learnt and propagated.

3.3 Components, materials, services

In the 60's and in the 70's - partly compelled by Eastern European construction policies, partly impressed by the general western enthusiasm for system building the state-owned Hungarian construction industry used building systems when executing the large-scale social housing program as well as when erecting industrial or public buildings. For social housing e.g. the French system CAMUS and the Danish system LARSEN-NIELSEN had been introduced, for industrial plants he British CONDER, for schools the CLASP, a British system again. Besides them also genuine Hungarian systems had been available both in the field of the heavy systems using reinforced concrete as well as in the field of the lightweight ones using steel, plastics and plasterboard. At the end of the 70's the firms engaged in social housing run already 10 so-called "housing factories", 4 of them Budapest, 6 in the major cities, with a yearly capacity of 3000-4000 apartment each. At the time of their introduction almost everybody had been happy with all these systems, but from the early 80's on almost everybody hated them. This turnover was partly an outcome of the poor quality of life experienced in the huge, heavy, monotonous housing blacks, partly it was a form of protestation against the Soviet type society symbolized by these blocks seen as housing monsters. (As a matter of fact we acquired CAMUS in its form developed in the Soviet Union being technologically much more mechanized than the original system was m France.) Better informed people also knew that in the meantime in Western Europe system building came absolutely out of fashion giving place to "post-modern" architecture representing "human scale" and preferring "environment-friendly", "organic" materials. Realizing all these changes also Hungarian architects reinvented bricks and timber as the basic materials of architecture.

It has to be mentioned that even before 1989 the Hungarian construction industry became acquainted not only to the - one could say - "closed" systems developed in Western Europe as CAMUS, LARSEN-NIELSEN, CONDER, CLASP, etc., but also to a series of components and machineries being able to be used in a very flexible - one could say - in an "open system" way. Now, after 1990's unlimited liberalization of the construction market all the building components, materials and equipments to be found on the Western European market became available also for the Hungarian architect. A number of western manufacturers created even affiliated firms in Hungary as POTAIN-Hungaria, HÜNNEBECK-Hungaria, SIKA-Hungaria, etc., but you may be supplied with any Western European building product - as a rule - in 72 hours. The old socialist Hungarian building product market characterized by a continuous scarcity is replaced by a market of abundance: in this special sense we have day-by-day possibilities as if we already were a full member of the EU; with sufficient resources, you may apply as sustainable technical solutions as available in Western Europe. You may reduce your energy consumption, you may improve the quality of your indoor air, you may choose materials of much higher durability, you may reuse your demolished old concrete as aggregate for a new one, you may manage your fluid waste much better than before, etc.

3.4 Human resources and skills

The communist coming to rule in 1948 smashed the private Hungarian construction industry without delay and a state-owned large-scale construction industry was created at once. Even individual craftsmen had been hardly tolerated as private contractors; most of them were driven into cooperatives. All the (19) counties of the country got so-called "state-owned construction companies" and the capital city was supplied with more of them, also with specialized ones (for finishing works, for budding services, for industrial buildings, for public buildings, for housing, etc.). The number of employees of these companies moved most often between 3000 and 5000 in each of them. This preference of operating with (relatively) gigantic companies prevailed not only in the construction industry but also in all the other branches of the economy getting in some cases companies even over tens of thousands employees.

From 1989 on this structure of the economy has changed rapidly. According to data published by the Ministry for Transport („Transport Policy of the Government of the Republic of Hungary; Budapest, 1996") the number and sizes of firms in Hungary changed between 1989 and 1995 as shown in *Table 3.*

	1989	1990	1991	1992	1993	1994	1995 1st half
State owned corporations and cooperatives *							
0-20 employees	1253	1353	1810	2138	2525	3514	5668
21-50 employees	1402	1282	1373	1585	1830	1499	1475
51-300 employees	2758	2835	2991	2821	2660	2108	1760
301 or more	2426	2257	1878	1195	760	280	191
Corporations with share holders **							
0-20 employees	66	152	282	483	900	1010	1141
21-50 employees	51	118	175	254	400	378	427
51-300 employees	90	192	322	492	750	789	783
301 or more	99	183	292	468	750	709	628
Limited Liability partnerships **							
0-20 employees	3266	14336	34488	49478	65000	78036	82610
21-50 employees	799	2596	4498	5014	5600	6085	6136
51-300 employees	366	1237	1968	2343	2800	3149	2945
301 or more	33	125	208	262	330	346	325

Table 3

Note: * Excluding housing co-operatives and water works
** Excluding inactive firms and ones with unknown number of employees

After 1989 most of the large state-owned construction companies became bankrupt and dissolved to smaller corporatives with share holders and/or to limited liability partnerships. The dissolution of the construction industry was so heavy that according to a report of the National Professional Society of Building Contractors (published at the end of 1996) 96 % of the contractors had been working with less than 20 people in 1996: In the same time - according to this report - the number of employees of the overall construction industry decreased from 450 000 in 1989 to 150 000 in i996. This loss is partly due to the fact that in sake of survival a higher efficiency of the labour force is required, it results, however, mainly from the overall recession of the

Hungarian economy and from the special recession of the construction within the framework of the whole economy. In the countries of the EU - on the average - construction produced almost 12% of the GDP, whereas in the last years this ratio was less than 7% in Hungary. A by-product of the given economic situation is the fact that the labour-force working on the black construction market is estimated to 30 000 - 35 000 men in the mentioned report, many of them illegally employed foreigners.

A positive feature of the situation is that the Hungarian firms which survived become step-by-step more-and-more competitive when compared with foreign construction firms acting on the Hungarian market. A negative feature is, however, that the actual quality control in construction is not really able to face all the difficulties and this is - of course - very disadvantageous in terms of constructional sustainability.

In the planned economy phase of the Hungarian development most activities had been heavily centralized and over-regulated. From the start of the transition period the role of the state was to be narrowed down and also its methods were to be changed substantially. Together with the right of accrediting building permissions also the task of quality control in building was given to the municipalities having been, however, not prepared to exert it adequately. Therefore, a certain re-strengthening of the responsibilities of the state seems to be indispensable. It is also clear that in this field some roles should be given again to certain civil organizations. In order to do this the chamber of architects and the chamber of engineers - having been terminated by the communist regimes - have been reestablished and they started to reorganize their activities.

Sustainability in construction is to a great extent simply a problem of quality; therefore the skills needed for a sustainable construction should be given firstly by the education and the training of architects, engineers and technicians. Their traditional curriculum did not involve, however, the study of the special issues of sustainability, so neither a general training in ecology, nor the special studies needed for conservation, reuse, recycling etc. Therefore, postgraduate three-years courses had been started to train environmental engineers already in the 80-es at the Budapest Technical University and these studies started to penetrate also into the undergraduate courses from the early 90-es. So at the Faculty of Architecture undergraduates are obliged to study a subject called "Architecture and Ecology". Sensitivity for and information on ecological and environmental problems are raised and given also on lower levels of education, including even teaching in elementary schools.

3.5 Research and development

Before and after World War I. building research had been carried out almost exclusively at the Budapest Technical University in Hungary. In a few cases also laboratories of the cement industry and of major construction firms as well as a few invention-minded architects had achieved findings to be mentioned even in an international context. After World War II - joining the fairly general European trend of that time to establish independent governmental building research institutes owned neither by universities nor by the industry, the Hungarian Institute for Building Science (ÉTI) was founded in 1947, adapting a role similar to the Building Research Station has had in Britain since the 20's.

After 1948 Hungarian building research became more-and-more influenced by the Soviet budding research system. As a consequence of this both the number of the governmental institutes and the size of their staff became much larger than in most countries of the western part of Europe. This was mainly due to the fact that in the Soviet Union - by principle - there was no industrial research at all and in the field of innovation everything was to be done by a vast, centralized network of governmental R&D institutions. These institutions happened to become very inefficient by the depressing difficulty of transferring research findings to industrial firms being not at all research-minded as interested only in the fulfillment of their production plan defined in quantitative terms.

Pushed into this bed - in a couple of years - Hungarian building research had grown to a network of seven governmental research, development and information institutes with a total staff of more than 5000 men having more than 1000 graduated research and information officers among them: a very exaggerated size for a country of 10 millions inhabitants. The main output of this network was the adaptation of the foreign and the creation of the domestic building systems brought into the practice of the Hungarian construction industry between 1960 and 1980.

From the middle of the 70's, due to the growing economic difficulties it became a heavy burden for the state to finance its R&D network in the building field. From about 1980 a slow erosion started with a loss of about 10% of the staff until 1985, a further 30 % until 1990 and a dramatic additional loss of 50% from the start of the transition until to-day: this means that only 10% of the original staff remained. Practically only one institute was able to survive, the former department of ÉTI dealing with quality control in construction becoming independent in 1963. Recently also the rest of ÉTI had been dissolved into it and now it exists with the name: Institute for Quality Control and Innovation in Construction (ÉMI). Independently from ÉMI a small group for research in urbanism and an other for building information do still exist maintained partly by the government and partly by practitioners respectively.

Parallel to these changes a considerable strengthening of research at the Budapest Technical University is in progress. This is an outcome of adapting the American system of granting PhD-degrees to graduate students having solved research problems in an organized way at research universities. For the time being about 50 graduate the working for their PhD-degree at the Faculty of Architecture in Budapest and they constitute a new, important and growing base for ongoing and future building research in Hungary.

In the field of basic research the National Fund for Scientific Research (OTKA) is acting as the most important sponsor. This fund is supplied by the national budget and uses a system for academic as well as for governmental and even for industrial research teams on condition of aiming at the solution of a basic (fundamental) research problem. For development projects supporting may be received through the National Committee for Technological Innovation (OMFB).

For the time being ongoing and/or needed Hungarian R&D activities concerning the built environment may be listed as follow:

- Investigation of the changing role of Budapest in the Middle and South East European region;
- Investigating the growth and the problems of the Budapest agglomeration;
- Analyzing the consequences of the radial - Budapest centred - transport system of the country and identifying the next needed steps to develop annular and transversal contacts;
- Investigating regional changes in the country in order to apply EU methods for identifying problem areas (social and economic decay, areas of obsolete industries, unilaterally rural-agricultural areas, areas of high unemployment);
- Preparing agendas for developing areas for recreation and tourism;
- Fostering voluntary small-scale regional association of numerous small villages in order to achieve urban advantages ,without destroying the given settlement structure;
- Investigations for finding more dynamic ways of disseminating and using information technology in housing, building, planning and utilization of land;
- Investigating the technology of lignite-based thermal power stations in order to reduce the sulphur-content of their smoke (causing acid rains) without making their fly-ash a dangerous, intoxicating waste;
- Further on-the-site experiments in order to adapt American procedures of financing and constructing, to realize large scale projects aiming at "affordable housing";
- Improving and innovating diagnostical instruments and methods used when evaluating the physical state of buildings and neighbourhoods; special attention should be given. to the structural safety if suspended outside corridors are suspected of being deteriorated;
- To adapt or develop suitable technologies for renovating deteriorated residential and industrial buildings, or only some of their parts; also ideas for . rehabilitating obsolete areas should be generated;
- When renovating old buildings the flexibility of their use should be increased significantly;
- It is of crucial importance that renovation should practically always be coupled to supplementary application of suitable thermal insulation in order to reduce energy consumption substantially; the possibility of measuring consumption individually in every apartment of multi-family houses is a fundamental prerequisite of saving energy;
- Increased and improved use of passive and hybrid solar heating;
- Developing increased use of natural lighting to save energy;
- Means and methods for improving indoor air quality;

- Studying combined comfort effects of heat, sound and lightning in order to improve conditions for mental work;
- Research to improve durability of structural concrete and of external finishes;
- Research to increase the use of environment-friendly materials as adobe and to constructional recycling of wastes as fly-ash;
- Segregation techniques of debris materials of pulled-down buildings (for example the reinforcement from the concrete);
- Adequate use of explosion techniques in demolishing buildings and structures;
- Toleration levels in case of radioactive materials (e.g. timber coming from areas attached by nuclear accidents), etc.

3.6 Strategic recommendations for the management of construction companies

In periods of transition as prevailing now in Hungary and in the whole area of Eastern Middle and South Eastern Europe a *thorough study of the ongoing processes* in the national and in the international building field is of crucial importance.

Special attention should be given to all forms of *market information* and to all responsible attempts aiming at *short- as well as at long-term forecasts* of construction activities.

Market information and market forecasts should be able to deal *with all the significant branches* of the construction and of the building materials industry, including analyses of the relations between the different branches, evaluating importance and actual forms of cooperation.

Market information should be completed by international and domestic *product information* and by information about international and domestic *research findings.*

Based upon the most important statements of this study it is quite clear that the leading task of construction in Hungary will be the completion of the system of superhighways connecting the major cities within the country and connecting the country with all the neighbouring ones. Strong firms acting in the civil engineering field should try to gain the role of general contractors in realizing various stages of the superhighway-construction, whereas minor firms should attempt to undertake the construction of the auxiliary establishments as gasoline stations, ensembles of buildings for convenient rest on the way, proper parking places, etc. All these tasks are relevant both in the intercity relation as well as within the metropolitan area of the country with its heavy need for suitable park & ride connections, garages etc. In all these tasks minimizing negative environmental effects should be a major concern.

The second outstanding comprehensive area of getting stimulating commitments is *to serve the building needs of foreign and domestic capital* eager to fulfill profitable investments both in trade and the industries. Banks, warehouses, shopping centers, shopping malls, new or rebuilt industrial plants are the most preferred tasks. To acquire special skills in any of these building types is very promising for a construction company. Many of these tasks get realized in areas of very dense traffic, so organization of the work causing minimum trouble is an outstanding feature of competence.

The third big area of construction is *to create or renovate residential buildings, neighbourhoods or even districts.* Although sufficient capital is available almost only in the case of high level villas, this huge area as a whole deserves heavy attention. In renovation works even small firms may be very successful if they are able to accommodate themselves to owners having only modest financial means; the crucial task in many of these cases is to unite a fairly high number of rather poor owners in order to achieve a high level of efficiency. In the same time even very small renovation tasks may employ a high number of craftsman as the need for them is extremely pressing. With the rapidly growing energy prices the need for better *thermal insulation* for example became very common.

In general: *the typical tasks of sustainable construction* as energy conservation, recycling of building materials, waste management etc. are so poorly covered by firms who are highly skilled in construction, that there is room for many undertakings willing to invest in this problem area.

A grave heritage of the Hungarian construction industry comes from the fact, that from the 50's to the 80's this industry was concentrated into some dozen very large companies working in an extremely autonomous way: this resulted in very low levels of cooperation. According to this it is one of the most important development needs of many of the Hungarian construction companies to improve readiness and ways of effective cooperation. This demands surely that the use of *information technology* should be enlarged in a substantial measure.

In the field of *computer aided architectural design* the progress in Hungary has been outstanding and this branch was able to achieve even a significant software export (e.g. the export of the ArchiCAD software of the firm GRAPHISOFT to the USA). Due to this progress Hungarian architectural design was able to overcome much better the same bad heritage of having been organized previously in too large design institutes. Hungarian construction companies should become at least as good in *computer aided management* as their fellow-teams of architects have been in computer aided design.

4. METHODOLOGY USED WHEN PREPARING THIS STUDY AND LIST OF REFERENCES

The principal author of this study started to investigate the problems having been dealt with here just after the Amsterdam meeting of CIB W82 in May 1995, where the first version of the five basic questions (cities, buildings, components, etc.) had been accepted. A bit later he was asked for by the leader of the sustainability project of the commission in that time to elaborate a short analysis of the environmental constraints of the building sector in Hungary. In order to do this he contacted the Hungarian Ministry for Environment and Regional Policy for support with suitable data. He received the document *Environmental Indicators of Hungary* prepared by that ministry in 1994 and an other one titled *National Conception for Environmental Policies* elaborated by the same ministry in the same year. Using these documents and relying upon his own expertise he wrote a study titled *Environmental Constraints of the Building Sector in Hungary* and presented it at the next meeting of the commission in Ascot, October, 1995.

After the Ascot meeting participants had been asked for elaborating short answers to the five questions defined in Amsterdam; these short answers were to be presented in Sophia Antipolis in April 1996. As his study "Environmental Constraints..." already gave implicit brief answer to the five questions the author prepared only a short completing document titled *Appendix to Environmental Constraints of the Building Sector in Hungary.* making the answers more explicit. This Appendix was presented in Sophia Antipolis where problems and structure of the final study had also been discussed. The detailed Instructions for the final National Reports had been sent to participants in September 1996 by Mr. Casper Richter, the leader of the sustainability project in this (the third) phase.

Having received the Instructions the author contacted the secretary general of the Hungarian Scientific Society for Building (ÉTE), an associate member of the CIB represented by the author in CIB W82. It was decided to ask all the six Hungarian members of the CIB for participating in the elaboration of the final National Report: The Hungarian full member of the CIB Institute for Quality Control and Innovation in Building (ÉMI) and the individual member Ms Anna Gáspár accepted the invitation and it was decided to start the actual work after the meeting of the commission W82 in Bucharest, November 1996, which was to discuss and finalize the Instructions.

After Bucharest a team representing the three participating Hungarian members was formed; ÉTE became represented by three persons (the author, Prof. László Bánhidi, former director of the Institute for Building Services at the Budapest Technical University and Mr. András Somos, expert for renovating the residential building stock of Budapest); ÉMI became represented by Dr Gábor Madaras, research director of the Institute, and the market information firm BAU-DATA became represented by its director Ms Anna Gáspár, an individual member of the CIB.

At the first meeting of the team the studies "Environmental Constraints" and the "Appendix" were presented briefly by the author and this was followed by a brain-storming of the team focused on the questions as described in the Instructions and put down by the author. After this brain-storming it was decided to leave a couple of days to the members to study the full text of the papers mentioned and they were asked for answering subsequently the questions of the Instructions in the form of self-interviews fixed on magnetic tapes. These tapes were handed over to the author, who studied them and put individually further questions to the members asking for written answers. This was done and this way the author became familiar with the ideas of the members in depth. This was the basic personal information given to the author before he started to write the national report.

Besides this the secretary general of ÉTE; Dr. Pál Seenger collected four recently elaborated governmental documents relevant for the national report. These were :

1. the National program for protecting the environment;
2. a Draft for a comprehensive conception of the regional development of the country;
3. the Transport policy conceived for the country;
4. a Report for the Parliament dealing with the built environment and the construction industry. These documents were taken as further information for the national report.

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REPORT 5

SUSTAINABLE CONSTRUCTION IN IRELAND : 2010

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NATIONAL REPORT (ABRIDGED)

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1. INTRODUCTION

1.1 Preamble

It was towards the middle of 1997 that Ireland became involved in this very valuable Study Project, initiated by CIB Working Commission 82 : Futures Studies in Construction , on the subject of developing a response, in built form, to « **sustainable development** » - a concept first given expression at the beginning of the 1970's, but elaborated in a readily understandable form only at the end of the 1980's (Bruntland Report, 1987).

We are grateful for the opportunity of this involvement, and warmly appreciate the guidance, documentation and encouragement offered by the members of W 82.

Joining the Project at such a late stage presented us with challenges, but also with the advantage of being able to learn from earlier contributions of the Project's many international participants.

Our considered view is that Sustainable Construction represents a quantum leap in the evolution of design philosophy, and that its relentless progress forward is inevitable.

We wish the Project every success.

1.2 National Policy in Ireland

Official national policy in Ireland with regard to « **sustainable development** » is set out in the following document :

> *Sustainable Development - A Strategy for Ireland*
> Government Publications. Dublin. 1997.

Also in 1997, a review of the construction industry was published :

> *Building Our Future Together - A Strategic Review of the Construction Industry in Ireland*
> Government Publications. Dublin. 1997.

Of interest in this document is the section on Environmental Sustainability.

Both publications, however, are long on general statements - but very short on matters of substantive and immediate implementation. Attached in Appendix 1 is a recently printed magazine article which shows Ireland's actual performance, in relation to housing, compared with other countries in Europe.

It is a continuing concern for the practical implementation of Sustainable Construction which first informed our approach to the Questionnaire Survey in 1997 (Section 2), and which now also directs our search for meaningful understanding (Section 3).

1.3 What is Sustainable Development ?

We have carried out sufficient investigations and research to be able to state, with certainty, that we do not yet know what « **sustainable development** » means.
More and more, however, we are beginning to see the wide scope of this concept, and the complex inter-relationships between different components:

(a) Environmental Protection
- ◊ land / marine use, and transport ;
- ◊ energy ;
- ◊ waste and emissions ;
- ◊ healing, preservation and enhancement of natural ecosystems ;
- ◊ awareness raising and education ;
- ◊ dissemination ;
- ◊ urban and rural land management, marine management ;
- ◊ etc.

(b) Human / Social Development
- ◊ justice and empowerment ;
- ◊ equality of opportunity ;
- ◊ inclusion ;
- ◊ « person-centred » environments and services provision ;
- ◊ health, welfare and quality of life ;
- ◊ etc.

(c) Cultural Development
- ◊ human identity ;
- ◊ local distinctiveness and civic pride ;
- ◊ social cohesion ;
- ◊ inter-cultural and inter-generational understanding ;
- ◊ skills enhancement ;
- ◊ urban and rural regeneration ;
- ◊ etc.

(d) Economic Development
- ◊ financial mechanisms and incentives ;
- ◊ employment generation ;
- ◊ socially responsible business ;
- ◊ the Information Society ;
- ◊ etc.

1.4 Implementation of Sustainable Construction

The strategy we would propose for consideration at international level, therefore, is three-fold :

I Raise awareness and irreversibly influence the mainstream international construction industry, related educational establishments and professional bodies by the year 2010.

II Use the time between now and 2010 to fully understand the concept of « **sustainable development** », and to assemble a coherent and comprehensive statement of the problem. Develop the framework for an effective and practical response.

III Target the remainder of the next century to implement this response, monitor and control implementation, and to continuously adjust and improve performance indicators. Refine and complete the response.

The present condition of our planet indicates very clearly that a voluntary, « laissez-faire » approach to implementation will not work. A firm, caring and sensitive interventionist policy is strongly advocated.

It is of absolute importance that a legal base evolves which will validate such a policy. This process has already commenced in the European Union (E.U.), and by implication, the remainder of Europe. See Appendix 3 of this Report.

We would not propose, however, that the response which will eventually be found to be suitable and appropriate for conditions in Europe, will be either suitable or appropriate for any other region of the world.

1.5 Ireland's Contribution

At a meeting of CIB Task Group 16 : Best Practice for Sustainable Construction in Paris, on 11th. June 1997, we drew attention to the need for international agreement on:

(i) the language and terminology of Sustainable Construction ;

(ii) the protection of indigenous architecture and methods of building.

We are progressing work in both of these areas.

2. QUESTIONNAIRE SURVEY - 1997

2.1 Methodology

As previously explained in the Introduction, a concern for the practical implementation of Sustainable Construction informed, to a great extent, the approach taken to this questionnaire survey last year:

(i) contacts were made only with front line participants, either individuals or organizations, in the mainstream Irish construction industry ;

(ii) those contacted were requested not to engage in attempting to foretell the future, but to express written views, opinions and observations within their own experience.

In order to encourage maximum participation in the survey, an undertaking was given that contributions would not be attributed to named individuals.

The following individuals / organizations were circulated with the questionnaire on Monday and Tuesday, 1st.- 2nd. September, 1997 **:**

- Head, Construction and Engineering Technologies, Forbairt ;
- Architect, Historical Buildings Section, Office of Public Works ;
- Building Contractor (SME) , Munster Region ;
- Multi-Disciplinary Environmental Consultancy, Dublin ;
- Lecturer, Faculty of the Built Environment, Dublin Institute of Technology (Bolton Street College) ;
- Manager, Irish Agrement Board.

<u>Survey Response :</u>

One questionnaire was never completed ; the last was returned on 7th. October, 1997.

After much discussion, one set of questionnaires was withheld. Genuine disagreement was expressed with the survey, the reasoning behind it, and what it was meant to achieve. The preferred course of action, in their view, was that a 'bottom-up', individual approach to sustainable development should be allowed to take place naturally in each society, at its own rate.

The response was sufficient to discern current thinking, and the general level of awareness about the subject in the mainstream construction industry.

2.2 Answers to Main Question & Six Subsidiary Questions

It was felt necessary to add a preliminary two-part question relating to the term, Sustainable Construction, and its meaning.

Have you ever heard of the term ' Sustainable Construction ' before ?

Three individuals/organizations answered "yes".
One answered "no".

If " yes " , what do you understand to be the meaning of this term ?

(a) Full lifetime, real production cost and reusability audit of materials and construction.
(b) Sustainable construction should mean that the construction of buildings becomes a cyclic process rather than a linear process as it is at present.
(c) Construction that can continue indefinitely.

2.2.1 Main Question:

What will be the consequences of sustainable development for the construction industry in Ireland by the year 2010 ?

(a) Without cost penalties, none. With penalties, concentration on renewable materials - careful evaluation before redundancy of buildings and elements.
(b) A radical change in outlook is required by the construction industry in Ireland to achieve sustainable development.
(c) Major changes in construction practices are required because of existing minimum attention to this issue.

2.2.2 Subsidiary Question No. 1:

What does this entail for town planners and the 'built environment' (urban and rural) by the year 2010 ?

(a) Audits of building stock relating more to elements rather than services/standards as presently. Development based equally on life cycle and immediate usability.
(b) Town planners seem to think that sustainable development can be achieved by simply having a higher density of people alongside modern public transport systems. This approach will not provide what is required and a more enlightened strategy is required.
(c) Retraining of planners/local authorities professional and technical staff is required.
A proactive stance in selling the concept and demanding a 'higher standard' of building from developers.

2.2.3 Subsidiary Question No. 2:

What does this entail for initiating, designing, constructing, maintaining, operating, and demolishing buildings by the year 2010 ?

(a) Demolishing of buildings should require audit/recycling of elements/materials. Operating will include maintenance costs.

(b) Buildings need to be designed, constructed and maintained so that they have a continuous life cycle.

(c) A total new approach is required - next to no attention is being paid at the moment by the sector.

2.2.4 Subsidiary Question No. 3:

What does this entail for construction related materials, components, component assembly, and building servicing by the year 2010 ?

(a) High energy elements, such as PVC doors and windows, will be more keenly evaluated against natural renewable elements, such as timber windows and doors.

(b) Construction materials and their assembly must be such that their production and use does not harm the environment and that they can be reused.

(c) Less use of virgin material, more reuse of demolition waste. Components should be designed for reuse. More attention paid to making better use of 'building' salvage.

2.2.5 Subsidiary Question No. 4:

What does this entail for human resources and skills needed in the construction industry by the year 2010 ?

(a) Quantities will include energy rather than solely cost. Skills in adaptability/reuse will be needed.

(b) A considerable amount of education will be required at all levels in the construction to ensure that everyone involved has the same common goal of sustainable development and retraining will be required for the new construction skills needed to build sustainable buildings.

(c) Rethinking and training for designers. Concept should be 'thought in', and then 'built in' to developments.

2.2.6 Subsidiary Question No. 5:

What does this entail for construction related R & D up until the year 2010 ?

(a) R & D in Ireland is limited and cost driven. Materials are generally imported so effects generally minimal.

(b) A significant amount of R & D will be required to provide the information and materials necessary for sustainable construction.

(c) Increased emphasis on R & D in the environmental end of construction with respect to reuse of materials.

2.2.7 Subsidiary Question No. 6:

Is it possible to formulate strategic recommendations for the management of construction companies based on the answers to the questions in this box ?

(a) Strategic recommendations for construction companies relate solely to requirements both legislative and economic (e.g. client requirements of Green Insurance Companies, etc.) .

(b) Strategic recommendations can be formulated and a group should be set up to achieve this.

(c) Yes ! in a general sense

- Investment in R & D
- Increase training and
- Develop standards
- Promote 'Sustainability' at design
- Design for reuse

2.3 Some Immediate Consequences for the Construction Industry in Ireland

In Ireland, there is no pressure (legislative, economic or financial) , there are no signals from the marketplace, and but sparse and isolated calls from individual clients for a move in the direction of Sustainable Construction.

At international level, even the language of sustainability causes strong disagreement, as witnessed at a conference held in Paris during June, 1997 - 'Batiment et Environnement', organized by CSTB / CIB.

There is no agreed terminology.

The Principles of Agenda 21 do not appear to be well known, or understood.

Reference to the existing body of relevant International (ISO's) and European (EN's) Standards is less than adequate.

It is early to talk in terms of good practice in Sustainable Construction, and entirely premature to think of best practice.

There is a profound need, worldwide, for radically innovative thinking in the construction industry.

Four matters, however, require immediate attention in the Irish construction industry **:**

- the craft base in the industry must be saved, significantly deepened and extended ;
- the use of materials, products or processes which have an ' **environmental impact** ' must be properly re-examined ;

- existing EU health and safety, and environmental legislation must be properly complied with, monitored and controlled ;
- the awareness of senior personnel, in all sectors of the industry, must be raised.

2.4 Recommendations for Action

Short to medium term actions in Ireland should take the following courses :

A high-level national research group should be established to examine the concept of « sustainable development » , and its practical implementation in this country.

A national forum on Sustainable Construction should be established to develop a suitable response, in built form, to that concept - and to act as a focus for construction related activities at national level.

(Human/social development is a particularly important component of 'sustainable development', and requires special attention in both of the above areas.)

An initial set of Sustainable Construction « **performance indicators** », suitable for application in Ireland (but within an EU context), should be compiled to cover :

- ◊ the process of construction ;
- ◊ newly completed buildings and civil engineering projects ;
- ◊ the operation, servicing, maintenance, adaptation, modification, alteration or extension of existing construction works ;
- ◊ de-construction, and disposal (incl. re-use) .

The political systems in Ireland, and at EU levels, should be lobbied :

- ◊ to make firm commitments with regard to the real implementation of Sustainable Construction ;
- ◊ to put in place suitable economic / financial mechanisms and incentives to foster and encourage a conversion towards Sustainable Construction ;
- ◊ to re-assure those individuals / organizations within the construction industry, e.g. manufacturers of plastic windows, who may feel threatened by this conversion to new practices.

The opinion of the public, politicians, government administrators, and all of the actors in the construction industry should be carefully nurtured by means of a concerted programme of awareness raising and education.

2.5 Case Study - Short Description of a Recently Completed Building

« Internet Office and Ecohouse Pavilion » , Lough Derg, River Shannon. Designed by Paul Leech, **Gaia Associates** , Dublin 2. Completed in November, 1995. (See Appendix 2).

3. TOWARDS AN UNDERSTANDING OF SUSTAINABLE DESIGN, CONSTRUCTION / DE-CONSTRUCTION AND MAINTENANCE

3.1 Introduction

The big picture on this planet, the long-term goal over the next century, is a fully sustainable natural and built environment, each co-existing with the other in balance and harmony, and each, in their own way, capable of providing for responsible human, social, cultural and economic development. Previous injury to the natural environment must be healed in order to arrive at this outcome ; initial damage repair by human intervention, sufficient only to promote a process of natural self-healing, is suggested.

This level of sustainability is a very complex phenomenon. Nobody yet fully understands what is happening and further experimentation on the natural environment should, to a certain extent, be out of the question because of its current state of fragility.

Sustainability of the 'built environment' (see definition below) can only be understood in relation to that of the natural environment ; it involves, with precision and reliability,

(i) establishing limits on the capacity of the natural environment to sustain itself ;
(ii) stopping short of those limits, by a controlled factor of safety, in any further future modification or extension to the built environment ;
(iii) altering the nature and course of human development, i.e. sustainable development.

The International Council for Building Research, Studies and Documentation (**CIB**) has determined to formulate a response to (ii) above on behalf of the construction industry worldwide, i.e. **Sustainable Design, Construction / De-Construction and Maintenance**.

An evolution in design philosophy, such as this, is also complex. We are only beginning to understand what is happening. In order to properly co-ordinate a response, however, and to provide an objective and quantitative basis for decision making, we must first of all define the problem and analyse the operation of its resolution. The system is dynamic. The method of work must be widely multi-disciplinary - a working dialogue between practitioners, researchers and end-users must be actively encouraged.

3.2 The Problem & Course of Its Resolution

See Figure 1 - Model of a Complex, Dynamic System

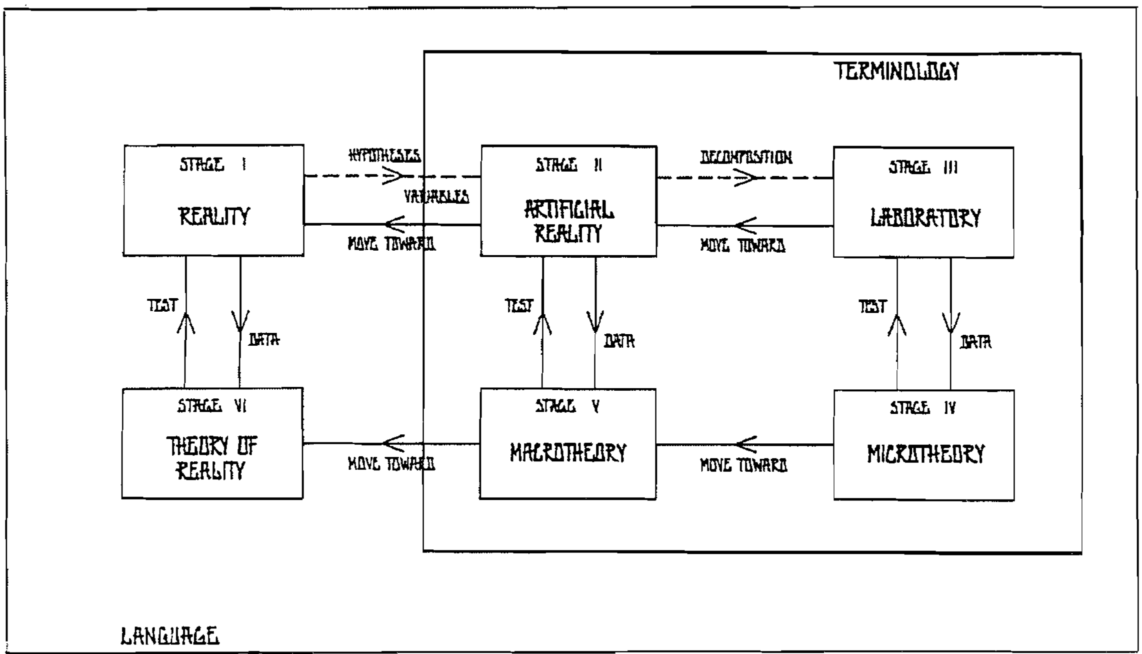

Figure 1 : Sustainable Design, Construction / De-Construction & Maintenance Co-Ordination and Experimentation

Stage I

The realistic end condition, or 'reality', is the design, construction / de-construction, and maintenance of sustainability in the built environment.

Literature dealing with 'reality' is reviewed. Relevant hypotheses are extracted, and as many variables as possible are identified.

Reference to statistics must be limited to those which can be shown to be impartial, reliable, objective, scientifically independent, cost-effective and statistically confidential.

Stage II

An 'artificial reality' is designed which is complex enough to permit testing of the hypotheses formulated in **Stage I**. Observations must be capable of description in quantitative terms.

Questionnaire surveys are carried out with real users of buildings, civil engineering works and infrastructural networks, e.g. transport. To be effective, it is essential that each survey is carried out, on a person-to-person basis, by an independent, competent, non-threatening individual, and using both open and closed format questions. These surveys are not only very valuable sources of information, but they formalize the process of consultation between practitioners and end users. See definition of 'person-centred design' in **3.3** below.

Stage III

'Artificial reality' is broken down into simple experimental situations at small and medium scale, e.g. advanced energy surveying of buildings or groups of buildings using infra-red thermography, detailed analysis of air quality in buildings and at external locations, real time monitoring of thermal comfort (EN ISO 7730) conditions in buildings, etc., which generate test results under controlled conditions, i.e. a laboratory in the real environment.

Special attention must be paid to measurement uncertainty, and test method precision.

Stage IV

A simple theory, or microtheory, is developed to explain the test results. When this microtheory is tested and found valid, it is expanded to contain test results in more complex situations, e.g. satellite and/or aerial based infra-red surveys of geographic regions. This process is repeated until a macrotheory is formulated which explains the 'artificial reality' .

Special attention must be paid to calculation uncertainty. Computer modelling packages must also be transparent to practitioners, and validated by an independent, competent individual and/or organization.

Stage V

'Artificial reality' is modified in the direction of 'reality' and **Stage IV** is repeated yielding a fresh macrotheory. The process is repeated again and again.

Stage VI

When a macrotheory is sufficiently developed, it can be used to extrapolate an explanation of 'reality' .

It is essential that such a 'theory of reality' is accessible to all concerned with the implementation of sustainable design, construction / de-construction and maintenance in the built environment and, therefore, a boundary to the use of terminology is delineated.

Terminology must focus on, and be always directly related to, the realistic end condition.

Without **research and development**, this system remains static and the problem cannot be fully resolved.

3.3 Interpretation

Adaptability :		The extent to which a building, or a building component, is designed when new, or capable of being easily modified at any later stage, to meet the changing living or working needs of the broad average of potential occupants, who may be disabled or able-bodied.
Buildability (CIRIA-GB)	:	The extent to which the design of a building facilitates ease of construction, subject to the overall requirements for the completed building.
Built Environment :		Anywhere there is, or has been, an intervention by a human being in the natural environment.
Construction Works (EU Directive 89/106/EEC)	:	Any building or civil engineering works.
Cost Effectiveness (IEC Treaty, 1994*)	:	To achieve a defined objective at the lowest cost, or to achieve the greatest benefit at a given cost.
Dimensional Co-Ordination (ISO 1791)	:	A convention on related sizes for the co-ordinating dimensions of building components and the buildings incorporating them, for their design, manufacture, assembly and/or installation.
Disabled :		Those people, of all ages, who are unable to perform, independently and without aid, basic human tasks or functions because of physical, mental or psychological impairment, whether of a permanent or temporary nature. This definition is derived from / based on the World Health Organization's definitions (1980) of 'impairment' and 'disability' only. The term **disabled** includes • wheelchair users ; • people who experience difficulty in walking, with or without aid, e.g. stick, crutch, calliper or walking frame ; • the elderly (people over the age of 60 years) ; • the very young (people under the age of 5 years) ;

- pregnant women ;
- people who suffer from arthritis ;
- the visually impaired ;
- the hearing impaired ; and
- people who panic in a fire situation or other emergency ;
- people who suffer incapacitation as a result of exposure, during a fire, to poisonous or toxic substances, and/or elevated temperatures.

Economically Reasonable Working Life :
(EU Directive 89/106/EEC)

(i) The working life is the period of time during which the performance of the works will be maintained at a level compatible with the fulfilment of the Essential Requirements.

(ii) An economically reasonable working life presumes that all relevant aspects are taken into account, such as

- costs of design, construction and use ;
- costs arising from hindrance of use ; risks and consequences of failure of the works during its working life and costs of insurance covering these risks ;
- planned partial renewal ;
- costs of inspections, maintenance, care and repair ;
- costs of operation and administration ;
- disposal ;
- environmental aspects.

Energy Cycle :
(IEC Treaty, 1994)

The entire energy chain, including activities related to prospecting for, exploration, production, conversion, storage, transport, distribution and consumption of the various forms of energy, and the treatment and disposal of wastes, as well as the decommissioning, cessation or closure of these activities, minimizing harmful environmental impacts.

Environmental Impact :
(IEC Treaty, 1994)

Any effect caused by a given activity on the environment, including human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures or the interactions among these factors ; it also includes effects on cultural heritage or socio-economic conditions resulting from alterations to those factors.

Human Health :

A state of physical, mental, psychological, social, cultural and economic wellbeing.

Improving Energy Efficiency : (IEC Treaty, 1994)	Acting to maintain the same unit of output (of a good or service) without reducing the quality or performance of the output, while reducing the amount of energy required to produce that output.
Life Cycle : (EN ISO 14040)	Consecutive and interlinked stages of a product (and/or service) system, from raw material acquisition or generation of natural resources to the final disposal.
Life Cycle Assessment : (EN ISO 14040)	Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product (and/or service) system throughout its life cycle.
Life Cycle Impact Assessment : (EN ISO 14040)	Phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts of a product (and/or service) system.
Life Cycle Interpretation : (EN ISO 14040)	Phase of life cycle assessment in which the findings of either the inventory analysis or the impact assessment, or both, are combined consistent with a defined goal and scope in order to reach conclusions and recommendations.
Life Cycle Inventory Analysis : (EN ISO 14040)	Phase of life cycle assessment involving the compilation and quantification of inputs and outputs, for a given product (and/or service) system throughout its life cycle.
Performance : (EU Directive 89/106/EEC)	Performance is a quantitative expression (value, grade, class or level) of the behaviour of a works, part of the works or product, for an action to which it is subject or which it generates under the intended service conditions (for the works or part of the works) or intended use conditions (for products) .
Safety : (ISO/IEC Guides 2 & 51)	Freedom from unacceptable risk of harm
SEED :	Sustainable , Energy-efficient , Environment-friendly Development.
Sustainable Development : (Bruntland Report, 1987)	Development which meets the needs of the present without compromising the ability of future generations to meet their own needs.

An improved definition of 'sustainable development' must also embody the following concepts
- the place of human beings in the environment, and the relationship between both ;
- the nature of human, social, cultural and economic development, their current imbalances and inequities, and their future course ;
- the healing of existing injury to the natural environment.

Sustainable Construction (CIB/W82 & TG16) : The creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles

Sustainable Design : The art and science of the design, supervision of related construction / de-construction, and maintenance of sustainability in the built environment.

The definition of 'sustainable design' embodies the following concept ....
- 'person-centred' design , i.e. that design process which places real people at the centre of creative concern and gives due consideration to their safety, health and welfare in the built environment - it includes such specific performance criteria as a sensory rich and accessible (mobility, usability, communications and information) environment, fire safety, thermal comfort (EN ISO 7730) , air, light and visual quality, unwanted or nuisance noise abatement, etc.
- an important 'person-centred' design **aid** is the questionnaire survey, carried out by an independent, competent, non- threatening individual, and which comprises both open an closed format questions.

Sustainable Engineering : The application of scientific principles to relevant aspects of sustainable design.

Welfare : A general feeling of health and happiness.

3.4 Reference Documentation

ISO 6241 : 1984

' Performance standards in buildings - Principles for their preparation and factors to be considered '

ISO 6707-1 : 1989

' Building and civil engineering - Vocabulary. Part 1 : General terms '

ISO 6707-2 : 1993

' Building and civil engineering - Vocabulary. Part 2 : Contract terms '

EN ISO 14040 : 1997

' Environmental management - Life cycle assessment - Principles and framework '

ISO / TR 14177 : 1994

' Classification of information in the construction industry '

International Charter for the Conservation and Restoration of Monuments and Sites

International Council of Monuments and Sites (**ICOMOS**) . Venice, Italy. May, 1964.

Rio Declaration on Environment and Development - Agenda 21

Adopted on 14th. June 1992, at the 19th. plenary meeting of the United Nations Conference on Environment and Development. Rio de Janeiro, Brazil. 3rd.- 14th. June, 1992.

E.U. Council Regulation (EEC) No. 1836/93 , of 29th. June 1993, allowing voluntary participation by companies in the industrial sector in a Community eco-management and audit scheme.

Helsinki Declaration on Action for Environment and Health in Europe

World Health Organization, Regional Office for Europe. 2nd. European Conference on Environment and Health. Helsinki, Finland. 20th.- 22nd. June, 1994.

International Charter for the Protection of Indigenous Architecture and Methods of Building

Conscious of the meaning of 'environmental impact' , it was agreed at a meeting of **CIB/TG16** in Paris, on 11th. June 1997, that work should commence on this Charter. Possible sponsorship of the document by the United Nations should also be explored. See Principle 22 of **Agenda 21** .

* **International Energy Charter Treaty**

Lisbon, Portugal ; December, 1994. Official Journal of the European Communities. **OJ L 380** . Office for Official Publications of the European Communities. Luxembourg. 1994.

4. APPENDIX 1 : SURVEY « SUSTAINABLE HOUSING IN EUROPE »

survey

Policy and practice do not always match

Sustainable housing in Europe

ANKE VAN HAL AND BIRGIT DULSKI

"Housing and the environment" does not always look the same in practice as it does on paper. Following an earlier survey of sustainable housing policies, a survey of sustainable housing practice in European countries was recently carried out. The country that scored best was Denmark - a result which will not surprise those familiar with the field. Yet some less likely countries, such as those in Eastern Europe, also turn out to be interested in sustainable housing. This issue of *Sustainable Building* presents the findings of the 24-country survey. To start with, however, here are some general comparisons and conclusions.

This issue of *Sustainable Building* coincides with the Second European Ministerial Conference on Sustainable Housing Policies, being held here in the Netherlands. One of the surveys conducted in preparation for this conference was carried out to determine the extent to which environmental measures are adopted in housing construction in the 24 countries attending the conference - in other words, the extent to which sustainable housing policies are implemented in practice.

A pre-conference survey of sustainable housing policies in the 22 countries attending the First Ministerial Conference (held in Copenhagen, 1996) had revealed that many countries did not yet have any specific policy on sustainable housing. Such national policies as existed were mainly in the form of building regulations and standards, and only occasionally was sustainable housing encouraged by means of financial incentives (tax breaks) or penalties, experimental projects or research. In half of the countries investigated, however, there was regular consultation on sustainable housing issues between the government and the building sector. Some countries appeared to be taking something of a lead. The Netherlands, Ireland and Austria, for example, had already adopted comprehensive environmental protection plans. Iceland and Portugal, on the other hand, appeared to show little interest in sustainable housing. In Eastern European countries, which only had limited funds available for housing of any kind and where the emphasis was on reducing housing shortages, sustainable housing policies were as yet non-existent.

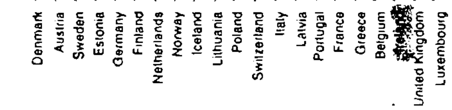

Chart 1: General: This chart shows the extent to which environmental measures are customary in housing construction, based on the entire range of measures which the researchers identified as environmental measures (see box). The percentages indicate how many of these measures were identified as customary by respondents in the various countries. Hungary, the Czech Republic and Spain are not shown, as the information from those countries was too limited and inconsistent to be considered reliable.

A year later, the survey of sustainable housing practice (as opposed to policy) has produced some unexpected findings. Of the three countries with comprehensive environmental protection plans, only Austria turns out to be doing a great deal in practice. The Netherlands is roughly average by European standards, and Ireland scores very poorly indeed. On the other hand, practice in Eastern European countries is far more satisfactory than the first survey suggested, in particular because those countries make considerable use of traditional materials, many of which are sustainable. At the same time, quite considerable attention is paid to the environment when building new dwellings, as Eastern European countries are keen to learn from Western experience and prevent problems from arising in the first place.

Although, owing to its limited scope (see box), this survey of sustainable housing practice can only be approximate, it is quite clear that policy and practice do not always match. Some countries have ambitious policies on paper but fail to live up to them in practice. Others continue to adopt traditional measures which are now considered environmentally sound in countries such as the Netherlands. For example, in countries like Poland, Estonia and Latvia, sustainable traditional building materials like (European) wood are still used. In countries such as these, more is done in practice than policy requires. Chart 1 shows the extent to which environmental measures are customary in housing construction in the various countries. However, the scores for the various countries are not always directly comparable; they can only be properly interpreted with reference to the specific situation in the country concerned. For example, the chart does not indicate the scale of housing construction, and this can distort the true picture. In Estonia (and a number of other countries), although quite a large number of environmental measures are adopted in new housing construction, very few new dwellings are actually built. The situation there can therefore hardly be compared to the situation in a country such as the Netherlands, where sustainable housing measures are becoming an increasingly established part of the much larger new housing sector. However, the conclusion that Denmark is Europe's leader in sustainable housing does appear to be fully justified.

Energy

The main sustainable housing measures that are adopted in practice turn out to be energy-saving measures. Almost every country scores better on energy than on other topics. Here again, Denmark is the leader, followed (some way behind) by Sweden.

As climatic conditions would lead one to expect, energy-saving measures are only adopted to a limited extent in southern European countries. Strikingly, despite its northern location, Iceland adopts relatively few energy-saving measures. However, this is due to the presence of geothermal energy, which is in plentiful supply and is the main source of energy there; as a result, energy-saving measures have relatively low priority.

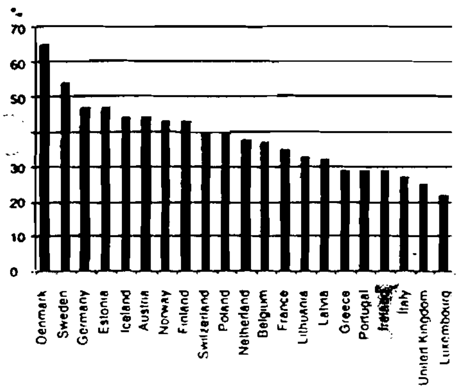

Chart 2: Energy: energy-saving measures.

Traffic

There are greater differences between countries in the case of traffic than in the case of energy. In Luxembourg, for example, few measures are taken to limit car traffic; average incomes are relatively high and petrol is cheap, so cars are used a great deal. In many other countries, however, measures to limit car traffic are more common, either for environmental reasons (CO_2 emissions) or for practical reasons (congestion). The popularity or otherwise of cycling also helps to account for the differences. In the Netherlands and Finland, for example, cycling is an accepted means of transport, even for people travelling to work (unlike for example in Poland).

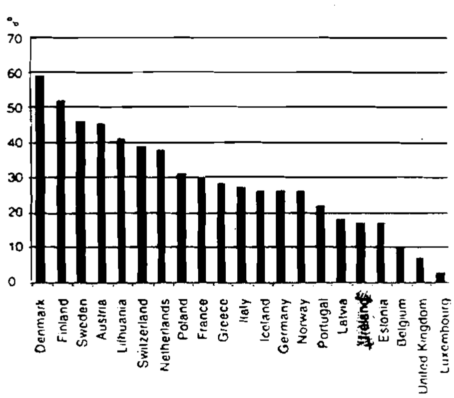

Chart 3: Traffic: measures to limit car traffic; promotion of public transport and cycling.

Water

Water is a topic which appears to be receiving increasing attention in Europe. Dehydration is currently a problem in many countries. However, this attention is only partly reflected in Chart 4, which shows the extent to which measures are taken to save water (and specifically drinking-water).

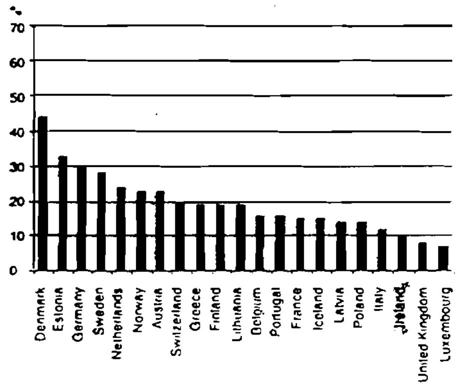

Chart 4: Water: water-saving measures, measures preventing dehydration

The scores for the various countries do not always reflect the true picture, as the questionnaire was based on the situation in the Netherlands. A number of measures which are usual in the Netherlands (such as water-saving toilets, taps and showers) are considered too advanced in certain other countries. Other measures which can greatly reduce water consumption were not listed in the questionnaire. In some countries, for example, installing water meters, increasing the price of water and/or regularly banning the use of hosepipes are the most popular water-saving measures. In other cases, certain measures listed in the questionnaire are quite simply prohibited. For example, according to respondents, the use of rainwater to flush toilets is against the law in France.

Materials

All 24 countries show at least some interest in the environmental impact of materials, and the differences between countries are not very great with regard to this topic (see Chart 5). The use of asbestos, red lead, products that damage the ozone layer and products with high levels of formaldehyde has been reduced to a minimum or completely banned almost everywhere. Another striking detail is that many countries have replaced PVC with the less harmful PP and PE for use in internal drains. Some countries still have traditional measures which were not originally adopted on environmental grounds but now turn out be environmentally sound. A good example is the use of European wood. Various countries which switched over to tropical hardwood in the past are now switching back to traditional types of wood for environmental reasons.

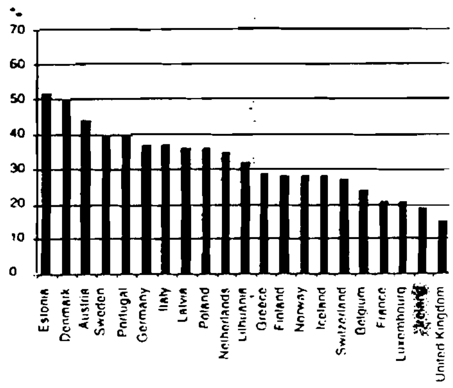

Chart 5: Materials: use of sustainable and environmentally sound materials

Another material which has traditionally been used almost everywhere is brick; one Danish respondent, however, says that brick should not be considered environmentally sound, because of the large amount of energy used in producing it.

Waste

The questions on the topic of waste (see Chart 6) were subdivided into the following subsidiary topics: separation of domestic and building-site waste; prevention of waste due to premature replacement of materials ("adaptable construction", for example by making dwellings accessible to disabled

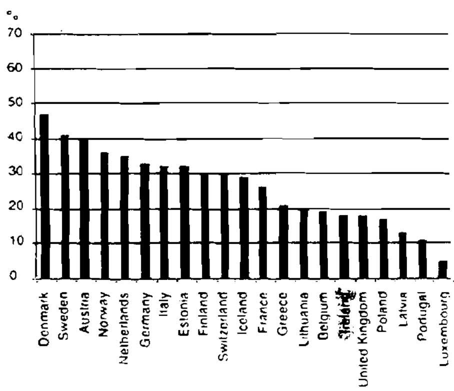

Chart 6: Waste: measures to prevent, limit and separate waste.

survey

1	Austria	9	Greece	17	Netherlands
2	Belgium	10	Hungary	18	Norway
3	Czech Republic	11	Iceland	19	Poland
4	Denmark	12	Ireland	20	Portugal
5	Estonia	13	Italy	21	Spain
6	Finland	14	Latvia	22	Sweden
7	France	15	Lithuania	23	Switzerland
8	Germany	16	Luxembourg	24	United Kingdom

people from the outset); measures to make separation of waste easier at the demolition stage; and measures to limit waste on building sites.

Domestic waste is separated in most countries. The number of fractions varies considerably, but paper and glass are separated almost everywhere. There is also great variation in the extent to which building-site waste is separated (ranging from no separation to seven different fractions). Various countries take specific measures to promote adaptable construction, but few measures are adopted to limit the use of foams and sealants, even though this would make it easier to separate waste at the demolition stage.

Health

The questions on the topic of human health (Chart 7) mainly concerned sound insulation, but there were also questions on measures to control radon and emissions of harmful gases from open fireplaces. Austria had the highest score on this topic, followed by Denmark and Germany. Only seven of the 24 countries took measures to deal with radon. Dwellings in a number of countries never have open fireplaces, thus limiting emissions of harmful gases; however, this is usually for reasons of cost rather than environmental reasons. In Portugal, in fact, open fireplaces are extremely popular at the moment. The respondents' replies indicate that sound insulation measures are adopted to some extent everywhere. At least one such measure is said to be adopted frequently or (almost) always in every country except Latvia, Italy, Poland and Portugal.

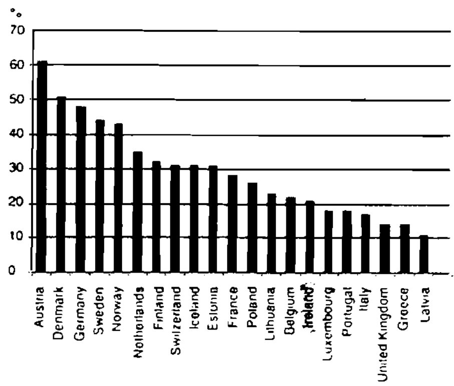

Chart 7: Health: sound insulation, control of emissions of harmful gases, etc

Flora, fauna and soil

Chart 8 shows that Austria is the country that adopts the most measures relating to this topic. Few extensive measures are taken at dwelling level, but far more are taken at urban development and dwelling environment level. The most common measures are inventories of archaeological and historical features, and soil quality analysis. In principle, all 24 countries take account of existing flora and fauna, but the extent to which they do so varies considerably. Specific features such as ponds for frogs and tunnels or viaducts for fauna are not common anywhere.

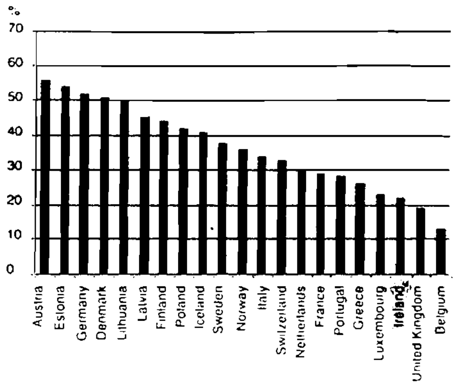

Chart 8: Flora, fauna and soil

Sustainable housing practice varies considerably from one country to another. Yet the survey, though only approximate, makes it clear that European countries are doing a great deal in this area. At the same time, it shows that ambitious sustainable housing policies are not automatically translated into practice. The most important conclusion of all is that the various countries can learn a great deal from one another, and that it is definitely worth while looking at what other countries are doing. ■

The authors

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For the survey entitled "Sustainable housing in Europe" (1997, commissioned by the Dutch Ministry of Housing, Spatial Planning and the Environment), a questionnaire was sent to carefully selected respondents in 24 countries. The respondents all had up-to-date knowledge of the current housing situation throughout the country concerned. The survey mainly consisted of multiple-choice questions. Respondents were asked to indicate how frequently certain environmental measures were adopted in new housing construction in their country. The list of 309 measures was compiled from Dutch lists of sustainable housing measures and are all considered to be environmental measures in the Netherlands. This list should clearly not be thought of as a yardstick for sustainable housing throughout Europe, as not all measures are equally relevant in every country. Differences in climate, economic circumstances and building traditions mean that the various countries' starting positions and the measures that they adopt cannot easily be compared. Nevertheless, for practical reasons, it was decided to base the questionnaire on the situation in the Netherlands. At the same time, respondents were specifically asked for comments and their comments were taken into account in the analysis. Various respondents said that the Dutch approach was too technical. Germans, for example, felt that the social context and the issue of compact versus dispersed urban development were missing from the questionnaire, while a Swedish respondent noted the absence of measures to combat damp and prevent allergic reactions.

The 126 completed questionnaires were processed with the help of the SPSS computer program, and were also analysed manually in order to process additional information and identify any inconsistencies or errors. Unfortunately, the responses from the Czech Republic, Hungary and Spain were so limited and inconsistent that the quantitative findings for those countries could not be considered reliable. Further inquiries were made in an attempt to obtain more accurate information. In order to compare the situations in the various countries, the percentage of measures which respondents said were adopted regularly, frequently or (almost) always in new housing construction in their country was calculated for each topic. These results were then displayed in topic-by-topic and country-by-country charts.

5. APPENDIX 2 : CASE STUDY « INTERNET OFFICE AND ECOHOUSE PAVILION »

Erratum

Accidently the text on page 24 of this issue of *Sustainable Building* (October 1997) was printed in Dutch instead of in English. We apologise. On this sheet the correct text is presented.

IRELAND

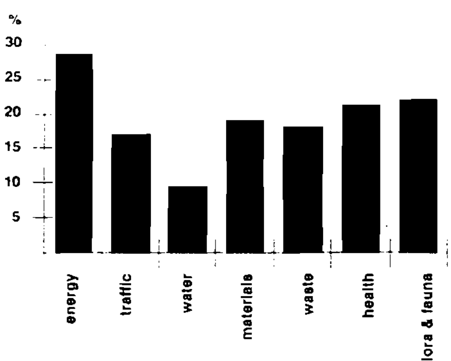
In Ireland, sustainable housing is still very much in its infancy, and any initiatives mostly come from private individuals (architects or clients). The government has begun to provide information on certain topics (such as radon), but otherwise very little attention is paid to these issues at national level. Energy has for some time been the area in which most measures are adopted.

Most dwellings are owner-occupied, and the rented sector is very small. Some 25% of dwellings are in the social housing category (in which social problems are particularly common as a result of poverty and urban decay). Considerable attention is being paid to the renovation and refurbishment of existing social housing in order to improve the situation there. As a result, most building activity involves existing housing; however, new construction is on the increase and reached record levels in 1996. The growth in this sector was mainly in urban areas.

"Internet" Office and Ecohouse Pavilion, Lough Derg, River Shannon
• Architect: Paul Leech, Gaia Associaties, Dublin • Completed: November 1995 • Special features: In this design, a new pavilion was added to an existing building. State-of-the-art environmental technology (energy-saving systems, PV cells, low-pollution, "breathing" materials, etc.) was used where possible. The pavilion is south-facing in order to ensure maximum use of passive solar energy. An existing well was incorporated into the design: the water is used to irrigate a year-round vegetable garden, as well as for cooling purposes (with the help of a heat pump).

Energy

New building regulations were issued in 1992, including separate energy standards. Additional sealing of cracks and pipe insulation are also more or less standard features. The main sources of energy are oil and gas. Energy supplies are very much market-driven, and oil is particularly cheap at the moment.



insulation values (indicative only):
façades: R_c = 2,05 m².K/W
floors: R_c = 1,95 m².K/W
roofs: R_c = 3,85 m².K/W
windows: U = 3,0 W/m².K

Ventilation is mainly natural, but the amount of mechanical ventilation is increasing, particularly in kitchens. Bathrooms, too, are often mechanically ventilated.

Traffic

There are no particular traffic measures in Ireland, in the sense of promoting public transport and low-speed traffic and limiting car traffic.

Water

Separate sewerage systems are a regular feature in Ireland. In general, however, few water-saving measures are adopted.

Materials

Galvanized products, asbestos and red lead are rarely used in dwellings, and products containing CFCs and HCFCs are avoided. Mineral wool is the most commonly used insulation material, although cellulose is also sometimes used. In addition to traditional alkyd paint, water-based paint is occasionally applied, but other types of low-pollution paint are never used.

Waste

Separation of domestic waste only occurs on a small scale in Ireland. Building-site waste is separated into hazardous waste, metals, wood, and roof tiles.

Health

Scarcely any measures have been taken in this area, apart from occasional measures to improve sound insulation between dwellings.

Flora, fauna & soil

Efforts are made to preserve valuable features as far as possible. Soil quality analysis and inventories of historically valuable features are also regularly carried out. Preference is given to native vegetation, and partitions between plots are often in the form of hedges.

6. APPENDIX 3 : INSTITUTE OF EUROPEAN AFFAIRS, DUBLIN « SEED » GROUP

INSTITUTE OF EUROPEAN AFFAIRS

IEA

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8 North Great Georges Street,
Dublin 1.
Telephone: (353) 1-874 6756
Fax: (353) 1-878 6880
E-Mail: iea@connect.ie
Web Site: www.connect.ie/users/iea

'SEED' GROUP

Established in the Autumn of 1997

Chair : Dr. Con Power

The remit of this Group covers Sustainable Energy-efficient Environment-friendly Development in all sectors of the economy, and in respect of impacts on the totality of the natural and built environment.

The terms of reference of the Group are :-

(i) to define the scope and coverage of the Group's own remit by listing the economic sectors, Government Departments and Agencies, and other authorities and entities, which operate in Ireland and in the E.U. within the arena of the Group's remit ;

(ii) to monitor E.U. energy and environment policies, treaties, legislation and programmes with special reference to their impact on, and relevance to, sustainable development ;

(iii) to identify all relevant issues from these E.U. policies, treaties, legislation, and programmes which will impact upon Ireland, and to state the nature, quantum, and proposed / likely time frame for such impact ;

(iv) to monitor and review the comprehensiveness, coherence and effectiveness of such policies, treaties, legislation, and programmes, as actually implemented in Ireland ;

(v) to identify realistic and practical policy choices for Ireland in this domain, not least in the context of economic development and employment policies, which may most directly meet the criteria of **'SEED'**.

(for further review)

1998-02-03

Comité d'Honneur
John Bruton
Pádraig Flynn
Dr. Patrick Hillery
Dr. Garret FitzGerald
Charles J. Haughey
Jack Lynch
[illegible]rt Reynolds
Richard Burke
Ray MacSharry
Michael O'Kennedy
Peter Sutherland

Amsterdam Treaty

Treaty of Amsterdam amending the Treaty on European Union, the Treaties establishing the European Communities and certain related acts, signed at Amsterdam, 2nd. October 1997.

(97 / C 340 / 01)

1. Sustainable Development

Replaced Article 2 of the TEC (Treaty establishing the European Community)

' The Community shall have as its task, by establishing a common market and an economic and monetary union and by implementing common policies or activities referred to in Articles 3 and 3a, to promote throughout the Community a harmonious, balanced and sustainable development of economic activities, a high level of employment and of social protection, equality between men and women, sustainable and non-inflationary growth, a high degree of competitiveness and convergence of economic performance, a high level of protection and improvement of the quality of the environment, the raising of the standard of living and quality of life, and economic and social cohesion and solidarity among Member States. '

Replaced 7th. Recital of the Preamble to the TEU (Treaty on European Union)

' Determined to promote economic and social progress for their peoples, taking into account the principle of sustainable development and within the context of the accomplishment of the internal market and of reinforced cohesion and environmental protection, and to implement policies ensuring that advances in economic integration are accompanied by parallel progress in other fields. '

2. Environment

New Article 3c in the TEC

' Environmental protection requirements must be integrated into the definition and implementation of the Community policies and activities referred to in Article 3, in particular with a view to promoting sustainable development. '

Declaration No. 12 to the Final Act

' The Conference notes that the Commission undertakes to prepare environmental impact assessment studies when making proposals which may have significant environmental implications. '

Replaced Paragraph 3 of Article 100a of the TEC

' The Commission, in its proposals envisaged in paragraph 1 concerning health, safety, environmental protection and consumer protection, will take as a base a high level of protection, taking account in particular of any new development based on scientific facts. Within their respective powers, the European Parliament and the Council will also seek to achieve this objective. '

3. Human Health

Replaced Article 129 of the TEC

' 1. A high level of human health protection shall be ensured in the definition and implementation of all Community policies and activities. '

4. Statistics

New Article 213a in the TEC

' 1. Without prejudice to Article 5 of the Protocol on the Statute of the European System of Central Banks and of the European Central Bank, the Council, acting in accordance with the procedure referred to in Article 189b, shall adopt measures for the production of statistics where necessary for the performance of the activities of the Community.

2. The production of Community statistics shall conform to impartiality, reliability, objectivity, scientific independence, cost-effectiveness and statistical confidentiality ; it shall not entail excessive burdens on economic operators. '

5. Personal Data Protection

New Article 213b in the TEC

' 1. From 1st. January 1999, Community acts on the protection of individuals with regard to the processing of personal data and the free movement of such data shall apply to the institutions and bodies set up by, or on the basis of, this Treaty.

2. Before the date referred to in paragraph 1, the Council, acting in accordance with the procedure referred to in Article 189b, shall establish an independent supervisory body responsible for monitoring the application of such Community acts to Community institutions and bodies and shall adopt any other relevant provisions as appropriate. '

6. Anti-Discrimination

New Article 6a in the TEC

' Without prejudice to the other provisions of this Treaty and within the limits of the powers conferred by it upon the Community, the Council, acting unanimously on a proposal from the Commission and after consulting the European Parliament, may take appropriate action to combat discrimination based on sex, racial or ethnic origin, religion or belief, disability, age or sexual orientation. '

7. APPENDIX 4 : HUMAN / SOCIAL DEVELOPMENT WITHIN THE EUROPEAN UNION

'Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.'

Principle 1

1992 Rio Declaration on Environment and Development (Agenda 21)

European Movement
Ireland

DUBLIN BRANCH INVITATION

Terry Loane, Chairman of the Dublin branch

has pleasure in inviting you to attend a

PUBLIC SEMINAR

on

'CITIZENS IN THE EU – Equality of Opportunity for 'Minority' Groups in Society'

The Treaty of Amsterdam which the Irish people will vote on in a referendum in a few months contains several significant measures for the benefit of citizens including anti-discrimination and human health. These and other issues will be discussed and debated at a day long seminar on -

Thursday 19th February 1998

From 9.00am to 5.30pm

In the offices of the European Parliament, 43 Molesworth St, Dublin 2

Issues affecting the Unemployed, Refugees, the Elderly, Travellers, Gay & Lesbians, Homeless, and the Disabled will be dealt with by the following speakers;

Maria Tyrrell
ICTU

Robert Eager
Solicitor

Michael O'Halloran
Senior Citizen's Parliament

Fintan Farrell
Irish Traveller Movement

Kieran Rose
Nexus Research

Dick Shannon
Director, Simon Ireland

Tom Cooney
Law Department, UCD

Carmel Clarke-Mudrak
Chairperson, Gingerbread

RSVP - Please complete the attached booking form and return to the National office European Movement, 32 Nassau Street, Dublin 2. Fax: 01-6798203 before Friday 13th February 1998

European Movement Company Reg. No. 21130 Gluaiseacht na hEorpa

32 Nassau Street, Dublin 2 • Telephone: 01-671 4300 • Fax: 01-679 8203 • E-mail: info@european.movement.iol.ie

President: Bertie Ahern, T.D. **Chairman:** Alan Dukes, T.D.
Vice-Presidents: Noreen Byrne, Peter Cassells, Proinsias De Rossa, T.D., John Donnelly, John Dunne, Mary Harney, T.D., Gay Mitchell, T.D., Dick Spring, T.D., Dr. Peter Sutherland, S.C. **Honorary Presidents:** Professor Jim Dooge, Dr. Garret FitzGerald, Sean Healy, Dr. Patrick Hillery, Dr. Miriam Hederman O'Brien, Eoin Ryan, S.C., Professor Louis Smith.
Vice-Chairman: Maurice O'Connell. **Hon. Secretary:** Mary McMahon. **Hon. Treasurer:** Séan Ó Riordáin. **Chief Executive:** Patricia Lawler.

Implementation of a Strategy for Sustainable Development and Construction - Region of Dublin

Seminar / Interactive Workshops in March / April 1998

1. Introduction

The big picture on this planet, the long-term goal over the next century, is a fully sustainable natural and built environment, each co-existing with the other in balance and harmony, and each, in their own way, capable of providing for responsible human, social, cultural and economic development. Previous injury to the natural environment must be healed in order to arrive at this outcome ; initial damage repair by human intervention, sufficient only to promote a process of natural self-healing, is suggested.

This level of sustainability is a very complex phenomenon. Nobody yet fully understands what is happening and further experimentation on the natural environment should, to a certain extent, be out of the question because of its current state of fragility.

Sustainability of the 'built environment' can only be understood in relation to that of the natural environment ; it involves, with precision and reliability, ...

- (i) establishing limits on the capacity of the natural environment to sustain itself ;
- (ii) stopping short of those limits, by a controlled factor of safety, in any further future modification or extension to the built environment, i.e. sustainable construction ;
- (iii) altering the nature and course of human development, i.e. sustainable development .

2. Objectives of Seminar / Interactive Workshops

(a) To bring together, mix and blend, some different components of sustainable development and construction, i.e. energy efficiency, environmental protection, and human / social development ;
(b) To commence the process of formulating a 'real' strategy for sustainability in a region of Ireland - **Dublin** - a region being the smallest viable unit ;
(c) To consider available options with regard to the actual implementation of such a strategy .

3. Some Useful Definitions

Environmental Impact : (IEC Treaty, 1994) — Any effect caused by a given activity on the environment, including human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures or the interactions among these factors ; it also includes effects on cultural heritage or socio-economic conditions resulting from alterations to those factors.

Human Health : — A state of physical, mental, psychological, social, cultural and economic wellbeing.

Sustainable Development : (Bruntland Report, 1987) — Development which meets the needs of the present without compromising the ability of future generations to meet their own needs.

Guideline Framework

Achievement of the Principle of Equality of Opportunity for Every Citizen in the European Union

Direct and meaningful consultation with people is essential. Set out below are a number of areas which should be actively considered by the relevant authorities in each Member State ....

1. Empowering People for Participation in Society

- respecting autonomy and independence
- re-adjusting education and training programmes to facilitate participation
- re-adjusting welfare and other supports to facilitate participation
- moving towards a 'person-centred' approach in the design / implementation of support services
- mainstreaming
- ensuring seamless provision of services
- ensuring the principle of participation

2. Removing Physical Barriers to Participation

- viewing access / egress / evacuation and health / safety / welfare issues in the light of equality of opportunity and the right to participate
- developing effective legislation, standards (nationally transposed EN's) , and technical guidance in order to eliminate all forms of barrier
- monitoring and controlling compliance with legislation
- moving towards a 'person-centred' approach in the planning / design / construction of a sustainable built environment

3. Opening Up Various Spheres of Society

- upholding the equal civic status of every person
- promoting employment for people as a key to social inclusion

4. Nurturing Opinion of the Public, Government Administrators, and Design Professions to be Receptive to Strategies on Equality of Opportunity for People

- awareness raising and education

1998-01-27

REPORT 6

SUSTAINABLE DEVELOPMENT AND FUTURE OF CONSTRUCTION ITALIAN INVENTORY REPORT

ROBERTO BOLOGNA
LUCIA CECCHERINI NELLI
ROMANO DEL NORD
GIOVANNI GALANTI
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NATIONAL REPORT

CONTENTS

1. INTRODUCTION

The authors suggest that Italian future scenario depends on the capability of the our country to deal with the global economic changes of the present times. The competitiveness in the international market requires the adoption of measures which tend to balance the safeguard of environmental systems with the needs of an economic recovery. Such trends probably will be dominant in Italy for the next year, and will feature the steps required to create sustainable development. For this reason the Italian report intends to analyse first of all the prevailing economic dynamics which can affect the decision-making processes and the implementation of an environmentally conscious strategy.

2. ITALIAN ECONOMIC SITUATION

Italy is going through an economic phase of transition which started in 1992 and is characterised by:

- restrictive policies in public expenditures, set to reduce the great public debt accumulated during the Eighties;
- constant effort of industry to achieve higher productivity rates, as their main strategy in order to participate in the global exchange market,

Present trends in economic policy aim for a rapid and secure economic recovery for the next year, which is considered attainable only by the introduction of Italy into the first group of countries joining the European monetary Union in 1999.

Objectives of an economy on the mend and increasing GNP will lead to great impositions on our country, regarding taxation pressure, cutback in salaries and reduction of expectations from the welfare state. Such aims are pursued, in fact, in a context defined by a socio-economic development model which has the following structural features and problems:

- absence of large amounts of natural raw materials; dependence on foreign countries for 80% of national needs for fossil fuels; in the sectors exposed to international exchange market, vocation to the production of high added value goods (for instance instrumental goods, cars, household appliances, etc.) and intermediate goods (for instance building materials and components) (see Tables 3);
- different growth measure of the advanced northern regions with respect to the southern regions which still lie in a worse economic state generally and with under-utilization of human resources;
- heavy unemployment figures (national average of 12% and over 20% in southern regions, mostly in the youth population);
- negative birth rate;

- drop in the role of the big enterprises (financial services groups, industrial companies, insurance companies) and presence of big public enterprises, raised in previous protective conditions and with a low grade of modernisation;
- development entrusted to small-medium enterprise's vitality, innovation capability and competitiveness in the international market.

3. ITALIAN CONTRIBUTION TO SUSTAINABLE DEVELOPMENT FOR THE NEXT 15-20 YEARS

3.1 Introduction

As regards changes in direction of a sustainable development, objectives formulated for the short-term seem lacking in "strong" options. The three fundamental issues of a sustainable development strategy in our country, i.e.

- protection of productive ecological systems,
- increasing division between the growth of production and environmental damage,
- changing economic objectives from quantitative growth to qualitative development,

are subordinate to the needs of economic pickup and improvement of the employment situation, to which, at least in the short-term, the government is able to respond in terms of a traditional industrial policy.

To realise the obstacles that limit, in Italy, the possibilities of taking decisive action in the direction of sustainable development, one has to consider the distance between the earthly Ecological Footprint of this country (a datum available only for the years up to 1993, expressed in m^2 of area per head and produced in 1996) and the theoretical availability of surfaces for ecological productive systems into its frontiers. The leap of 5/1 means that the Italian socio-economic system uses an environmental carrying capacity of 5 times as much as the national resources may offer. Even though the value is lower than in many other industrialised nations, the evaluation of needs for growth in economy and major consumption styles do not allow for the prediction of a drastic turnabout in the use of natural productive systems (see Tables 1-2).

The first step forward is a progressive reduction of local and global environmental damage. A development model shows that in Italy, however, there will not be trends to withdraw from the improvements gained, as little as they would seem.

3.2 Decisive factors and trends

For the year in progress a trend is foreseen of economic growth based upon the environment capacity of sustaining influences of human activity, as far as the limits defined by environmental laws permit. The national and regional normative system in defence of the environment - which extend quite widely from the control over emissions of industry and urban pollution, the purchase of energy saving measures, the defence of water systems, the defence of the environmental and cultural estate, to the

Environmental Impact Valuation for great infrastructures - at least ensures the minimum level of protection and prevents major environmental risks. In spite of continuous threats to their application, these normative systems form a relatively efficient tool for the sustainement of high quality environmental systems.

Some factors which contribute to a higher grade of sustainability:

- recent activities of the Ministry of the Environment (such as the adoption of a law on waste finalised to reduce the quantity of refuse products, development of waste recycling and utilization for energy purposes; the continuous incorporation of EU directives into national law; the promotion and enlargement of natural parks and protected areas; the special measures for protecting, cleaning up and renewal the city and the lagoon of Venice and the city of Brindisi);
- the research and development activity led by the ENEA (National Authority for New Technologies, Energy and Environment), directed to promote development of renewable energy, productive process efficiency, product innovation finalised to a reduction in the use of scarce raw materials, introduction of solar technologies in buildings, etc.;
- the adoption of the Sustainable Development National Plan (1993) in the execution of the Agenda 21 program (but considered mostly unfeasible);
- the Italian participation in IPCC (Intergovernmental Panel on Climate Change) and the commitment to stabilisation of CO_2 emissions at 1990's level before 2000;
- the participation of the city of Bologna at "Urban CO_2 Reduction Project", co-ordinated by ICLEI (International Council of Local Environment Initiatives);
- the first voluntary initiatives for accession to environmental agreement systems (ecolabel and ecoaudit) by a small but growing number of industrial companies, mostly in the chemical sector.

3.3 State of the environment and the territory in Italy

The main problems emerging in the case of Italy concerns above all:

- structural problems; need for infrastructure modernisation, growth, productivity, moderation in cost of the welfare state ;
- important trends; growth and specialisation of cities: tendency to extend the city borders as a result of the process of sub-urbanisation, also without population growth (taking away territory from agriculture and from woods and interfering with natural areas of global ecological interest); tendency to functional specialisation of uses of the urban ground as an effect of the land market which tends to eliminate the differences between activities from the urban tissue/web ;
- rapid de-industrialisation and accelerated expansion of service industries ;
- stabilisation of big cities and growth of small and average cities ;
- like in the rest of Europe, the decrease of pollution due to industries and heating owing to the substitution of sources of energy (natural gas) and to relocation of industries out of urban areas ;
- increase in the big cities of local atmospheric pollution linked to urban transport on the road (tropospheric ozone, nitrogen oxides, carbon monoxide), of noise and of traffic congestion ;

- increase of the natural resources used and of waste emissions as a consequence of the increase in economic activities and change of life-styles; high levels of energy consumption (domestic sector represents 1/3 of total consumptions), increased use of water (but 30%-50% lost before reaching the end-user) ;
- adoption of trends of economic and industrial politics which are mainly based on the capacity of ecological systems to absorb the effects of the economic growth ;
- cities will suffer the consequences of an environmental change and of the deterioration of global natural resources ;
- the increase in the deterioration of suburban areas around the major cities ;
- the worsening quality of life in urban areas ;
- the increase in the quantity of derelict industrial land in cities, consequently the intensification of de-industrialisation processes ;

The Italian situation, furthermore, features some phenomena and peculiarities, compared to other western industrialised countries, such as:
- the end of the expansion processes in urban areas and the prevalence (already over 50%) of the transformation process of existing buildings over new construction activity;
- the presence of the most important and a considerable quantity of historical-artistic patrimony in the world;
- the high quality of areas of territorial resource (agricultural, coastal, mountain) and of ancient settlements (small cities, central urban structures, networks of small centres);
- the existence of a large preserved and protected patrimony of monumental and historic buildings;
- the trend by some regional and local administrative authorities of implementing activity for the transformation initiatives on territory with advanced objectives towards sustainable development in an independent manner by national programming lines (i.e. Toscana, Lombardia, Trentino-Alto Adige, etc.).

Such issues contribute to partially down-size the framework of existing environmental problems (deterioration of environment in major cities and of rivers are among the principal ones), and would be the basis of endogenous development trends founded on local resources, so that offering good long-term prospects to the alternative and various paths to sustainable development.

3.4 Intervention guidelines for the future

3.4.1 Requalification of territory

The government investments over the next 5-10 years will be probably be concentrated on the interventions directed to modernise and maintain the principal infrastructure networks (urban underground systems, motorways, high speed railways, structures to develop the sea traffic), the most important of which, for the short term of their realisation, concerns the works programmed in the Capital on the occasion of the Catholic "Millennium". Alongside these, however, there have been defined some urbanistic programs supported with national and European funds and regarded especially significant because of their nature of demonstrative experience and their ecological contents, such as:

- the ecological urban renewal of the neighbourhood of the city of Rome, well-known with the name of Saline-Ostia Antica (see study-case);
- the initiative of soil reclamation of the derelict industrial settlement of Bagnoli (Napoli), which received state funds in 1996, to allow the project of a complete transformation of the area in order to develop eco-compatible activities and enhance green public areas;
- the plan of reclamation, re-conversion and environmental valuation of the basin of the Lambro, Seveso and Olona rivers (territory which represents the 15% of the area of the Lombardia region, comprises 5 million inhabitants, and at the same time is one of the richest and most deteriorated areas in Europe); the territorial planning of this area has the peculiarity of an organic integration between the objectives of ecological restoration and a development led by alternative approaches which will base on local resources;
- the project for a derelict industrial area in the city of Torino, named "RE-Start, Renewable Energy Strategies and Technology Applications for Regenerating Towns", promoted by the Directorate General for Energy (DG XVII) of the European Commission and co-ordinated by RESET e.e.i.g., which is the most important project approved in the Energy/Building Chapter during 1996; it promotes some targeted demonstration projects concerning an innovative energy-environmental integration on the city scale;
- the plan for environmental safeguard and cleaning of Venezia's lagoon, incorporated in the public financing law of the 1997.

3.4.2 Activity of Research & Development, Process and Product innovation

Among the various strategies of government intervention capable to stimulate further progress towards secure sustainable development are the activities of research and development led at the present time by the ENEA in the sectors of the environmental technologies, the development of renewable sources of energy, of innovation of product and especially in the fields of energy saving and of the application of advanced solar technologies in buildings.

In the area of construction; Italy has already led for ,ore than a decade several initiatives in the field of experimentation with passive solar systems and components and of implementation of bio-climatic buildings tanks to the co-operation of corporations, of national research (National Council of Research, Universities, ENEA) and firms. A not very relevant part (5% of the interventions financed by the state), but however significant for its innovative character, the public housing property presents already a large number of technological and installation related integrations aimed at energetic saving whilst the buildings are in use. As a consequence of engagement of the research institutions of the University in the bio-climatic building field, pursued and intensified during these last few years, one expects a further circulation of passive solar concepts and technologies in the implementation of new buildings and particularly in the planning of urban requalifying and of the resources of existing buildings.

A particularly important field in the Italian climatic context will be represented by the research aimed at the summer natural air-conditioning of buildings and at the future application of concepts therein expressed. Such expectations are motivated by the expansion of the demand for better standards of comfort and by the reduction of operating costs; such demands appear to be contradictory in consideration of the technologies currently available.

3.4.3 Protection of the environment and territory

The process of integration in the EU and the consequential normative harmonisation will enable Italy to adopt the measures of environmental safeguards subscribed at European level, significantly more advanced with regard to the national framework and with the possibility of making use of European structural funds for assistance in the clearance and support of depressed areas.

The major boost to environmental safeguard politics (although sectorial) currently due to the initiatives of the Ministry of Environment (parks politics, rules for waste management, incentives for the use of renewable resources and of innovation of product in the industrial field);

Long term actions possibly adaptable in the environment and territory fields, include the following:

- definition of strategies on the base of control standards of pollution (water, air, soil, noise, chemical substances)
- engagements on the physical structure of the city (use of the ground, transport, public open space, planning and zoning);
- development of trends to greater efficiency of compact settlement models and mixed uses of the urban ground; currently tendencies operate in opposite directions (decentralisation and specialisation uses of urban ground), consequential increase in the number of private vehicles, increase in the number of families and the reduction in average household size;
- reduction in the impact of activity on the environment (energetic saving etc);
- in the field of transport, reduction and rationalization of the demand of mobility, increase in the use of public transport (currently only 20% of the total demand);
- management of the natural resources;
- energy efficiency (net consumption of resources per unit of service produced);
- waste recycling

3.5 Conclusion

It may be supposed that, as far as Italy is concerned, the future scenery of a medium/long term period named "considered sustainment", as a consequence of the processes in operation that synthesise the aspects indicated thus far:

- adoption of engagements in defence of the local and global environment, which is not to be more ambitious than the main indications at international level;
- increase in processes of endogenous development and of independent decision-making processes of individual administrations that tend to counter-balance the

consequences of the lack of economic political lines explicit in the direction of the endurable development on one side and to bringing forward some changes which will in any case be indispensable on the other.

Tables

1. Ecological Footprint for Italy (per head) (date 1993, 57,120,000 pop.)	
Productive ecological systems	**[ha/ph]**
Territory for energy (absorption CO_2)	1,10
Agricoltural land	0,27
Pasture	0,55
Woods	0,23
Built up area	0,06
Terrestrial	**2,21**
Sea	0,90
Total productive ecological area used	**3,11**

Ref: P. Lombardi, *L'Impronta Ecologica dell'Italia*, in M. Wackernagel, W. E. Rees, *L'impronta ecologica*, Edizioni Ambiente, Milano 1996.

2. Ecological balance for Italy (1993)	[ha/ph]
	2,21
Availability of terrestrial productive ecological systems in Italy	0,44
Deficit of productive ecological systems in Italy	-1,77
Mean Availability of productive ecological systems in the world	1,53
Deficit of productive ecological systems in Italy with respect to mean Availability in the world	- 1,44

Ref: P. Lombardi, *Italia 2000, Iniziative per un Paese Sostenibile*, in L'Attenzione, rivista WWF per l'ambiente e il territorio, n. 4, Dicembre 1996.

3. Balance of energy in Italy (1996) [millions of tons equiv. to oil]	
Production	34,2
Imports	157,7
Exports	18,1
Deposit variations	1,2
Gross internal consumption	**172,6**
Consumption of Fossil fuels	153,3
Consumption of Hydro-electric Power	19,3

4. METHODOLOGY

The presence in the national territory of a large number of schools on sustainable thought in buildings have persuaded the research group to develop a methodological strategy for the collection of the necessary data for the compilation of this national report. In particular we have developed a questionnaire containing the principles questions on which to have an answer to define in our country the sustainable buildings for the year 2010. This questionnaire was sent to the research centres with interests finalised to the same principles, distributed on the national territory, and in particular to the various university departments, in particular the architecture faculties, to obtain a scientific and technical verification on sustainability themes.

A large number of documentary studies and publications (see Bibliographic references) has been consulted by the task group to define the background of the report and organise the information.

5. ANWER ON MAIN QUESTION AND 5 SUBQUESTIONS

5.1 Main question

The meaning of sustainable constructions, and more precisely of sustainable building, can be defined by the following principles:
- complete interaction with the environment, and its natural phases and its resources availability
- they are designed for efficiency of functioning during the time
- they are designed for the longevity, the re-use and recycling of their materials
- they are designed to optimise energy efficiency
- they avoid the production of refuses and dangerous emissions in the phase of construction and during the life itself of the building
- they foresee air-conditioning elimination, where possible
- they avoid the use of electricity for heating and cooling, through passive design
- for their construction local, recyclable and re-use resources have been used
- they use little exhaustible materials, like wood

To follow these principles does not mean to apply these concepts to our buildings, but means most of all to verify the sufficient conditions for its application in the economic conditions in the way to influence less as possible on consequences that the application of more than one principle could cause on the environment.

However in the definition of the concept “Sustainable Construction”, it is appropriate to specify that these principles are necessary but not sufficient in order that to build in a sustainable way, it is fundamental to base our foundation on a “sustainable society” where harmony exists inside peoples, between peoples and with the planet.

Which will be the foreseeable consequences of sustainable development in the industry of construction in the year 2010?

The environmental issue in our country, which has by now assumed an historical dimension, has passed from an origin with characteristics of protestation, from which sprung the requirements of limits and prohibitions, to a position which has in time assumed always more a position of proposal, intended as a means to supply new development models.

The old purely defensive position has been abandoned in order to acquire a new one which meets the agreement also with the economical subjects (the productive sector, the industries, ...) for whom this new conception badly reconciles.

The contrast which characterises the economical position relatively to sustainability derives from the certain absence of an acceptability threshold within which interventions aimed at reaching an environmental equilibrium may also be convenient from an economical point of view. Practically, how much are we willing to invest in sustainability terms, and which is the limit over which interventions aimed at an environmental equilibrium are no more sustainable?

According to a statistical study brought forward in these last years in Italy, the environmental issue defined as a better relationship with nature, even if it is broadly perceived, acquires only a role of secondary emergency. In fact, because of the absence of clear and accessible information, it derives that the environmental degradation assumes principally a meaning of "health risk"; this, translated in the building field, and in particular in the role they assume as shelter or dwelling, means a greater attention towards that criteria which interacts above all with the physical health of man. Therefore the consequences of the concept of sustainability in the built environment are translated into:

- use of materials which are not dangerous for man's health who uses and lives in these spaces;
- less waste of resources (such as water, territory, natural environment) as their distribution or reduction has a direct influence on man's life;
- quality of the built product (creation of healthy spaces) which implies life quality;
- recovery of pre-existances (existing buildings, unused areas, building principles) which allows the re-appropriation of unused spaces and cultures by now lost.

Transferring these principles directly into the building industry sector, we obtain:

- research of new materials for buildings in order to satisfy the requirement of non toxicity of the built environment;
- rationalisation of the resources present on the territory and utilisation of renewable resources;
- research and introduction into the market of innovative components able to render the built product an efficacious system for the control of dwelling quality;
- greater credits and greater investments of the building industries in the sector of building retrofitting, therefore specific competencies, compatible materials and more information.

The numerous existing building patrimony (historical and not) in Italy favours the trend of the building sector in this direction. In fact, it is believed that in a near future, the beginning of the next century (2010), as it is already taking place in these years, the trend of the building industry in Italy will be directed exactly towards the re-development of existing buildings, not only as a recovery of the historical and cultural patrimony of our country, but above all as it represents a 'renewable' resource which allows in all the phases of the building process, from the urban re-qualification up to the utilising phase, to follow the enunciated principles of sustainability without great waste and dissipation of the resources (just think of the almost total elimination of the phase of destruction, with the re-utilisation of the building materials, of the re-discovery of principles and building qualities of energetic saving inherent in buildings of the past, and of the possibility of integrating innovative technologies which utilise renewable resources such as the sun).

5.2 Five subquestions

1. What is implied in the planning of the cities and of the built environment in the year 2010 ?

Following the principles of:

- increase of settlements with centralised production of energy (ecological village)
- transformation of abandoned areas into natural areas
- constitution of small specialist settlements with "zero" consumption (low consumption)
- ecological revision of the in force rules and procedures for the localisation, dimensioning and organisation of settlements,

the consequences that sustainable development implies in this ambit, lead to the realisation of planning and building processes which:

- evaluate the environmental efficiency of settlement models and diffuse principles of ecological design of settlements;
- utilise vegetation as a symbiotic nature/building technology by means of processes of transformation of micro-climate, reduction of pollution, re-equilibration of cycles, urban agricultural production, etc..

2. What is implied in building design, construction, maintenance, use and demolition in the year 2010?

The impact related to the use, the management, the distribution and the final disposal of the product by now hangs over the impacts determined by fabrication. Therefore the prospect of sustainability requires the strengthening of the processes of dismaterialisation both of the production and of the consumption, the reduction of the intensity of matter, energy and emissions into the environment for each rendered service unit (eco-efficiency).

Following the principles of:
- buildings constructed for man's health and for nature's health
- attention towards life quality and not towards life standards
- respect of local resources
- which follow functioning principles
- which respect the use vocation of the pre-existence and the consequent function
- new typologies and building systems which are ecologically characterising,

sustainable development for buildings implies in a medium term prevision (2010):
- the formation of competencies in the field of conscious design respectful of the environment
- the formation of a consciousness of the "sustainable" in the operators of the project, the process, building and the use of buildings of the future
- control of the building process, with a particular attention towards the problems of buildings' life cycles, materials recycling, demolition of works
- control of the quality of urban and building spaces, in order to define intervention strategies and to define, through the individuation of risk and critical elements, the modes and the procedures which allow the government of the process of retrofitting existing buildings
- buildings which contain not dangerous furnishings for man and which therefore result highly reliable and with best performances in time; i.e. buildings which, having low maintenance costs and optimised exercise expenses, are also economical houses.

The objective of dismaterialisation may be reached by operating on more lines:

1) to increase the efficiency of employment of resources in the phase of process and production, i.e. reduce the indemnity of environmental damage for unit of fabricated product and for unit of generated income.

2) to optimise the employment of environmental resources on the whole life cycle of the product, through a re-design of the product which improves its environmental performances in the phase of finding and choosing the raw materials, in the phase of utilisation of the product or in the phase of its disposal. The development lines of eco-design are numerous: the miniaturisation and the lightening of the products, the employment of renewable or biodegradable products, the reduction of toxic substances, the improvement of the energetic efficiency of the product and the limitation of its releases, the capacity of adaptability and of self-optimisation, the easy maintenance, the re-usability and the possibility of easily dismantling the good.

3) to substitute the satisfaction of consumption needs with services instead of with new merchandise, with dismaterialised services instead of with physical goods, i.e. by expanding the life duration, the intensity of use and the number of users of existing goods. In other words, it means selling information instead of goods.

3. What is implied in the production of components, materials, services and assembly in the year 2010?

With reference to the conditionings of availability and cost of energy, it is necessary to have a programme of development of processes, technologies, innovative systems for production and transformation of energy and exploitation of national resources, renewable sources and energy saving.

Following the principles of:
- use of recyclable materials
- easy dismantling of buildings and possibility of re-utilising employed resources
- reversibility of building processes
- use of local material, energetic and productive resources
- use of high efficiency plants
- plant control and management according to the specific user requirements and not to the services
- employment of technologies and systems which use renewable energies (solar passive systems, photovoltaics, etc.)
- employment of integrated components
- new ecological technologies which act in civil plant design and installation and in the production of sub-systems.

Sustainable development in these sectors implies:
- the evaluation of the penetration of passive and hybrid technologies for climatisation, with particular reference to summer cooling.
- the in depth studying of the issues and of the necessary changes in order to arrive at practising an interactive technological innovation which considers the user and the environment, conscious of the inescapability of the limits of growth.

In particular, from the research sectors which operate in the fields of energy and environment arrives a technological offer with a transversal value and plurality of application camps, principally aimed at:
- process technologies: laser, robotics, irradiating technologies, separating technologies, agricultural bio-technologies;
- plant technologies: fluid dynamics, thermodynamics, combustion physics and engineering;
- materials: functional materials, advanced ceramic materials, materials for high temperatures, membranes, thin films, plasmas;
- modelling and computer science: mathematical models and high performance calculations, artificial intelligence and expert systems, image treatment, decision support systems, territorial informative systems;
- diagnostics and measurements: tele-bearing, agricultural bio-technologies, advanced diagnostics, bio-sensors.

In the energy sector, the technological process is awaited principally for:
- components and equipment which utilise / produce / transform energy, improving its performances (electrical engines, cars, building shells, domestic appliances);

- processes, in particular industrial processes for the fabrication of products of any nature (production of aluminium, heat recovery in brick furnaces, re-utilisation of fabrication rejects and residuals);
- systems, through the substitution of products or actions on the conditions which determine the demand and the management procedures (substitution of transportation method, reduction of mobility demand, traffic fluidification, automation of domestic appliances management).

The development will particularly concern the energetic components for the habitat aimed at the improvement of the dwelling quality through the development of technologies, materials, furnishings and network services, designed for the people's comfort, their safety and protection and considering individual and social needs. The following is foreseen:
- technical and "standard" guides for the intelligent management of the building system, adequate for the climatic profiles and the users' needs with the development of modular systems for new buildings and retrofitting;
- development of connections with external tele-services and their integration into the living system;
- assessment and definition of functional characteristics of new classes of domestic appliances adequate for domotic connections;
- tests on domestic appliances and equipment of illumination with high energy efficiency.
- In the field of new renewable energy sources, the development of the following is foreseen:
- photovoltaic technologies;
- innovative solar thermal components for residential and tertiary buildings;
- application of wind energy;
- energetic qualification of biomass;
- qualification of design methods for bioclimatic architecture and for buildings with low energy consumption with the analysis of spontaneous typologies and the design of components and systems.

4. What is implied for the human resources and the necessary capacities for the building industry in the year 2010?

In the next years, in the building industry a great technological effort is required, oriented in particular towards the transformation of products and production processes through the adoption of innovative technologies able to satisfy the new environmental needs. In this sense the protection of the environment is not so much a constraint to economical progressive, but more of an opportunity for investments and new demands of goods and services.

For an innovation policy it is therefore necessary to promote aimed programmes for the transfer to the companies of the research, of the competencies and the processes, and for the diffusion of technologies with the actuation of new forms of interaction between research - university - production companies - services.

The inter-relations between the different phases of the innovative process are such and so many that it is necessary to operate in a parallel and synergetic way on both the demand and offer sides of research. In a context where the range of available technological options for the industries are ever expanding, no company can count on its own forces to cover the innovation needs and therefore the alliances and the technological exchanges become ever more necessary.

Therefore, following the principles of:
- reduction of the built impact on the environment,
- in depth studying and diffusion of the competencies

The activities of technological support and promotion in the environmental sector for the industrial system will consist of:
- specific but well integrated competencies of the various processes of building, from the design to the construction to the disposal of the buildings;
- increase of the responsibilities on the consequences that buildings may have on the environment;
- validation and certification of products and processes (eco-label, eco-audit);
- development of innovative technologies in the environmental field;
- pre-normative research activity for the safeguarding and improvement of the environment;
- development of evaluation methods of the risks tied to the presence of physical, chemical and biological agents.

5. What is implied for the issue of R&D in the year 2010?

In Italy, in the environmental sector the finalisation of the R&D activities must consider the following issues:
- territory government from an urban and hydro-geological point of view;
- reduction of air and water pollution;
- minimisation of the production, recycling and disposal of refuse;
- management of the marine resources and of the coastal pollution;
- limitation of the impact of activities related to the agricultural, industrial, mobility and transportation systems;
- diffusion in the production system of low environmental impact technologies;
- correct management of the water resource (minimisation of the use of stratum water, efficiency of purification, re-use distribution).

In terms of development of research themes, sustainability implies:
- interest for the great horizontal issues such as energy, environment, mobility.
- interest for the issues of environment and man's health safeguarding and the promotion of strategic researches directed towards these.

In the energy field one of the principal objectives is the development and the modernisation of the national energetic system oriented towards:
- rational and efficient use of energy and resources (demonstrating interventions and experimentation of new energetic technologies for residential employment and

building retrofitting, energetic-environmental diagnosis, innovations in production processes, formations of technicians and diffusion of information);

- innovative technological solutions for the exploitation of renewable and alternative energies (research, experimentation and diagnostics on advanced photovoltaic systems, certification and diffusion of solar thermal systems, qualification of eolian sites, processes of thermal-physical conversion of biomass and industrial refuse and their energetic utilisation);
- realisation of advanced plants and infrastructures for the best exploitation of combustible fossils and energetic diversification;
- new technologies for the reduction of consumption and of the polluters produced by urban transport systems;
- technological solutions for the problem of radioactive refuse;
- technologies and systems for the feasibility of energy production from nuclear fusion.

6. MAIN GENERAL CONSEQUENCES FOR WHOLE CONSTRUCTION INDUSTRY

6.1 The resource "built and natural inheritance"

Among the resources mentioned in the common methodology for the phase III it has been retained to emphasise the resource "built and natural inheritance", which is intended as the exploitation of the urban, territorial, natural and archaeological settlements, characterised by the particular historical, architectural, environmental value, often protected and internationally recognised (UNESCO) as a resource and inheritance of the whole human kind.

In Italy, particularly, this resource is of great interest because of its importance and diffusion and it is also of increasing value for all the human activities in all sectors and not only in the field of construction.

6.2 Main combinations between principles and resources and consequences for phase

6.2.1 Planning

Combinations

- preservation and exploitation of the built ant natural patrimony
- reuse to the territory in terms of re-qualification and restoration of areas in bad conditions

Consequences

- development of rules and standard at each level of planning and design, defined on a environmental and geographical basis

- development of strategical programmes for the production/transformation/use of renewable energy resources and the recycling of resources water and materials
- development of new systems for the land mobility
- development of restoration and re-qualification programmes
- increasing analysis of environmental consequences for all the phases of the building process and risk analysis related to the transformation process on the environment.

6.2.2 Design

Combinations
- reuse and restoration of built and natural patrimony
- extreme exploitation of the renewable energy resources
- pursuit of excellent quality of materials, their durability and non-toxicity
- reuse of the resource water

Consequences
- increasing centralisation of design as the synthesis of the conditioning factors of the whole building process
- revaluation and re-integration of "traditional" technologies from an innovative point of view
- study and implementation of innovative technologies for the exploitation and reuse of energy resources, water and materials
- study and implementation of innovative technologies for the building envelope.

6.2.3 Construction

Combinations
- use of recyclable and non-toxic materials
- protection of the land and preservation of the resources water and nature

Consequences
- minimising of the effects of the construction activities on the environment
- specialisation of the construction companies and manufacturers in the sector of restoration, recycling and demolition
- specialisation of the construction companies and manufacturers in the systems for the building envelope
- increasing intersectorial partnership between construction companies and manufacturers
- development of control and monitoring of the construction activities

6.2.4 Operating

Combinations
- energy conservation
- reuse of the resources water and materials
- protection of the nature (land and build and natural inheritance)

Consequences
- sensitisation of users to the problems of building operating and maintenance
- development of tools of regulation and control (manuals, codes of practice, etc.) for the operating and maintaining activities
- introduction of computerised systems for the building management

6.2.5 Demolition

Combinations
- land and built and natural patrimony conservation
- reuse of the resources water and materials
- protection of nature (land)

Consequences
- definition and development of selective demolition techniques
- development of methods and tools for the technical and economic assessment of the deconstructing activities
- definition and development of methods and techniques for recycling materials and their destination

7. MAIN RECOMMENDATIONS

7.1 Introduction of rules and standard for the sustainability and eco-compatibility in the planning and design activities

- systematic introduction of the principles of sustainability and eco-compatibility in the land and urban planning tools, by means of rules and standard at each level of the transforming activities of the land and human settlements
- definition of the correlations and verification of the suitability of the interdipendencies between the different levels of planning and design
- definition of the evaluation and approvation criteria of the planning and designing results in terms of sustainability and eco-compatibility.

7.2 Continuous and permanent education

- promotion of programmes of initial and continuous and permanent education of the operators in the construction sector, at each level and for all the operative phases, in order to create a common conscience of the problems of the sustainability in the professional activities and to train specialised operators with finalised competencies.

7.3 Control of the constructing activity

- definition of means and activities minimising the effects of the constructing (site), maintaining and deconstructing activity, with respect to the surrounding life conditions as well as the waste of resources (materials, water etc.) and environmental pollution; this in the perspective of an increasing development of the building and urban restoration activity

- responsabilisation of the construction companies and manufacturers on their activities, also by adopting criteria of company management aimed to quality in terms of eco-compatibility (Quality Systems)

7.4 Exploitation of the resource "built and natural inheritance"

- exploitation of the land and human settlement patrimony in terms of resource more than constraint, in the perspective of real economic development with effects in all sectors (industry, tourism etc.)

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9. CASE STUDIES

The choice of the cases study have take into consideration the great field of buildings interventions needed for the following research, therefore examples are among the most significant of three different field of interest: urban planning, retrofitting (multi-storey building in historical centre) new building construction (scholastic building) and building component. The cases of study on urban planning are the following two; one regarding urban regeneration, Saline-Ostia Antica close to Roma and the other is the urban masterplan of the Municipality of Cavalese in the Province of Trento. Both examples are very significant, in the first case, there is a considerable sustainable intervention of urban planning, in a consolidate urban structure, the other is an example of big interest for the possibility to diffuse the Town planing instruments to increase energy savings strategies especially in other Italian Municipalities.

The schedule of the retrofit is about the Bianchi Palace, a early XIX century building in the historical centre of Perugia, this choose was given by the necessity to individuate the retrofit principles, in historical buildings.

For what concern the new building construction we have chosen a school building to point out the building construction processes phases in design, construction, and practising. The last schedule is referred to the building component, a window, studied and realised to maximise ventilation, solar gains radiation and shading factor.

The chosen cases study are the most representative in the sustainable scenery for the Italian Industrial construction of 2010.

The schedules are divided in four parts, at the top on the left side, there is the description of the project, the location with the indication of the name designers.

On the right side is indicate the typology of the intervention.

The schedule is divided in two columns, one for text description and the other with photographs and drawings.

A stripe at the bottom indicate the processes phases, resources and principles of the examples analysed.

P1 Urban Planning case study

URBAN REGENERATION, SALINE -OSTIA ANTICA, ROMA, 1995

Architects: F. Sartogo, J. Eble, M. Bastiani, V. Calderaro

Saline-Ostia Antica represents an urban organism covering 900 ha on the outskirts of Rome, whose history has alternated between consolidation and cycles of decline. With the recent agricultural reclamation operation, it has regained its structure and identity. But today the agricultural crisis and progression of the built city are compromising the morphological and structural continuity. The project will reconstruct the relationship between built city, agriculture, and natural environment in a visibly global system.

The organisation of innovative technological elements such as the "Energetic Power Ecostations" will restablish the flow of circulation, infrastructure, and create new urban polarities.

Water Concept
- Introduction of rain-water channel, and water point systems.
- Support of bioclimatic urban vegetation bu the water system.
- Cleaning lagoon system as new landscape.

Urban vegetation and bioclimatic system
- Bioclimatic green central spine
- Green belt against pollution and noise from the two roads
- Inter-relation of specialised agricultural border gardens and the internal
- green space of the new solar buildings.
- Urban forest connecting the lagoon system and the green border.

Ecological and Energy Concept
- Use of solar energy for water control (canals and ponds)
- Photovoltaic innovative technology for public lighting
- Ecostation, covered market, social and activity space, covered by
- photovoltaic panels producing energy.
- Biogas power station
- Mixed function district
- Solar district
- Urban district
- Solar pilot project with example of zero-energy building

BUILDING PROCESS PHASES: urban planning
RESOURCES: land, existing building, energy and water
PRINCIPLES: nature protection, renewal and recyclable

P2 Urban planning case study

THE NEW URBAN MASTERPLAN OF CAVALESE (Trento) 1991

Architects: G.Stelzer, G. Carlino

The urban masterplan of the Municipaly of Cavalese promotes a series of technical and co-ordinated measures, normative for energy savings interventions, discouraging law elusion, for an adequate solar energy use in the new buildings constructions and/or in retrofitting and in general in the research of building quality and in the valorisation of existing buildings.

Five levels of building intervention are checked in the Cavalese masterplan, some of them enter directly in the normative and technical advisory, while some other belong more properly at the dimensional-program- management of the administration. The first two levels individuate the planning level and the building level which much more are involved in the sustainable development of the city.

Planning level

- Individuation of new edifying areas.

For the individuation of the new building areas Municipality have produces the "solar plans", to use in parallel to other instruments for territorial analysis.

- Building density and forms of edification.

From the energy point of view is foresee the possibility to build adjacent "jointed" in the way to reduce losses from the building.

The building level

- Right to sun

The new projects have to take into account a series of typological schemes foresee by the plan , to verify the graphical envelope shadows buildings.

- Thermal insulation

This point facilitate all the intention to insulate in a consistent way the own building, and define the use of the insulating and the quantity.

- Solar components

The volume of solar components, such as, the volume of greenhouses and veranda south, south-west and south-east exposed, can be added to the maximum allowed building volume.

- Glazing surfaces

The Cavalese masterplan define also the form and the dimension of the windows and their number in relation of the size.

BUILDING PROCESS PHASES: development and planning, design
RESOURCES: land, existing buildings and energy
PRINCIPLES: conserve, re-use

P3 Historical building retrofitting case study

PILOT PROJECT FOR THE INTEGRATION OF RENEWABLE ENERGIES BIANCHI PALACE PERUGIA, 1995.

Architects: F. Sartogo, M. Bastiani, P. Baldugrani

The basis of the case study project for Bianchi Palace derives from historical-critical research on the environmental and climatic morphological matrices, the project take part at the Rubuild Pilot Project and was launched under the RECITE Programme of the European Union, in response of their policy for the promotion of renewable energies.

Principal concepts of the project

- Functional and energetically rationalisation in the use of the building (atrium, elevator, services, horizontal and vertical distribution elements).
- Elimination of the sixth floor addition.
- Emphasis on the reconstruction of the "Atrium", as a reminder of the original "corte, with the function of vertical element distributing energy flows for solar passive heating, passive cooling and natural illumination of the internal spaces.
- Utilisation of the consistent masses of the wall structure as thermal accumulation elements (for cooling or heating according to the different seasonal conditions).
- The transparent covering system, composed holographic- optical elements and photovoltaic modules, allows to direct solar radiation into the atrium below in order to illuminate the internal spaces and thermally charge the existing wall masses during warm periods, while it allows to intercept direct solar radiation during warm periods, directioning it towards the photovoltaic modules in order to produce electric energy. Due to the "chimney-effect", the atrium also permits the cooling of its wall masses during the night-time in warm periods, for the passive cooling of the building.
- Integration of the bioclimatic system with technical systems through the use of the same air circulation system; expulsion air as cool source for the heat pump during warm periods in order to increase its efficiency.

BUILDING PROCESS PHASES: operate
RESOURCES: existing building
PRINCIPLES: Conserve, re-use

P4 New building case study

ELEMENTARY SCHOOL OF PONZANO IN EMPOLI 1996

Architects: Marco Sala Associates

The project of the school building poses an interesting problem for the energy designer from the point of view of energy conservation. Occupancy is both various and impermanent: classrooms are used to a greater or lesser extent according to their function; the length of a school day is generally shorter than a working day but after hours activities in the form of cleaning and extra curricular/adult education courses result in the extension of energy utilisation in any given day. Defining the areas where energy is used and sequentially identifying the areas of waste is the logical and essential process which must be executed. Many are the energy saving strategies used in this school building:

1. Ventilated roof
A metallic roof with controlled openings is realized above the classroom ceiling structure. Vasistas ventilation windows, internally operated by command rods, permit the obtainment of a transverse ventilation under the roof.

2. Super-insulation of walls and roof
Super-insulation of walls and roof is obtained by means of panels in expanded polystyrene with closed cells.

3. Insulating glazing
Reduction of winter heat losses and of the "cold wall" effect both for walls and ceilings.

4. Natural ventilation
The incorporated ventilation in the window frames excludes the possibility of annoying gusts of air for children.

5. Thermal bridges
Exclusion of thermal bridges, by means of interposition of a continuous insulation layer on the heads of walls and floors. Insulation of the ground floor from the earth.

6. Buffer space
The central distribution space also acts as a southern solar caption greenhouse during winter.

7. Special glazing
Use of a special glazing with air exchanger, reduction of heat losses from direct window ventilation.

BUILDING PROCESS PHASES: design, operate
RESOURCES: energy, materials
PRINCIPLES: conserve, renewable

P5 Building component case study

NEW FACADE TECHNOLOGIES,ACTIVE INTELLIGENT WINDOW

Architect: Marco Sala Associates

The Active Intelligent Window. is comprised of a range of elements each with a specific or variable functions depending on outdoor conditions. The elements are contained in two main sections: the upper section contains the glazing panels, which in turn enclose variable transparency film operated on a roller system. The lower section is within a compartment clad on the interior by a filter panel and on the exterior by a punctured opaque glass panel; contained within these panels is the rotary heat exchanger and an upper and lower fan for air intake and exhaust respectively. The intelligent control system and sensors are also located here, as well the local control for the different configurations. The heating strategy of the window covers the concepts of solar collection, heat storage and heat distribution; while the cooling strategy refers to solar control, internal gain minimising and heat dissipation.

The entire unit is contained by a P.V.C. frame that allows the insertion of the whole element into the building structure, as well the substitution of damaged elements.

The glazing is made up of two panels: the external laminated glass panel and the internal low emissivity double glazed panel. The aim of low emmisivity glass coatings is to reduce the radiation exchange between the internal and external panels of an insulating glass unit.

The movable film within the glazing panels is utilised at all times of the year: along its length it has a section that is 100% reflective which may be wound onto one of the upper rollers, another that is 50% reflective onto the other upper roller and linking the two is a transparent film.

At the bottom of the glazed section is a tensioner to keep the film taut and allows free movement of the film; this configuration allows control of solar gain and insulation levels in an innovative manner.

BUILDING PROCESS PHASES: design, construct
RESOURCES: energy, materials
PRINCIPLES: renewable

REPORT 7

SUSTAINABLE CONSTRUCTION IN JAPAN A PERSPECTIVE TO THE YEAR 2010

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION - INITIATIVES ON SUSTAINABLE CONSTRUCTION IN JAPAN

In early 1990s, the issues relating to construction and the environment got great concern only by limited number of people in Japan like academics, research minded practitioners and government officers.

However, in late 1990s, construction and the environment is the critical issue for most of the construction people in Japan. The word sustainability is frequently used in articles and papers in magazines and journals relating to construction.

Public sectors are now taking various measures to constrain environmental impacts by construction. Public sectors are now integrating these independent and fragmented measures in order to realize more holistic and comprehensive approach. Various non governmental organizations (NGO) were established to encourage or to initiate measures.

This national report summarizes various research and practical initiatives related to sustainable construction since early 1990.

2. INITIATIVES BY THE MINISTRY OF CONSTRUCTION (MOC)

2.1 The framework of governmental policy

In November 1993, the Environment Basic Act was enacted in Japan. The act gives comprehensive legal basis for environmental policies and measures implemented by the governmental bodies. All acts, regulations and codes are requested to harmonize with this law. The Environment Basic Act declares three basic principles. These are:

- Enjoying and preserving the benefit of the environment
- Developing sustainable society by reducing environmental impact
- Promoting international collaboration toward conservation of global environment

Based on the Environment Basic Act, the Environment Basic Strategic Plan was established by the Cabinet in December 1994. It gives the basic strategies for integrating policies by the government in the coming decade. These are:

- Cyclic utilization; Realizing socioeconomic system with less environmental impact by cyclic utilization.
- Harmonization with nature; Harmonized coexistence with living creature by conservation and restoration of ecologies environment

- Participation; Participation of all organization to the activities toward 'cyclic utilization' and 'harmonization with nature' under equaled role sharing
- International frameworks; Promotion of international collaboration

Prior to the Environment Basic Strategic Plan by the Cabinet, the Ministry of Construction (MOC) established the Environmental Policy Plan in January 1994. In the plan, there are two significant recommendations. The Plan declares that the environment issues are not the additional requirements to the facilities constructed by MOC, but the basic demand that all facilities should meet in their basic nature. The Plan involves recommendation that construction industry should establish the action plan voluntarily.

Up-to-date information in terms of MOC policies is available from Web site (http://www.moc.go.jp)

2.2 A voluntary action plan by construction industry consortium

Pushed by the recommendation, ten industrial associations in construction industry established a consortium called as Environmental Action Board. The participant bodies of the Board involve the association of contractors, building consultants, house producers and so on. In 1996, the Board declared the Vision of Construction Industries' Environmental Action. The vision puts its basis on the idea of sustainable construction.

2.3 MOC Eco city projects

So-called Eco-city project was started by Building Research Institute (BRI) in 1991. BRI is the governmental agency in Ministry of Construction (MOC). This is the five years' large size research project where university researchers and practitioners in construction industry were invited.

As a part of the Eco-city project, LCA program was developed as a tool to aid environmental conscious building design. This is a software for PC. The designers are able to get the life cycle energy consumption and carbon dioxide emission by entering parameters. It is easy for designers to compare energy consumption and carbon dioxide emission among possible alternatives.

In the process developing the software, required data was collected by MOC. To get the figures of embodied energy and carbon dioxide emission per unit quantity of building materials and components, the questionnaire survey was implemented to the fabricators of building materials and components. In the questionnaire, all resource materials and energy input were filled in. MOC also did analysis of I-O (Input - Output) tables. The figures obtained in questionnaire survey and I-O table analysis was compared. Then BRI table of embodied energy and carbon dioxide emission was constructed as one of the sub-package of LCA program.

In order to get operational energy and carbon dioxide emission, one year monitoring surveys were implemented in ten Japanese cities. The quantity of energy and resource used by one dwelling was modeled by correlated parameters.

The LCA program is now being distributed to the practitioners in building industry.

2.4 Recycle Plan 21 Initiative by MOC

The Ministry of Construction (MOC) is the body to implement public works. Thus, it is a 'strong' and influential client. MOC organized regional board composed of local office of MOC, local councils and association of firms in construction industry. The regional body is a promoting body to realize the following purpose:

- Minimizing the quantity of construction by-products by design measures
- Maximizing the recycling by intensive exchange of information among parties involved in construction work
- Promoting appropriate disposing wastes in terms of which reuse is difficult
- Encouraging R&D

These initiatives are called as Recycle Plan 21. The long term goal of this initiative is realization of almost 100% reduction of disposed waste, except particular wastes which have difficulty in reusing. Its short term goal is 50% reduction of disposed construction waste. Thus, it needs 10% reduction in production of construction by-products plus upgrading recycling ratio of construction by-products from 42% to 80%.

The initiative is generating considerable effect to reducing construction waste in public works. However, it is not certain whether the effect could reach the level defined as the figures above

2.5 Green governmental buildings initiative

The public building department of MOC initiated green governmental buildings initiative in 1996. The initiative aims to construct and renovate governmental buildings with less environmental impacts. By 1998, the initiative made draft guideline together with environmental impact assessment method (check-sheet). The guideline involves the following recommendations:

- Less contextual impacts to surrounding area by constraining change of original geographical features, increasing planted area and preventing pollution.
- Less energy and resource use by intensive insulation, utilization of renewable energy and natural light, introduction of ventilation cooling, application of efficient equipment, utilization of rain water and by systematic operation of building equipment for balancing of energy use.
- Better longevity by improving adaptability, utilization of more durable building materials and components.
- Utilization of 'eco-material' like materials with less environmental impacts, recycled materials and byproducts.
- Appropriate reuse and disposal

The guidelines will be applied to all newly constructed and refurbished governmental buildings.

The Ministry of Education implemented 'Eco-school project' in 1995. Many local authorities made and/or are making design guidelines on environmental conscious building.

2.6 Strategic policy programming after COP3

COP3 held in Kyoto in December 1997 decided to demand to industrial countries to reduce greenhouse gas emission by 2010. Japan promised to reduced 6% than the quantity level in 1990.

After COP3, Japanese government established task force to make the comprehensive policy program in terms of measures taken by governmental bodies for reducing green house gas emission.

Comparing with EU countries and north American countries, Japanese industrial sectors already realized fossil energy efficient industry. More energy efficient facilities are disseminated. Japanese manufacturers are supplying more energy efficient products. The statistical figures indicate that the quantity of green house gas emission from manufacturing sectors has been almost stable since 1990.

The fact suggests irrationality of the indicator based on quantity level in 1990. However, Japanese government feels strong responsibility to prevent global warming. Japanese government is now making serious effort to reduce green house gas emission. The target is transportation sector and non-industrial sector, because the green house emissions from these sectors are considerably increasing since 1990.

Thus, reducing green house gas from building operation is now becoming the critical issue. Under the comprehensive policy program, MOC is now making policy plan. MOC established the Advisory Committee composed of experts from academic bodies, industry and consumers. MOC requested the Advisory Committee to submit the recommendation report by May 1998. The report is expected to contribute to establish policy plan. The policy plan is expected to integrate already implementing measures exemplified in Table 1.

- Upgrading comprehensive insulation level
  - Revision of Energy Saving Guideline for housing (Minister's ordinance)
  - Revision of technical requirements for Government Housing Loan Corporation's loan
- Registration of qualified insulation technicians
- Encouragement of 'Environment symbiosis' urban regeneration projects by subsidy
- Facilitation of 'Eco-care' Building pilot project by supplying low interest loan.
- Encouragement of replacement by more energy saving building services by providing benefit in tax payment.

Table 1. The example of present measures by MOC for greenhouse gas emission.

3. INITIATIVES BY ARCHITECTURAL INSTITUTE OF JAPAN (AIJ)

3.1 Global Environment Research Committee

Architectural Institute of Japan (AIJ) is a unique body; It is an academic body. It has about 40 thousands' members. The members are academics and practitioners including architects, engineers and construction managers. Up to date information is available from Web site (http://www.aij.or.jp/).

AIJ initiated global environmental special research program in 1990. Following the special research program, AIJ established the Global Environmental Committee. Under the committee there are more than ten research groups. Each group is composed of researchers and practitioners. The research committee is organizing workshops and symposium in every three months. The Committee already published reports and proceedings (AIJ, 1997, see Appendix 1).

By the initiative of the Global Environment Committee, AIJ will organize symposium on 'sustainable construction' at the annual conference in September 1998.

Under global environmental research committee, AIJ established sustainable building research sub-committee in September 1997 chaired by Prof. Murakami at the Univ. of Tokyo. The mission of the sub-committee is to establish criteria and indicators for sustainable building from Japanese perspective. The final report of the sub-committee would be published by the end of 1998 (The author is the secretary of the sub-committee).

3.2 Building Agenda 21 by AIJ

Architectural Institute of Japan (AIJ) announced Building Agenda 21 to the public in October 1995. The agenda represents general understanding among Japanese academics in terms of sustainable construction. The agenda is based on the principle of AGENDA21 in UN Global Environmental Summit in 1992 and on Japanese Environmental Basic Act in 1993. The Agenda declares:

A life cycle of building has profound interrelationship with global environment. The effort of environmental conscious measures would make great contribution to preserving and redeveloping of global environment. The member of AIJ must notice the responsibility for global environment and need to participate in decision making process more positively. 'Sustainable construction' is the significant theme that AIJ must put first priority. Thus, AIJ proposes seven principles for future research activities.

Seven key principles involved in the agenda are :

- Establishment of the methodology to evaluate life cycle impact of building to the environment, as well as creation of measures to constrain impact by using the methodology.
- Producing code of practice of planning together with reconsideration of present life style from the aspect of energy consumption.
- Prolonging the life of buildings in order to prevent rapid resource consumption.
- Reducing energy and water consumption in building operation and setting up measures to use reproductive resources.
- Planning for sustainable land utilization and for preventing pollution to water, air and land
- Creating measures for healthy environment
- Promoting technology transfer and information exchange for international cooperation.

In July 1997, Building Agenda 21 was revised as 'Action Plan for the Global Environment' (Appendix 2).

3.3 AIJ President's appeal in December 1997

The president of AIJ announced the appeal to the public for constraining carbon dioxide emission on 2 December 1997. It declares that 30% of reduction of carbon dioxide emission for newly constructed buildings is feasible if they meet to the conditions that AIJ offered, while 15% reduction is possible from existing buildings if they are properly refurbished based on the AIJ guidelines. These measures could contribute to the reduction of carbon dioxide emission up to 5% in national scale. The appeal also insists on the necessity of longevity of buildings; it proposes the three times' extension of building life than present situation (Appendix 3).

4. INITIATIVES BY PROFESSIONAL AND INDUSTRIAL BODY

4.1 Code of practices and guidelines

Industrial Associations established permanent organization on sustainable construction. For instance, BCS established Global Environment Committee.

Codes of practice or design guidelines are being made. Japan Institute of Architects (JIA) published the guideline of 'sustainable design'. The Building Contractors Society (BCS) published guidebook of environmental conscious design. Building Department of MOC is now developing design guideline for environmental conscious public building.

4.2 Reduction of consumption of tropical wood plywood forms for cast-in-site concrete

In 1992, Building Contractors Society (BCS) announced officially to the public that member firms of BCS would realize 35% reduction of consuming tropical wood plywood forms for cast-in-concrete within coming five years.

Though the author does not have any data on actual figure of reduction, it is certain member firms of BCS made an effort to realize the figure by applying following measures; Using plywood made from renewable wood such as pine and cedar, applying durable plywood forms such as paint coated plywood forms, using metal forms, using precast concrete and so on.

The problem is that only member firms of BCS seems to make intensive effort for the last five years. BCS is composed of about 90 largest contractors. In another word, other smaller contractors did not join the effort so positively. (There are almost a half millions' construction firms in Japan!)

4.3 ISO 14000s and environmental management

The number of environmentally conscious firms would be increased rapidly by the introduction of ISO 14000, because the Japanese clients of construction are now enthusiastic to introduce environmental management system (EMS). Institute of Building Energy Conservation (IBEC), nonprofit subsidiary body of MOC, established EMS research consortium. The consortium is composed of governmental officers, university researchers, practitioners from the industry. The consortium is now editing several documents to support activities to establish environmental management system in the firms relating to construction industry. (The author is the chair of task group of the EMS consortium.) The EMS consortium published following manuals, tool-kits in order to encourage and assist construction firms to introduce EMS.

- ◊ Manual of establishing EMS
- ◊ Manual of environment impact assessment
- ◊ Checklist of environment performance
- ◊ Environment database
- ◊ Domestic environment code database

Several large contractors and prefabricated house producers are now preparing to establish environmental system and to take ISO 14000s approvals. Already 12 firms relating to construction got ISO(JISQ) 14001 approval.

4.4 GBC 98

Two Japanese teams, IBEC and Building Contractors Society (BCS), are participating Green Building Challenge (GBC98). IBEC is also the counterpart body of IEA-Annex group.

5. KEY ISSUES IN JAPAN

5.1 Review of environmental impacts by construction industry

The researchers in construction industry are now making an effort to review environmental impacts by construction industry. These efforts are done by personal basis or by single organization or by collaboration of various organizations through industrial associations of contractors, suppliers and fabricators relating to construction industry. The following are results of the review.

5.1.1 Global Warming

Total CARBON DIOXIDE emission in Japan increased 7.2% among 1990 and 1994. Construction works in sites only occupy 1.3% in total national CARBON DIOXIDE emission. However, production of construction materials has contribution of 12.8%, transportation related to construction has 3.4%, operation of buildings has 16.5%. As a total, Japanese construction activities have over 34% share in national CARBON DIOXIDE emission (Sakai 1992).

5.1.2 Energy use in summer time

Japan belongs to Asian monsoon region. Thus, air-conditioning in summer time requires more intensive load in energy use than heating in winter time, in most of the country. In another word, most of Japanese architects and engineers put much concern on cooling system in summer time in building design.

5.1.3 Depletion of Tropical Forests.

Plywood made by tropical timbers has been used as forms for cast-in-site concrete in Japan for long years. Only 3.4% of consumption of tropical woods is exported. However, erecting facilities for exportation give incentives for unplanned and uncontrolled consumption in tropical country. 33% of exported tropical timbers are consumed in Japan. 10% of Japanese domestic consumption of tropical woods is used in construction industry (Osaka Building Contractors Association, 1992).

5.1.4 Ozone Depletion

Halons from fire safety devices and CFCs from insulation materials have potential for ozone depletion. Recycling of these materials from dismantled buildings is now being promoted in Japan. At present stage, Japanese construction industry has 5.5% share of total national emission of Halons and CFCs gas.

5.1.5 Acid Rain

Researchers in Japanese construction industry understand that construction industry has little potential for acid rain, because NOx and SOx emission from construction machinery has small share in the whole national emission.

5.1.6 Construction wastes

In 1990, 76 million-ton amounts of construction wastes were produced in Japan. It is about 21% of total industrial waste in Japan. Compared with other industrial sectors, this is the largest share. Only 42% were recycled. The government statistics suggest that 127 million-ton amounts of construction waste would be produced. Upgrading the recycling ratio is the critical issue in Japan.

5.2 Capacity of space

The habitable land area in Japan is 126 thousands' km2 among total land area of 379 thousands' km2. It is comparative with UK; Japan has about 120 million's population that is almost double of UK. The national gross population density in Japan is 329 persons per km2 while 236 persons per km2 in UK. The population density in habitable area in Japan is 988 persons per km2 while 245 persons in UK. The figures of demographic and geographical condition suggest how intensive the density of economic activities in Japan is. Consequently, the limitation of capacity of space is a critical issue for environmental matters in Japan.

For instance, the high density of energy consumption in urban area cause the phenomena called as 'heat island'. This is local concentration of heat atmosphere by heat transmission, energy consumption by building and transportation in urban area. Urban climate modeling is 'hot' topic among researchers. In this context, the constrain of energy use is not only global environmental issue but also local issues in Japan.

The limitation of capacity of space also causes the lack of waste disposal space. The reuse of waste is becoming the sensitive issues in Japan not only by the reason of resource saving but also of space saving.

5.3 Short life buildings

In the past three or four decades, Japan repeated the short term repetition of 'new build and demolition'. It was proved that RC structural office buildings have around 40 years' life in medium, while steel structural has around 30 years in Japan (Yashiro, 1990). Eventually the author presented at the first CIB W82 symposium that quite a certain amount of construction waste would be produced in coming future, if Japan should keep repetition of short cycle of demolition and new build activities (Yashiro, 1992)

The short life tendency was generated by the recovery of war disaster and by the rapid economical growth. The tendency made affection on the nature of Japanese construction industry. There was a sign that some parties in the industry promote demolition of usable building to get their job opportunity. Considering that Japanese construction volume (i.e., over one million dwelling units newly build per year), short life buildings in Japan have global impacts in natural resource conservation.

Governmental agencies, public bodies, industry associations and academic institutions announce the achievement of 'long life building' policies and programs. All the 'future building' R&D projects promoted by various kinds of organizations involve the paradigm of 'long life'.

5.4 Global supply chain

Construction materials and energies applied in construction activities are involved in the global network of supply chain. Various resources and raw materials for construction are imported. The vast volume of construction in Japan made great influence on environment in the other countries.

99% of aluminum ingots used in Japan are imported from Australia, USA, Indonesia and etc. It is understood that usage of aluminum by Japanese construction industry generates energy consumption in these countries.

6. ANSWER TO FIVE MAIN QUESTIONS AND FIVE SUB-QUESTIONS

6.1 What kind of buildings will be built in 2010? And how could we adapt existing buildings?

Though it is not certain how comprehensive the idea of sustainable construction would be disseminated among Japanese construction industry by 2010, it is quite certain that considerable numbers of building built in 2010 would be designed based on the following paradigm.

- Long life design which assures effective whole life cycle management
- Separation of decision making level such as open building by realizing interchangeability of subsystems (which is expected to assure reuse of materials)
- Low embodied energy and carbon dioxide emission
- Low energy use and carbon dioxide emission in operating building
- Involving a sort of autonomous mechanism
- Low environmental impacts on surrounding area
- non-toxic indoor air quality

The most important issue in Japan is providing measures to prolonging the life of existing buildings. In another word, establishment of modernization method of existing buildings constructed after 1970s is the critical issue in Japan.

6.2 How should we design and construct them?

It is certain that more intensive negotiation and discussion would be required among construction team (architects, engineers, contractors, fabricators and so on) in each project to find the most appropriate way toward sustainable construction. Moreover, in total process of projects, constructing agreement among interested parties (not only stakeholders) would increase its importance than now. The construction process would be more complicated. In this circumstances, not only automated way is effective, but also excellent human skill would be effective. The most innovative construction would be the most appropriate combination of automation and excellent human skill.

6.3 What kind of materials, services and components will be used there?

Following materials would be the preferable materials:
- Low embodied energy and carbon dioxide materials
- Renewable materials
- Materials with less environmental impacts

In this context, timbers and wooden materials would have popularity than now. There is an encouraging fact; Japanese forests would be recovering its sustainable cycle in late 1990, whose sustainable cycle was destroyed during the time of world war II. However, there is also discouraging fact. Domestic timbers are more expensive than imported timbers from North America. There are economic constrains to establish sustainable supply-demand chain in specific region.

6.4 What kind of skills and standards would be requested?

Apparently sustainable construction requires different skills and ways of thinking to construction people. For example, recycling of construction waste requires skills to dismantle building elements into basic elements.

Environmental performance indicators proposed in ISO 14000s would be the basis for new standard. Methodology of LCA disputed under the framework of ISO 14000s would be also the basis as well.

So called boundary problem would be the critical issues in terms of quantifying the environmental impacts, because construction industry has the nature of assembling product from the other industries. Some agreement is needed in the definition of boundary (Yashiro, 1997).

6.5 What kind of cities and settlements would we have then?

Low density building complex and districts together with preserved nature would be the paradigm in city planning in 2010.

7. GOOD PRACTICES

There is not agreement on the definition of sustainable construction yet, because Japanese 'construction people' including practitioners and academics prefer 'concept follows practice' attitude than 'practice follows concept'. Thus, prior to establishing the definition, many pilot attempts are being implemented concurrently. It is expected that feed back from experiences of daily practices and pilot attempts would establish precise definition of sustainable construction in future.

7.1 'Environment symbiosis' building

Japanese traditional culture involves the paradigm of harmonization with nature. It is acceptable for Japanese people to define human as only one of the players in the environment.

Based on these cultural basis, the word of 'environment symbiosis' building is more frequently used than sustainable building, environmental conscious buildings and green buildings in Japan.

7.2 Good practice projects

The pilot projects and experimental projects of are being done concurrently by various institutions.

NEXT 21 projects in Osaka city is the most integrated and innovative example of sustainable design, where open building idea assures harmonization of independent measures (Utida, 1995).

TEPCO (Tokyo Electric Power Corporation) is now monitoring their experimental 'autonomous' buildings.

Housing and Urban Development Corporation (HUDC) and local councils are now constructing environment' friendly' estates in nationwide.

Remarkable example is Fukasawa Housing Complex in Setagaya-ku Tokyo. It is typical example of environment symbiosis building. It was designed by architect Kazuo Iwamura. He involves feasible environmental friendly measures in the council housing project where budget is extremely tight.

Moreover, specific type of passive solar house called as OM solar house is being rapidly disseminated among timber detached houses. Around ten thousand's OM solar house was constructed in Japan.

These projects are worth to visit. It is uncertain whether the impacts of these good practice projects are strong enough to encourage future clients and construction professionals to try similar projects. In addition, some people in construction industry have misunderstanding that these pilot projects are expensive projects.

8. BARRIERS AGAINST SUSTAINABLE CONSTRUCTION

The disputes among researchers and practitioners in various opportunities made by concurrently undergoing initiatives identify barriers against comprehensive approach:

- Understanding on responsibility of construction sector to the global environment is not matured in the whole construction industry.
- In almost all firms in Japanese construction industry, environmental impacts by the activities of the firm had not been reviewed precisely until recently, partly because they are less conscious about environmental issues, and partly because the methodology of precise review of environmental impacts has not been established.
- There is not clear agreement on role sharing and responsibility allocation among members of construction team in the projects (including clients).
- Tight contract budget makes construction firms hesitation to apply environment-friendly measures
- The pressure by the clients had not been strong until recently.
- Exchange of information and ideas within construction team and with other industrial sectors has not been adequate, because there has not been the platform of exchanging information.
- Necessary information were not available for most of construction firms.
- Environment-friendly materials are not available at reasonable price in the market.

The following recommendations are proposed as the measures to overcome the above mentioned barriers, through the disputes and discussions among researchers and practitioners in Japan.

- Dissemination of knowledge (especially to executive board members) about the significance of responsibility of construction firm to the global environment
- Developing and disseminating the methodology of reviewing environmental impacts of the construction firm
- Promoting education and training of employees and operatives
- Establishing agreement in terms of role sharing and responsibility allocation among members of 'construction team' in the projects (including clients) in order to keep necessary budget for sustainable construction
- Setting up information network to introduce good practice to other department of the firm or other firms in the industry

- Constructing common comprehensive data base to provide necessary information such as; LCA data, cost data, delivery data and so on.
- Encouraging construction materials industry to provide environment-friendly materials
- Awarding good practice and good client
- Introduction of environment management system
- Establishing the professions of 'construction environment consultant'

9. CONCLUDING COMMENTS - WHAT IS INCENTIVE FOR SUSTAINABLE CONSTRUCTION?

Possibly, in a long term, investment to the environment would generate the benefit to the construction firm and whole construction industry. This is the logic that several books published in USA do emphasize. However, there still exist misunderstanding in Japan that measures toward sustainable construction requires additional cost. In short term, this misunderstanding would meet the reality than the opposite understanding. Japanese government is providing or will provide economic incentives such as tax reduction, low interest financing and subsidies. However, there is a limitation in the effect (, partly because Japanese policies do not involve ideas of bringing up new environment business). The author is obliged to have the doubt that economic motivation would be the most significant incentive to disseminate sustainable construction in Japan.

Explicit demand in terms of sustainable construction issues by the client gives construction firms marketing motivation. Thus, the demand by clients can be the different incentive. This is one of the reasons why Japanese large contractors are enthusiastic for sustainable construction issues, because their long term good clients are environmental conscious firms. Contrarily prefabricated house producers have less motivation. Most of their clients put much priority on value for money rather than environmental issues. Consequently, these firms are less passionate to implement measures toward sustainable construction.

Different with European culture, there exists other incentive in Japan; Japanese construction firms put much significance on the reputation or credibility of the firm in the society. Thus, reputation can be the other incentive toward sustainable construction for firms in construction industry. If Japan would be successful in making social system to upgrade reputation of firms doing good practice of sustainable construction, comprehensive movement in the whole construction industry toward sustainable construction would be generated.

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11. APPENDIX 1 : THE LIST OF PAPERS INVOLVED IN AIJ PROCEEDINGS 'ARCHITECTURE AND URBAN PLANNING MEASURES TO MITIGATE CLIMATE CHANGE' SUBMITTED TO UNFCC-COP3 KYOTO, DEC. 1997

I. Life Cycle Assessment

1 Development of Guideline for Life Cycle Assessment of Buildings Subcommittee on Life Cycle Assessment Guidelines, Research Committee on Global Environment of AIJ.

2 A Study to Evaluate Environmental Impacts and Costs throughout a Building's Life Cycle Masaaki Sato.

3 System Boundary Definition for Evaluation of Embodied Carbon Dioxide Emission by Construction. Tomonari Yashiro.

4 Example of Estimating CO2 Emissions from the Wooden Structure Building. Kazuharu Takemoto, Kanji Sakai.

5 Carbon Storage for Timber Structure - Service Life and Recycling. Takanori Arima.

6 Why Trees Should Be Cut for Global Environment? Mario Tonosaki.

7 Buildings and Building Service Systems for Global Environment Age Laboratory for Global Environment and Building/Building Service System Advanced Research Center for Science and Engineering, Waseda University.

8 Evaluation of Global Environment Load with LCCO2 for Urban Cities. Laboratory for Global Environment and Building/Building Service System Advanced Research Center for Science and Engineering, Waseda University.

II. Ecological Architecture and Building Service

9 Earthport Tokyo Gas Kohoku New Town Building. Energy Saving Office Building Using Natural Energy & Cogeneration-Fumio Nohara. Osamu Shibata.

10 Energy Conservation in the TEPCO R&D Center. Power Engineering R&D Center, Tokyo Electric Power Company.

11 Effect of Natural Ventilation System at Ecological Architecture. Moriyama Laboratory, Research Center for Urban Safety and Security, Kobe University.

12 Ecological Architecture in the City of Kobe. Kobe City Council.

13 The New Kobe City hall Building as Ecological Architecture. Kobe City Council.

14 Utilization of Rainwater for Public Buildings in Kobe City Kobe City.

15 The Utilization of Solar Energy for Public I3uildings in Kobe Kobe City.

16 Ecological Architecture as Products of the Workshop-Ohgo-community-welfare-center with children Kobe City.

17 Ecology in Harmony with Economy-Rokko toll office, Rokko workshop, Yanagidani toll office. Toshihiko Omori.

18 Seeking Environment-Conscious Architecture Part I A Look into Architecture from a Thermodynamic Point of View. Shukuya Laboratory of Building Environment, Musashi Institute of Technology.

19 Seeking Environment-Conscious Architecture- Part 2 Solar Control. Shukuya Laboratory of Building Environment, Musashi Institute of Technology.

20 The Effect of Shading Devices. Hirotsugu Yamada.

21 High Efficiency Air-Conditioning System for Computer Room. Hirofumi Hayama, Manabu Kishita, Akira Takakusagi.

22 Evaluation of Halon Replacement Agents for Application to Telecommunications Equipment. Takayuki Abe, foshiyuki Murata, Akihiko Kujuro.

23 An Environment-friendly Air Conditioner for Telecommunications Equipment Rooms. Shisci Waragai, Tsnneo Uekusa, Kazuo Chiba.

III. Urban Energy System

24 The Reduction of C02 Emission by Promoting the Sppread of District Heating and Cooling in all over Japan . Satoru Sadohara, Katsnnori Nagano, Masao Miura, Kimiya Murakami, Masakazu Moriyama, Yoshiyuki Shimoda, Tadahisa Katayama, Ilirotoshi Yoda, Hiroki Kitayama.

25 Energy saving by transportation networks of url) an waste heat and heat source water. Yoshiyuki Shimoda and Minoru Mizuno.

26 Energy Saving by means of Effective Usage of heat Pump. Toshihiko Tanaka, Toshio Ojima.

27 The Study about the District heating and Cooling Plan by Unused Energy Moriyama Laboratory, Research Center for Urban Safety and Security, Kobe University.

28 Transition of CO_2 Emissions from the H lousing all over Japan and its Reduction. Shuichi Miura.

29 Actual Situation and Transition of Carbon Dioxide Emission in Tohoku Area. Shuichi Miura.

IV. Urban Climate

30 CFD Analysis of Warming Mechanism of Urban Climate. Working Group on Modeling for Urban Climate, Subcommittee on Dynamics for Urban Environment.

31 Global Warming and Urban Climate in Okayama City. Atsumasa Yoshida.

32 Characterisitics of Urban Thermal Environment Using Thermal Image. Shuhei Yamamoto.

33 Climate Analysis for Urban Planning in Kobe. Moriyama I Laboratory, Research Center for Urban Safety and Security, Kobe University.

34 An Ecological Development with a Predictive lool of Urban Climate. Yasunobu Ashie.

V. Urban and Regional Planning

35 Proposal for the Vertical City as Ultra Super high-rise Building for Improvement of the City Environment. Shizuo Harada, Masayoshi lizuka.

36 Proposition of Formulae» for Energy Conscious Urban Planning. Research Group of Urban Structure and Energy.

37 Landscape Conservation in the Intermediate Zone between Urban and Rural Land Use. Kiyoko Kanki.

38 Configurational Scheme of Zero Emission System for Kampo Medicine Factory. Yasuyuki Asakura, Kazuhiro Takamatu.

39 Global Environment from the Sea. Kenji Hotta Riichi Kobayashi.

12. APPENDIX 2: ACTION PLAN FOR THE GLOBAL ENVIRONMENT

The Architectural Institute of Japan - July 1997.

1. 1. Architecture and the Global Environment

Attention has focused recently on worldwide deterioration of the environment, including problems such as global warming, depletion of the ozone layer, and waste pollution. Architecture has always been a fundamental factor in the human living environment and it strongly reflects regional history and culture. Since ancient times, mankind has striven to create comfortable and safe surroundings in which to live. However, as our living spheres on the earth have expanded and economies have become dynamic, we gradually realized that everyday acts which from a narrow perspective were thought to improve our living conditions have actually been aggravating environmental quality on a global scale. It is time to review the interactive relationship between architecture and the global environment from the perspective of Earth as the dwelling place for mankind.

2. Our Measures

Since 1990, the Architectural Institute of Japan has conducted a special research program to study preservation of the global environment because we recognized that both architects and their patrons were partly responsible for ecological deterioration. In 1995, we established the Global Environmental Committee and initiated broader, in-depth research in the fields of science, technology, and art. Based on the outcomes, we summarized priority issues to be addressed by the Institute and developed our action policy for each effort presented herein, with the attendant goal to actively advance its implementation in order to realize sustainable living spheres while conserving the global environment.

3. Deployment of our Action Plan

The Institute conducts fundamental research for the specific issues under the policy, and promotes activities for timely disbursement of the research benefits to society. We must examine the progress of such activities when necessary; periodically incorporate the findings into the policy of the Institute as a whole; and transfer the Action Plan to subsequent generations.

4. Member Awareness and Action

We encourage our members to be aware that their professional knowledge can contribute toward relieving environmental problems, and to make the utmost effort to resolve the issues in each field while vigorously participating in relevant activities.

The Action Policy

1) Lifestyle
As the current global environmental issues have arisen as a result of the entire chronicle of human endeavors, we must reevaluate the roles and significance of economics and ethics in a broader sense, while also pursuing the traditional architectural discipline that has emphasized studies of human living environs related to architecture itself. We take initiatives in establishing an entirely new architectural paradigm, and in proposing and promoting alternative lifestyles suitable to the era of global environmental awareness, without being confined to the concepts of architectural production and consumption alone.

2) Analysis and Assessment of the Environmental Load
Toward the goal of proposing means to curtail environmental load, we undertake comprehensive research and development to establish databases and methodologies for load assessment, exemplified by the CARBON DIOXIDE issue that is said to be the major contributor to global warming, in the field of architectural life cycle; namely, the series of architectural stages from planning, design, and construction, practical use, and modification, to eventual dismantlement and removal.

3) Use of Resources
Architectural production has traditionally been responsible for the mass consumption of our natural resources; toward the goal of curtailing depletion of our resources, we examine and propose ways to enhance architectural longevity and durability; appropriate use of architectural resources reflecting regional characteristics; methods to reduce resource consumption and promote recycling; and development of materials to reduce architectural waste and improve structural planning and construction design.

4) Use of Energy
The quantity of energy and water consumed in the process of architectural construction and operation has been a profound load factor to the global environment. We conduct further research toward reducing the amount of these wasted resources, and improving utilization efficiency and recycability. We also work to discover and implement innovative design techniques such as the use of natural energy to foster our symbiotic coexistence with the natural environment.

5) Use of Land
On reflection that our previous development activities in pursuit of economic efficiency often resulted in devastation of our ecosystems, we strive to provide prime living environments for all people through the better use of land and superior

design techniques while also embracing ecological conservation. Furthermore, we promote new research and design activities to create buildings and cities that are hospitable, pleasant, and safe from disaster.

6) Health
Based on our experience that inadequacies in pre-development assessment of environmental impact have led to the change and degradation of our environs, we endeavor to undertake research on the desirable status and methodologies for environmental conservation in relation to human living conditions. In addition, in order to protect our health and the earth's ecology from contamination and deterioration, we propose and disseminate architectural measures, regional planning, and design techniques that enable us to alleviate damage caused by water, air, and soil contamination.

7) International Cooperation
As global environmental issues exactly involve the entire human endeavors on global scale, worldwide collaboration is essential. Through the exchange of information with other nations and organizations, we encourage reciprocal utilization of all experiences and achievements and promote further international cooperation toward our goal.

13. APPENDIX 3 : AIJ PRESIDENT'S STATEMENT ON THE MEASURES TO THE GLOBAL WARMING

The research by AIJ members indicates that carbon dioxide emission by building activities including manufacturing and transporting building components and operating buildings occupy about 40% of national total emission in Japan. It means that building activities in Japan reaches almost 1% of global total emission. In addition, the emission by building activities in Japan is apparently increasing. The constrain of carbon dioxide emission by Japanese building activity is quite significant from global aspect.

AIJ established the Global Environment research committee in 1990. The committee implemented and encouraged various research activities in order to identify the correlation between building and the global environment. The achievements of these researches are published as reports for public attention.

AIJ held the symposium titled as 'AIJ action plan and the global environment' at the annual conference in September 1997. The it organizes eight hours continuous brain storming titles as 'The responsibility and role of building people for the global environment' in October 1997.

At the opportunity of COP3 conference in Kyoto, AIJ decided to initiate following actions to encourage reduction of carbon dioxide emission from buildings.

1. AIJ has the following understanding in terms of reduction of carbon dioxide emission.

A. 30% reduction of life cycle carbon dioxide emission (LCCO2) is feasible for newly build buildings if the recommended measures by AIJ members are installed into design/construction/operation program. It is quite significant to the recommended measures should be the comprehensive paradigm to all activities relating to construction.

Simulation by AIJ members shows that 5 % reduction of carbon dioxide emission from all building activities would be realized only if 30% reduction from all new constructed buildings and 15% reduction from all refurbished buildings are realized for coming ten years.

The other research by AIJ members proves that 30% reduction of whole life cycle carbon dioxide emission from newly constructed office buildings is technologically feasible. Though certain methodology for reduction is not established in terms of other usage of buildings, 30% reduction appears to be feasible by integrating socio-economical measures.

B. For reduction of carbon dioxide emission, three times of extension of building life is definitely required. The extension is feasible.

The field survey implemented by AIJ member shows that medium of RC structural office building is 38 years and steel structural is 29 years. The medium of the life of wooden structural houses is 40 years. The figure in USA is around 100 years. Eventually, carbon dioxide emissions for constructing building occupy about 40% of whole life cycle carbon dioxide emission.

The extension the life up to the level in European and North American country gives great effect for reduction of carbon dioxide emission.

The technological requirements to realize the extension of building life are; structural safety for maximum scaled earthquake possibly occurred in every 100 years and durability of structural materials against acid rain. Moreover, the paradigm change is required in socio economical system and custom such as; the strategy of construction investment, the regulation of possession and utilization of building asset, maturity of second hand building market and adaptability of building. Theoretically it is not so difficult.

2. AIJ starts following action in order to propose basic measures for reduction of carbon dioxide emission within one year.

3. AIJ will establish interdisciplinary task force to make the proposal.

REPORT 8

MALAYSIAN OUTLINED PAPER ON CIB W82 PROJECT «SUSTAINABLE DEVELOPMENT AND FUTURE OF CONSTRUCTION»

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NATIONAL REPORT

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1. INTRODUCTION

This paper was prepared with the aim to form part of the International Synthesis of result of CIB W82 Project on «Sustainable Development And The Future of Construction». On 19th March 1998 at CIB W82 project meeting in Paris, Malaysia was invited to submit a brief outlined national paper by 1st May 1998 to enable the Coordinator to incorporate into project paper which will be presented at CIB World Building Congress 1998 in Gavle, Sweden 7-12 June 1998.

Thus, this paper briefly outlined Malaysian scenarios and vision by the year 2010 in the realm of construction industry.

2. DEFINITION OF SUSTAINABLE CONSTRUCTION

The definition given by Kibert is to be adopted, that is, «the creation and responsible management of a healthy built environment based on resource efficient and ecological principles».

3. NATIONAL CONSTRAINTS AND SPECIAL ISSUES

The following issues were identified :-

1) Large proportion of the population lives in urban settlements.
2) Illegal immigrant create economic and social problems.
3) The availability of land, air and water of good quality is a problem.
4) Mushrooming of squatter settlements.
5) Means for cooperation and large-scale responsibility toward sustained development still exist.
6) Unsustainable urban sprawl.
7) Depletion of forest.
8) The hot climate needs policy to sustain the energy as most houses have installed air-conditioning units.
9) The volume of road vehicles is alarmingly responsible for the emission of Co_2.
10) Management of Toxic and Industrial waste needs to be reviewed.
11) Environmental protection during the construction process.
12) Utilization of imported building technologies and materials.

4. ANSWER TO THE MAIN QUESTIONS

4.1 Cities and settlements in 2010

1) Denser cities with dense urban buildings of low and high rise.
2) More low-rise suburban buildings, less apartment houses, smaller scale and village-like environment.
3) Demolition or refurbishment of inferior urban and suburban housing.
4) More greenery and greener urban areas, careful planning of non-built land.
5) Functionally more integrated and more heterogeneous cities.
6) Teleworking will be more common which allows workers to live in less urban or in rural areas.
7) Enhanced public transport system and central pedestrian areas.
8) Efficient energy distribution and utilization.
9) Adequate and clean water supply.
10) Integrated waste management system.

4.2 Building

1) High and good quality, no quality defects.
2) Flexibility, multiple use, functionality of building.
3) Small amount of new building, utilization, economic renovation and modification of existing buildings.
4) Small energy consumption, energy conservation, autonomous energy production, energy-economic construction, new energy sources, energy storage.
5) Long/short service life, life cycle costs.

4.3 Design and construction

1) The needs of the user, the participation of the client/user.
2) The increasing amount of design work, more demands for design, more investments to design work.
3) The importance of ecological knowledge, life-cycle analysis, environmental and ecology databases or other information systems, ecological profile data.
4) The importance of local natural conditions and environment.
5) Optimum use of passive solar energy.
6) The increase of construction on-site, specialized on-site construction.

4.4 Materials, services, components

1) Recycling and re-use of materials, products and equipment.

2) Recyclableness of materials and ease of demolition.
3) Easy repairs and service of equipment, little need of repairs, durability, long service life.
4) Economic use of resources, renewable natural resources (like wood), small energy content of materials.
5) Healthy non-poisonous and non- allergenic materials.

4.5 Skills and standards

1) Skills, qualified labour, expertise.
2) Autonomy and responsibility of labour, quality production.
3) The ability to handle both new and old materials.
4) Flexibility of regulations, non-descriptive regulation.
5) The importance of life-cycle and overall performance.

5. CONSEQUENCES TO CONSTRUCTION INDUSTRY IN 2010

5.1 Consequences to built environment

(1) LAND

1) Limited amount of space available.
2) Less flexibility in future planning.
3) Conserved open space and green areas.
4) Combined transport corridors.

(2) ENERGY

1) Integrate town planning and energy management.
2) Depletion of energy resources.
3) Reduced energy consumption.

(3) TRAFFIC

1) Restricted mobility.
2) Reduced noise and air pollution.
3) Integrate side development with advanced public transport systems.
4) Optimized capacity of existing transportation networks.
5) Create new transport networks.

(4) WATER

1) Combined use of drinking water and grey water.
2) Closed system, non run-off to sewage system.

(5) **MATERIALS**

1) Use of local materials.
2) New in-situ diagnosis and repair techniques.

(6) **OTHER ASPECTS**

1) Social sustainability.
2) Public involvement in planning.
3) Maintain rural settlement structure.
4) Imply ecological principles in physical planning.

5.2 Consequences to initiating and designing

(1) **LAND**

1) Efficient use of land.
2) Intensive use of land.

(2) **ENERGY**

1) Integrated design for energy efficiency.
2) Refrain from air conditioning.
3) Passive cooling and lighting.
4) Safeguarding indoor environment.

(3) **WATER**

1) Drinking water conservation.

(4) **MATERIALS**

1) Durable, non-toxic, recyclable and reusable.
2) Durable coating system.
3) Design for disassembly, short lived components.
4) Local materials, traditional and non-traditional construction.
5) Lightweight construction.

(5) **OTHER ASPECTS**

1) More information and communication.
2) Customer participation.
3) Environmental accounting of building.
4) New building designs taking account of tele-working and IT applications.
5) Optimization through eco-balance tools.
6) Integration of building functionalities.
7) Post completion design assessment.

5.3 Consequences to construction and demolition

(1) LAND

1) Ensure flora and wildlife protection.
2) No blasting to create building site.

(2) ENERGY

1) Minimize transportation.
2) Energy saving refurbishment.

(3) MATERIALS

1) Produce operating manuals for building systems.
2) Construct for disassembly, modular approach.
3) On site waste management.
4) Refurbishment without nuisance to occupants.
5) Labelling of products to facilitate selective removal and recycling.

(4) OTHER ASPECTS

1) Turn key process.
2) Increased partnership between designers, contractors and manufacturers.
3) Quality standards for whole building.
4) Improved working conditions.
5) Business opportunities for recycling.
6) Improved site logistics.

5.4 Consequences to operating and maintenance

(1) ENERGY

1) Easy retrofit of energy saving system.

(2) WATER

1) Establish tools and systems for water management.

(3) MATERIALS

1) Planned maintenance and refurbishment programmes.
2) Decision support systems to consider between refurbishment or demolition.
3) Adapt building for future needs.

(4) OTHER ASPECTS

1) Better control of indoor air quality, noise and health risks.

2) Tools for control.

5.5 Consequences to components, materials, services and assembly

(1) ENERGY

1) Passive and hybrid technologies for cooling.
2) Passive lighting systems.
3) Systems for easy retrofit in existing buildings.

(2) WATER

1) Integrate saving system into building design.

(3) MATERIALS

1) Logistics for reuse and closed-loop recycling.
2) Exchangeability of components through standardized dimensions.
3) Renewable and durable materials.
4) Use of local resources.
5) Development of new materials for easy retrofit.

5.6 Consequences to skills and standards

1) Qualified labour.
2) More specialization in environmental issues.
3) Performance based building regulations.
4) Integrated knowledge of whole building process.

6. RECOMMENDATIONS

6.1 Policies

1) Continue and reemphasize existing regulations and strategies.
2) Review and develop measurable performance standards.
3) Promote interdisciplinary training and courses.
4) Promote awareness and R & D on Sustainable Development.

6.2 Design

1) Develop new design standards.
2) Adopt open system.
3) Adopt and adapt jointing and assembly techniques.
4) Impose minimum recycled material content.

5) Consider environmental qualities of material.
6) Adopt more integrated approach to design process.

6.3 Manufacturing

1) Product development base on life cycle consideration.
2) Practice better waste management.
3) Practice reliable labelling scheme.
4) Reengineer production process of standardized elements.

6.4 Construction

1) Reduce environmental impact during process.
2) Reengineer process to meet the concept of open building.
3) Increase partnership with designers and manufacturers.

6.5 Operation and maintenance

1) Establish maintenance programs.
2) Develop and apply decision support system for refurbishment.

7. CONCLUSION

To meet the challenges to strengthen the ability to pursue the fundamental policy of achieving sustainable development and national unity, a number of new strategies need to be formulated. The Development Plans need to retain, reemphasize and continue to give serious attention to strategies for generating sustained and improved economic growth. It will also address the need to balance growth with the protection of the environment and indigenous natural resources.

REPORT 9

SUSTAINABLE CONSTRUCTION IN THE NETHERLANDS

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NATIONAL REPORT

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1. INTRODUCTION

1.1 Methodology

The approach used in this study is to analyze the long-term goals and targets set by the national government and other bodies in the Netherlands and to derive from these a national agenda for the year 2010 (what do we want to achieve?). This normative framework is then used in conjunction with a definition of sustainable construction to identify the major issues and challenges facing the construction industry. These challenges, relating to socio-economic factors, technologies, and process management, are further elaborated at several scale levels: urban settlements and infrastructure, buildings and materials/components.

Full use is made of available future studies in the Netherlands to draft the outline of the present national report. A round-table discussion was held with experts in various fields to solicit their opinions and to define priorities. For those not able to attend the round-table discussions, drafts of the report were circulated for comments.

Moreover a limited number of face-to-face interviews were held with experts to identify the most important issues and their priorities. Taking the agenda for 2010 as a starting point ensures that the scenario used reflects a realistic, economically and politically backed approach towards sustainable construction in 2010 as viewed by Dutch society.

1.2 Scenario

The scenario adopted for 2010 is a policy target-based approach. It retains the direction and relative dynamism of the economic and political changes observed during the past years, including trends recently recognized. It involves a considered balance between environmental objectives and economic sustainability (CIB scenario 3: considered sustainment). Long-term goals and standards are set by government. Policy will keep relying on the principle of self-regulation in which the government sets realistic targets and directions, with target groups being responsible for meeting these goals. Partnership and consultation remains an important environmental policy tool. Where targets are not met, regulation will be enforced by government.

However, it is realized that the environmental problems of the future will have an international dimension. The increasing use of fossil fuels, lack of space and biodiversity all relate to questions of resource redistribution on a global scale so that a quantum leap forward can only be made in a strong together scenario.

1.3 The Netherlands: concerns for tomorrow

Demography

The Netherlands has the highest population density in Europe (499 inhabitants per km^2 projected to 2010). As everywhere else in Europe, life expectancy is on the increase and is projected to reach 76 years in 2010. In 2010, those over 65 will make up 24.1% of the population. This ageing population, together with an anticipated decline in total population after 2025, will have a significant impact on the demand for housing and infrastructure. Careful planning of supply and demand will be needed in order to ensure that the housing supply remains adaptable to future needs as well as to prevent overcapacity.

A large proportion of the population (roughly 90%) live in urban settlements and some 30% of these people complain about nuisance from noise and odours.

Mobility and transportation

Dutch society owns 5.7 million cars and 0.6 million trucks which means 185 road vehicles per km^2. Of the total amount of freight within the Netherlands, 98% is transported by road. Road traffic alone is responsible for 22% of the national CO_2 emission. Because of the Netherlands' favourable geographic location with respect to the European hinterland and the opening up of new markets in Eastern Europe, its role as a transit country will only increase. Projections indicate a 70% increase in road transport kilometres between 1986 and 2010. Other modes of transport (rail, inland waterways and sea) urgently deserve attention.

Land use

Urbanization, the transport network, water catchment areas and recreation will increasingly compete for the limited space available. Growing conflicts concerning land use are expected between the demands for mobility, agriculture and urbanization. The problem of allocating space is not restricted to the Netherlands itself but also has a global dimension. The Netherlands uses up to five times its own surface area in other countries for the production and import of food, livestock fodder and timber.

Another point worth mentioning is that the highly populated western areas of the Netherlands are characterized by unstable soil conditions requiring large quantities of foundation materials (sand, gravel, concrete). Although natural resources for these materials are abundant within the country, their extraction causes large-scale permanent changes in the landscape which increasingly meet opposition from society.

Energy use

Energy consumption and economic growth are closely related. For the Low Countries, the effects of CO_2 emissions on the global climate are of particular importance in view of a possible rise in sea level. In this complex global issue the Netherlands aims at increasing the efficiency of energy use with an expected stabilization of CO_2 emissions by 2020. As the country's natural gas reserves, mainly used for domestic heating, are used up in the coming decades, the energy economy will change considerably, with much effort put into the search for alternative forms of energy and a possible reappraisal of nuclear energy.

Water management

Water management is of extreme importance. Much energy and infrastructure is needed to keep the ground water table at levels acceptable both to agriculture, the built environment and recreation. As fresh water of sufficient quality to be used for irrigation and drinking water becomes scarcer, water conservation and the prevention of soil dehydration will become key issues in the coming years. Coastal and river defences in the delta area of the Netherlands will require large quantities of raw materials for strengthening in order to cope with an anticipated rise in sea level due to global warming.

2. SUSTAINABLE CONSTRUCTION, AGENDA 2010

2.1 Definition of sustainable construction

Sustainable construction must be seen as a special case of sustainable development aiming at a specific target group (i.e., the construction industry). The construction industry is defined as all parties that develop, plan, design, build, alter, or maintain the built environment and includes building material manufacturers and suppliers.

In the Brundtland report (1987), sustainable development was originally defined as: "leaving sufficient resources for future generations to have a quality of life similar to our own". Later, the Advisory Board for Research on Nature and Environment in the Netherlands described it as follows: "sustainable development implies that the environmental impacts of human activities stay well within the limits of how much environmental impact the biosphere can absorb" **(RMNO 1994)**. This introduces the notion of "environmental utilization space" which is a complex concept involving resource availability, depletion indicators, pollution indicators and insight into the resilience of the biosphere at different levels of scale. The need to make choices and the introduction of value judgements becomes inevitable, and one of the difficulties is how to allocate the environmental space amongst the various sectors of industry and the developing countries. However, the attractiveness of the concept is that it allows taking a clear normative position on global equity.

By the year 2040, the world population will have increased to between two to two and a half times its current level. With an annual economic growth of 2.5% in the industrialized countries and 3.5% in the developing ones, the pressure on the environment per unit of wealth will have to be reduced by a factor 5 so as not to exceed the level of 1990. Taking into account that natural resources and wealth should be shared equitably throughout the world, an extremely ambitious 20-fold reduction in resource consumption by the high-consuming countries is needed (Sust. Res. Manag. RMNO). Extrapolating this figure to the year 2010 means a reduction by a factor of 10 in the consumption of resources.

The official Dutch definition for sustainable construction is: "a way of building which aims at reducing (negative) health and environmental impacts caused by the construction process or by buildings or by the built environment"(**1990 NEPP+**). The following principles were adopted:

- integral life cycle management (closed cycle of raw material use, retention in the cycle through life-time extension, prevention of waste, prevention of emissions);
- reduction in energy use;
- quality improvement (materials, buildings, built environment).

In the Netherlands, long-term government policy is based on the identification of three closely interconnected sustainability variables (or key resources):

- energy (energy efficiency, controlled growth of mobility)
- mineral resources (efficient use of raw materials and water)
- land use and bio-diversity (stringent planning of land use)

Energy is essential for all economic processes. It involves two environmental aspects: the environmental impact of the use of fossil fuels (CO_2, NO_x), and the energy needed to keep nonrenewable raw materials available (extraction and recycling).

Mineral resources including **water** are used in large quantities in the built environment. Most of these resources are nonrenewable and require an efficient use combined with closed-loop recycling.

Competition for **land use** will probably become more intense in the Netherlands than in other countries with lower population densities. The availability of space which is suitable for use is rapidly diminishing. Land is needed for buildings and infrastructure, availability of natural resources (biomass, water, minerals), conservation of viable biotopes and production of renewable energy. The concept of "land use" requires the integration of environmental policy and physical planning.

Bio-diversity involves maintaining the natural growth of renewable raw materials and the conservation of the life support function of nature including the biochemical processes essential for life (decomposition, regeneration and oxygen production). Construction work has a direct impact on bio-diversity through fragmentation of natural areas and ecosystems.

Many of the long-term goals and targets set by the national government or other bodies are related to these resources. They also offer a framework for defining an operational concept of sustainable development. A **more precise definition** of sustainable construction might be: "the reduction of the use of natural resources and the conservation of the life support function of the environment by construction processes, buildings and the built environment under the premise that the quality of life be maintained"

The definition involves 3 primary key verbs: reduce, conserve and maintain. The issues involved and the principles involved are summarized in Table 1.

The boundaries of the system to which this concept applies can be defined at different levels of scale: building components, buildings, the urban network, the country as a whole, or even the global system. The higher the level, the more influence is exerted by physical planners and designers.

At the level of buildings, a sustainable building can be defined as a building that:
- consumes a minimum amount of energy and water over its life span;
- makes efficient use of raw materials (environmentally friendly materials, renewable materials, enhanced life cycle, possibility for disassembly);
- generates a minimum amount of waste and pollution over its life span (durability, recyclability);
  uses a minimum amount of land and integrates well with the natural environment;
- meets its user's needs now and in the future (flexibility, adaptability, site quality);
- creates a healthy indoor environment.

SUSTAINABLE CONSTRUCTION		
CRITERION	**RESOURCES**	**PRINCIPLES**
1 Reduce	. Use of energy sources . Use of mineral resources . Use of water resources . Use of land	Minimize depletion through: - reuse - recycling - use of renewable resources - efficient use (extended lifespan of products, energy and water efficiency, multi-functional use of land)
2 Conserve	. Natural areas . Bio-diversity	Conserve through: - prevention of toxic emissions Restore through: - remediation
3 Maintain	. Healthy indoor environment . Quality of built environment	Maintain through: - low-emission materials, (energy) efficient ventilation, compliance with occupants' needs - provision of amenities, transport, recreation, security - abatement of noise, pollution and odours Restore/improve through: - renovation, rehabilitation

Table 1 : Principles of sustainable construction in the Netherlands

2.2 Agenda 2010

In order to effect lasting large-scale changes, long-term goals and standards are set by the government. These national environmental policy targets can be used to define the issues for 2010 within the adopted scenario. However, it should be realized that these targets are still well outside the boundaries of the "environmental utilization space". Not only does the question remain in regard to how far we must reduce the pressure on the biosphere (the prognosis is for a 10-fold reduction by 2010), but also: who should be responsible for reducing this pressure taking account of the global equity principle? This touches the roots of current economic thinking in the industrialized countries, and an open question remains as to whether it is politically achievable. Therefore, the agenda 2010 is a policy target-based one and not one based on taking maximum account of the global equity principle. Agenda 2010 for the Netherlands, together with the key issues for the construction industry, are presented in the Table 2.

The main driving forces for the coming decades will be energy, mineral resources and land/water management. The general issue centres around the question: how can we do more with less (or the same amounts of) resources within a viable economic framework? The challenges for the construction industry can be summarized as follows:

Socio-economic factors

It is anticipated that concern about the pressure on the environment due to human activities will lead to full acceptance of the sustainability concept and that this concept will be fully integrated into decision-making processes. To mediate this, the government will have to adapt the tax system by integrating environmental costs. Environmental performance standards will be included in the building regulations. For the construction industry, the most important issues will be life-cycle thinking, re-engineering of the building process, and education and training (social engineering).

Energy

In a "business-as-usual" scenario, CO_2 emissions would increase by 60% by 2020. The reduction targets will still lead to an increase of 10% by 2020 and represent a compromise between economic growth and environmental impact. Agenda 2010 aims at substantially increasing energy efficiency through the increased use of renewable energy (solar and wind energy, waste/biomass burning) and by reducing mobility. The energy factor will become very important in physical planning and design processes.

Mineral resources and water

The management of material flows in the economic processes will focus on the principles of less "in" and "out" and on "retention," meaning a reduction in the use of nonrenewable raw materials in favour of renewable ones, closed-loop recycling and extending the life cycle of products. The issues for the construction industry as a whole focus on efficient designs, life cycle flexibility, and strategies to extend the service life of existing buildings. A tremendous effort will have to be put into upgrading the existing housing stock to the standards of 2010. The increasing use of fresh water for irrigation, industrial purposes and the preparation of drinking water will result in the large-scale introduction of water-saving technologies into the built environment.

Land use and bio-diversity

The struggle over land and the sustenance of bio-diversity will result in less space being available for the built environment. This will have a major effect on physical planning and use of land, and will involve issues such as long-term decision-making, multiple land use - including underground construction - and the total quality of the built environment.

Key sustainability issues	Agenda 2010 (goals)	Key issues for construction industry
1 General (socio-economic factors)	Incorporate sustainability into decision making; Environmental performance standards in building regulations.	Decision-support systems, information technology, interdisciplinary cooperation, re-engineering of building process, incentives for innovative technologies.
	Incorporate environmental costs in the tax system or in prices.	Life-cycle costing, full cost pricing.
	Full acceptance of the sustainability concept.	"Social engineering", education.
2 Energy	30% Increase in overall energy efficiency (1995 to 2020).	Embodied energy, energy use and supply, urban planning.
	Increased energy performance of buildings (23% in 2000).	Insulation, intelligent building services, alternative energy sources, maintaining healthy indoor environment.
	10% Renewable energy (2020).	Optimal use of solar energy and biomass.
	35% Reduction in mobility.	Physical planning, public transport, energy-efficient transport systems, tele-conferencing, tele-working.
	Energy taxes.	Energy-efficient production.
3 Mineral resources	Decreased use of nonrenewable raw materials (annual use of 1% of established reserves).	Lean design, durable products.
	Increased use of renewable raw materials (20%).	Use of biomass.
	Closed-loop recycling (90%).	Infrastructure for recycling/reuse, product stewardship.
	Water conservation (25% reduction in household use by 2010).	Efficient use of drinking water, prevention of water pollution.
	Extended service life of buildings; Management strategy for existing building stock.	Life-cycle flexibility, regeneration of existing building stock, sustainable design and site quality.
4 Land use and bio-diversity	Conserve open areas.	Use of third dimension, land reclamation, compact building, multi-functional use of land, right use in right place.
	Interconnected wildlife areas, buffer and compensation zones.	Physical planning of infrastructure, reconstruction.
	Conservation of ecosystems.	Emissions of building products in use, management of river systems, remediation of soil/water pollution.

Table 2 : Agenda 2010 and key issues for the construction industry

3. MAIN CHANGES EXPECTED IN THE BUILDING AND OPERATING PROCESS BY 2010

3.1 Introduction

In order to clarify the level of decision making throughout the building process, the main changes are classified according to levels of scale: Urban network and infrastructure, buildings, and materials and services. For each level, a table summarizing the main changes is presented which also indicates the process stage in which the main decisions have to be made. To make the allocation of these decisions and their interactions easier to understand, the stages of the building process and operation process are clustered into four levels:

Process level 1: Development, planning and design (decisions in this stage are highly interrelated)

Process level 2: Construction and deconstruction (mainly technical issues following the design)

Process level 3: Operation (main question: how to adapt the existing building stock to the standards set for 2010 -maintenance, refurbishment, renovation, demolition-).

Process level 4: Material supply (development of sustainable materials and components)

3.2 Urban framework and infrastructure

Urban development meets two areas of concern which cannot be separated easily: the upgrading of the existing urban fabric, and compliance with the housing needs within the current city limits. Both are faced with the problems of availability of space and transport infrastructure. At the scale of towns, the sustainability principles of conserving natural areas and maintaining the quality of the built environment are becoming increasingly important and will place the emphasis on urban and spatial planning. Strict adherence to the policy of limited urban extension reduces the possibilities of starting new developments beyond currently built areas.

As many cities are confronted by an ageing infrastructure, high noise and pollution levels, and a lack of social cohesion -factors that are all conducive to urban decline-, urban renewal projects will become increasingly important.

Land use

The rigid urban fabric puts restrictions on the amount of space available. In addition to high-rise buildings, underground construction will increase, particularly for use as shops, parking lots and transport infrastructure. This will create opportunities for redesigning the above-ground fabric and for creating new green areas. Infill within cities will be characterized by high-density building requiring special attention to the 'social' sustainability (noise pollution, security, privacy) of these compact quarters. Building densities may be as high as 60 dwelling units per hectare.

Infill should be combined with "outfill": the creation of new open spaces such as small squares, parks and playgrounds.

Compact building allows less flexibility in future planning. Some of the city districts may be designed as light constructions (not requiring heavy pile foundations) allowing easy removal, e.g., by land or water, in anticipation of future patterns for the use of space.

Much space in densely populated areas is occupied by so-called "nuisance zones" (areas around industrial complexes or highways where building is not permitted because of the high noise levels). Increasingly, these spaces will be filled by utilizing new designs in which the building façade facing the noise source functions as a sound-reducing wall.

For new developments, the original fabric and ecological structure of the site should be retained or restored as far as possible. Existing water structures are to be incorporated in the plan. The infrastructure plan will be an integral part of site development.

Construction sites in urban areas always cause minor (and sometimes major) disruptions in function. For infrastructure works, new underground drilling techniques will offer promising possibilities since they will cause no interruption to above-ground activities.

Renewal or refurbishment projects in buildings will need new construction and demolition techniques that minimize disruption of building services and reduce nuisance to occupants and surroundings.

In order to cope with existing soil pollution in cities, advanced in-situ remediation technologies are required that combine speed with efficiency.

Energy/water

Site planning should take account of the availability of local energy sources (excess heat from power plants and refuse incinerators) to be used for district heating. Water management will rely on the use of closed systems. Pavements and roofs will be designed in such a way that rainwater directly infiltrates the soil, thus safeguarding ground and surface water systems. Surface water supplied to buildings by a service pipe other than the one supplying processed drinking water can be used for toilet flushing and gardening purposes.

Looking further ahead, a future trend might be the creation of selfsufficient communities that are relatively independent of centrally provided services due to the use of renewable energy sources and on-site treatment of domestic waste combined with energy recovery. Such resource-efficient communities will help create a more stable society that is less vulnerable to interruptions in services, and even to a depletion of resources.

To reduce urban traffic, priority must be given to public transport and good connections with parking facilities at the city rim. The traffic infrastructure will be an integral part of site development in order to effect a systematic reduction in car use.

Materials

Ageing underground infrastructures such as sewage systems, ducts and cables will need repair or replacement. For the repair of these systems existing, in-situ diagnosis and repair techniques will require further development. When replacement is inevitable, new integrated systems will be used that are easily serviceable and can be repaired without interrupting the functioning of the above-ground structure.

The ever-increasing amount of urban waste and the limited possibilities for residents in a compact city to separate waste into recyclable fractions will require new building-integrated and user-friendly systems for collective waste disposal. In the near future, residential waste could be transported via underground ducts to local collection points.

3.3 Non-urban infrastructure

The demands being made on non-urban infrastructure will increase in the coming decades. The main issues involved will be the creation of environmentally-friendly modes of transport and the safeguarding of the land from flooding. Both require linear infrastructure with its inherent problem being the fragmentation of natural areas and large-scale use of raw materials. Making the maximum use of existing infrastructure to meet future needs should receive carefully consideration as a first priority.

Land use

To reduce taking up land for new transport infrastructure, information technology can be used to make optimal use of existing capacity. Efficient land use can be achieved by combining transport corridors (roads, rail, cables, ducts). Since many public and private parties will be involved in susch projects, the construction industry could take the lead by offering complete concepts for combined transport including their exploitation.

New underground drilling techniques will offer challenging opportunities for new types of underground transport infrastructure, such as the container transport of goods. The experience gained in the Netherlands with land reclamation can be used to create new land in the coastal areas for types of infrastructure incompatible with densely populated urban areas. This may involve airports, sea terminals, storage of hazardous materials, wind energy parks, etc.

Water management and materials

The management of our large river systems and sea defences requires much effort. It not only requires large quantities of sand and clay to reinforce our dikes, but much energy is also used in transporting these materials to the proper locations. A better understanding of hydrological processes may favour new concepts like building with nature, i.e., combining man-made interventions with the natural action of water. Examples include using breakwaters to enhance natural sand suppletion in coastal areas, extending the flow capacity of rivers through the selective removal of containing dikes, etc.

3.4 New buildings

In the specification and design of new buildings, three key issues will play a dominant role: land use, energy efficiency (in combination with a healthy indoor environment), and reduction in the use of raw materials and water.

Land use

Land use restrictions will promote the use of the third dimension. High-rise construction may increase, but new conflicts will arise (problems of solar shading, energy use and lack of public appreciation). It is more likely that underground construction will become popular, particularly for storage and shops. This will create possibilities for redesigning the above-ground structures for new buildings and recreation. In addition to these two options, new buildings will increasingly be built over or integrated into existing infrastructure (roads, railways). For this type of double land use, several issues relating to safety aspects, legal implications and public/private ownership will still require solving.

Creating multi-functional buildings, particularly office buildings, can reduce the problem of unoccupied buildings and prevent taking up more land for new construction.

The highly popular slanting roofs in the Netherlands may well be redesigned as flat roofs allowing rooftop space for recreation or even car parking. It is even foreseeable that buildings will be designed to be transportable to other locations in anticipation of future patterns of spatial use over time.

Energy

The energy efficiency goals can be met through improved designs incorporating the optimum use of passive and active solar energy. This may lead to innovative roof and façade designs including solar panels, passive lighting systems and translucent insulation. Insulation and recirculation ventilation will become quite critical from the point of view of maintaining a healthy indoor environment. Heat recovery systems for ventilated exhaust air will be used rather than recirculation. Electrical heat pumps will gradually replace gas-fired central heating systems, the additional advantage being that no gas supply net is required. Low-temperature heating systems (floor or wall heating) can significantly improve the energy efficiency of buildings. For larger building complexes, heat and cold storage systems in the subsoil can be applied.

The ever-increasing mobility leads to more attention to the combination of living and working. Tele-working may lead to smaller office buildings and changes in the lay-out of dwellings. Living and working may also be combined in one building situated at a favourable location.

Water

Technologies to reduce the spill of high-quality drinking water need to be integrated into the building fabric.

Materials

Efficient use of raw materials can be achieved through several means, including lightweight constructions that use a minimum of raw materials, and the use of renewable or recyclable materials. However, a more significant reduction in material use is possible by designing buildings that can be used much longer than the buildings presently in use. This requires design for flexibility, creating buildings that are adaptable to the changing needs of owners and occupants.

In order to keep the raw materials within the building cycle after buildings have reached the end of their service life, jointing and assembly should be designed to allow easy disassembly for reuse or recycling of components (reversible building process).

The increasing amount of domestic waste and the separation into recyclable fractions will require new building-integrated collection systems or the design of user-friendly communal systems for waste collection.

3.5 Management of existing building stock

At the current rate of new construction, only 15% of the building stock in 2010 will consist of buildings built after 1995. The majority will be older buildings that do not meet the standards set for 2010. In addition, demographic trends indicate that large percentages of the housing supply will have to be adapted to the needs of the elderly. This may involve splitting of dwellings, adding new services and improving horizontal and vertical access. A tremendous effort will have to be put into upgrading the existing building stock. Sustainable renovation or even reconstruction will become increasingly important. The agenda for 2010 will confront us even more with the dilemma of whether demolition and building anew, or upgrading an existing buildings, is the best solution from the point of view of sustainability.

Land use

To reduce taking up land, vertical or horizontal extensions to existing buildings will be added without affecting their support structures. This requires lightweight construction technologies, possibly incorporating passive or active solar energy systems.

Regeneration will also involve the reallocation of old utility buildings for new functions such as housing.

Energy

Building owners will be required to improve the energy efficiency of their buildings. Retrofitting of installations will become a major issue. By using new heat recovery systems, the energy use of existing buildings can be reduced by 25%. An additional energy-saving measure for old buildings without cavity walls is the application of external insulation. New installations that can be easily retrofitted into the existing building fabric need to be developed.

Materials

The environmental impact due to the conservation of building components (paints etc.) and maintenance activities is still too large. There is a need for durable coating systems which can be applied to traditional building materials.

Ultimately, one can expect that the support/infill modularity developed for new buildings can also be used when existing buildings are renovated or reconstructed, thus creating a highly flexible and adaptable building stock.

3.6 Materials, components, building services

At the level of materials, components and building services, many of the issues discussed previously for buildings are equally important. The goals set for the use of natural resources as well as current trends indicate that the building material industry needs to reconsider the environmental performance of its products. Important issues are: embodied energy, durability, low emissions in the use phase and recyclability.

Land use

To reduce further degradation of ecosystems, the emissions of products in use have to be reduced. This will mean the development of environmentally friendly coatings and pretreatment of building materials in the workshop.

Energy

The embodied energy of the products must be lowered by improving the energy efficiency of production processes and by using renewable raw materials and low-energy recycling methods. Increasing durability and technical life expectancy of building components also results in the use of less energy and raw material per unit of time.

In the fields of heating, cooling, ventilation and lighting, the energy-reduction targets offer ample opportunities for innovative products. New technologies include: heat recovery and storage systems, small-scale CHP units, electrical heat pumps, photovoltaic cells, glass fibre technology for passive lighting, translucent insulation, flexible underfloor air conditioning, advanced sensor technology, etc.

For buildings exposed to high external noise levels (e.g., near airports, highways, industry) new soundproofing materials and techniques which can be easily retrofitted to existing buildings will be required.

Water

Reduction in the use of drinking water can be achieved through the storage and utilization of rain water for sanitary, washing and gardening purposes, the cascade-use of drinking water, and the use of water-saving equipment. Many water-saving techniques are proven technologies which only need reinventing and modification for incorporation into the building fabric.

Materials

Infill components and systems should be made readily exchangeable through standardization of dimensions and connections (plug-in systems), taking into account the different life expectancies of these components. Components should be easily disassembled and repaired, bringing a halt to the "throw-away society." In this scenario, designers and building material manufacturers will have to cooperate closely in developing new concepts.

Specifiers of building materials and components will increasingly take into account the recyclability of these materials as well as the possibilities of returning products to the manufacturer at the end their useful life cycle.

URBAN FRAMEWORK AND INFRASTRUCTURE	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND	**Sustainable city**:		**Sustainable city**:	
	Optimum public transport (commuter)	1	Compact living and working infrastructure to reduce mobility	1
	On-site treatment of urban solid/liquid waste	1	Integrated physical planning of urban and rural areas, design for future value (flexibility)	1
	Control of noise and air/water/soil pollution	1,2	Create and maintain attractive and safe living quarters, individual-choice housing	1
	Conservation of cultural heritage	1	Reduce dependence on resource-intensive infrastructure	1
	Creation/conservation of green areas	1		
	Sustainable renewal:		**Sustainable renewal**:	
	Infill within cities, high density building	1	Site quality and inhabitant security	1,3
	Construction/demolition techniques which minimize interruption of functions and nuisance to occupants and surroundings	2	Integrate existing and new fabrics	
	Underground construction (infrastructure, shops, storage) and redesign of above-ground areas	1		
	Isolation/encapsulation of existing soil pollution	1,2		
	Renewal engineering for ageing urban infrastructure:		**Renewal engineering** for ageing urban infrastructure:	
	In-situ reconstruction (sewerage)	2	Safety of components and systems	2
	Accessible and adaptable multiple-use systems for underground infrastructure	1	Minimal disruption of function	1
ENERGY	**Energy management**:		**Energy management**:	
	CHP applications, district heating, heat pumps	1	Integrate town planning and energy management	1
WATER	**Drinking water management**:		**Drinking-water management**:	
	Split sewage systems	1	Public health aspects	1
	Split systems for water supply	1		
	Treatment of grey water at the source, and reuse	1		
MATERIALS	**Management of urban waste**:		**Management of urban waste**:	
	User-friendly central collection points	1,4	Develop logistics	1
	Local treatment and energy recovery	1,2	Public health aspects	1

Table 3 : Major challenges facing construction industry (Urban and infrastructure development)

Numbers indicate the process levels were decisions have to be made

NON-URBAN INFRASTRUCTURE	Challenges facing the construction industry	
RESOURCES	**Technical issues**	**Process-related issues**
LAND	**Sustainable mobility**: Optimum use of existing capacity (IT) 1 Combined transport corridors (roads, rail, cables, ducts) 1 Increased transport by waterways 1 Underground transport systems 1,2	**Sustainable mobility**: Cost benefit considerations for parties involved (public/private partnerships) 1,3 Corridor analysis (environmental impact assessment) 1
ENERGY	see mobility	
WATER	**Climate change**: Regeneration of coastal and river defences to meet future rise in sea-level 1 Constructing with nature 1,2 **River and water system management**: Water buffering systems, controlled infiltration of water, water capture areas 1 Pollution control (preventive/remedial) 2,3	**Climate change**: Understanding the basic principles 1 **River and water system management**:
MATERIALS	**Construction using the minimum of raw materials**: New technologies for river containment (dike reinforcement using a minimum of raw materials, building with nature) 2 Optimal use of recycled materials in infrastructure works (techniques to prevent water/soil pollution) 1,2	**Raw material extensive construction**: Performance criteria and functional requirements 1,2,3

Table 4 : Major challenges facing construction industry (non-urban infrastructure)

Numbers indicate the process levels were decisions have to be made

NEW BUILDINGS	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND	**Land use-efficient building** (using third dimension):		**Land use-efficient building** (using third dimension):	
	Underground construction, tunnelling techniques in soft soil	2	Legal implications of double land use	1
	Building over road/rail systems	1,2	Safety aspects	1,2,3
	Ground surface-free buildings	1,2	Cost/benefit considerations for parties involved (public/private partnerships)	1,3
	Flat roofing systems for recreational use or parking	1,2	Environmental impact assessment reports	1
	Extend service life of buildings:		**Extend service life** of buildings:	
	Design for flexibility, open building	1	Understanding needs and requirements of future users, consumer participation	1
	Durable and repairable components	1	Tools for assessment of life cycle costs	1,3
	Removable/transportable buildings	1		
ENERGY	**Energy-efficient buildings** (zero-energy buildings):		**Energy efficient buildings** (zero-energy buildings):	
	Integrated design for passive/active solar energy (roof and facade design), electrical heat pumps, subsoil energy storage and retrieval, low-temperature heating, passive lighting systems, building management systems	1,3	Integrate into building design	1
WATER	**Minimize water consumption**:		**Minimize water consumption**:	
	Cascade use of drinking water/grey water	1	Integrate into building design	1
			Health and safety aspects	1
MATERIALS	**Recyclable/reusable constructions**:		**Recyclable/reusable constructions**:	
	Design for disassembly and recyclability	1	Design and demolition process	1,2
	Prefabrication, industrialized assembly techniques	2	Life-cycle costing and flexibility	1,3
	Raw materials-efficient buildings:		**Raw materials-efficient buildings**:	
	Constructions using a minimum of raw materials, lightweight constructions, renewable materials	1	Reduction in building volume, taking into account work station rotation and tele-working (office buildings)	1

Table 5 : Major challenges facing the construction industry (development of new buildings)

Numbers indicate the process levels were decisions have to be made

EXISTING BUILDINGS	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND	Save land by **re-destination of non-functioning buildings**: Stripping and retrofit techniques	 2	Safe land by **re-destination of non-functioning buildings**: Decision support (demolition/renewal)	 1,3
ENERGY	**Upgrading energy performance of existing building stock**: Heat recovery systems External insulation	 3 3	**Upgrading energy performance of existing building stock**: Safeguarding indoor environment	 1,3
WATER				
MATERIALS	**Regeneration of existing building stock**: Refurbishment technologies (adding vertical or horizontal extensions; lightweight constructions) Integration of lightweight constructions/ components with passive and active solar energy Smart construction techniques allowing occupants to stay in the building	 2 1 2	**Regeneration of existing building stock**: Decision support (demolition/refurbishment) Set performance environmental standards for buildings that will be renovated Understanding needs and requirements of future users, consumer-oriented renovation	 1 1 1

Table 6 : Major challenges facing construction industry (management of existing buildings)

Numbers indicate the process levels were decisions have to be made

MATERIALS, COMPONENTS, BUILDING SERVICES	Challenges facing the construction industry			
RESOURCES	**Technical issues**		**Process-related issues**	
LAND				
ENERGY	**Embodied energy of products**:		**Embodied energy of products**:	
	Renewable raw materials	4	Energy-efficient production techniques	4
	Low-energy recycling	4		
	Extend service life; demountable and repairable components	4		
	Energy-efficient installations, energy-saving materials:		**Energy-efficient installations, energy-saving materials**:	
	Heat recovery, small-scale CHP units, heat recovery systems, electrical heat pumps, active solar energy	4	Integrate into building design	1
	Advanced sensor technology, building management systems, individual climate control	4		
	New passive lighting systems	4		
	High-performance insulation materials	4		
WATER	**Water-efficient installations**:		**Water-efficient installations**:	
	Water-saving equipment, reuse of water	4	Integrate into building design	1
	Rainwater catchment systems	4		
MATERIALS	**Resource-efficient products**:		**Resource-efficient products**:	
	Renewable raw materials (biomass)	4	Craddle to grave responsibility of manufacturers	4
	Closed-loop recycling	4	Exchangeability through standardized dimensions	4
	Recyclable products	4	Logistics for reuse or recycling	4
	Lightweight, non-monolithic structures	2,4	Measuring tools to predict structural service life of components and for condition assessment	1,4
	Improved performance and durability	4		
	Exchangeable components:		**Exchangeable components**:	
	Prefabrication and dry connectable components,		Exchangeability through standardized dimensions	4
	Plug-in infill systems	2,4	Develop design guidelines	1,4
	Low-emission (in use) products:		**Low-emission (in use) products**:	
	Pretreatment, advanced coating systems	2,4	Design for disassembly and repair/re-coating in the factory	4

Table 7 : Major challenges facing construction industry (Building material supply)

Numbers indicate the process levels were decisions have to be made

4. MAIN CONSEQUENCES TO THE CONSTRUCTION INDUSTRY

4.1 City planners and the built environment in 2010

Urban planning

The economical use of space is of increasing importance for purposes of town extension, industrial development and new infrastructure. In the Netherlands, the physical planning policy is aimed at preventing the further fragmentation of the countryside by suburbanization, new industrial sites, and new transport corridors. The main challenge to the physical planners will be to adapt and regenerate the built environment within the existing urban fabric and to involve environmental issues in the planning process at the earliest possible moment. This requires concerted decision-making at all levels and optimization of the management of energy, water and waste. For urban planners, this means integral thinking, optimally combining the existing and new urban fabric.

Integral decision-making must involve:
- Efficient use of land, combining underground and above-ground constructions.
- Taking into account the availability of local energy sources (excess heat from power plants and refuse incinerators) for district heating.
- Water management relying on the use of closed systems (direct infiltration of rainwater into the soil, split service lines for drinking water and grey water) and incorporating existing water structure into the city plan.
- Waste management (residential waste to be transported via underground ducts to local collection points).
- Maintaining excellent quality by creating a flexible living and working environment in order to make cities again competitive with suburban developments (offering services and recreation, accessibility and social sustainability).

Environmental impact reports now required for very large projects will in future also be required for smaller scale developments, forcing planners to look at alternatives with reduced environmental impact. These reports should address sustainability issues such as energy supply and transport needs in relation to building density, water management on the site, and the future value of the development taking into account demographic trends.

An important issue will be how to create self-sufficient communities that are, to a considerable degree, independent of centralized resource-intensive utilities through the use of renewable energy sources and energy recovery from domestic waste. Such resource-efficient communities may significantly reduce energy demand from conventional sources.

Non-urban infrastructure

To maintain environmentally friendly modes of transport and to safeguard the land from flooding, careful planning of linear infrastructure is required. This will involve making maximum use of the existing infrastructure to meet future needs. Information technology will become an important tool for optimizing the existing capacity of transport infrastructure.

The combination of roads, rail, cables, and ducts into single transport corridors reduces the amount of land taken up and offers promising possibilities for underground construction and drilling techniques. This will require careful physical planning of underground and above-ground land use.

A better understanding of hydrological processes will favour new concepts like building with nature for creating new land in coastal areas and enhancing sand suppletion to reinforce river and sea defences. Infrastructure incompatible with densely populated urban areas may well take advantage of this newly created land. This may involve airports, sea terminals, storage of hazardous materials, wind energy parks, etc.

4.2 Building and operating processes in 2010

4.2.1 The building process

Thinking in terms of life cycles, one of the key elements of sustainable construction, is, compared to other production processes, severely hampered by the fragmentation of the building process. Currently, the processes of procurement and contract negotiation in the building industry are broken down into separate entities with separate responsibilities, all of which discourage cooperation and the feeling of having a common responsibility for the end product.

Of all consumer goods, buildings have the longest service life while strategic planning does not look ahead but a fraction of that time. The initial costs of construction still play a dominant role. Risk and liability factors not only form a barrier to innovative process management but also to technological innovation.

Many of the sustainability issues ensuing from Agenda 2010 can only be effectively addressed by construction companies through re-engineering of the building process and the adoption of industrialized construction techniques. Design and build and/or Build, Operate and Transfer (BOT) contracting will not only significantly improve the construction process as a whole (reduction of project delivery time), but may also facilitate the adoption of the principles of life-cycle sustainability.

4.2.2 Initiative and design

Clients play a crucial role in the end quality of a building product. A common saying is "the quality of a building reflects the quality of the client". Adopting new sustainability concepts is often perceived as taking risks. Ways to increase awareness should be developed which lead to a better understanding of costs, benefits and risks. Thinking in terms of life cycles will be the key phrase. Design, build and operate contracts will enhance the notion of life-cycle costing and the future value of real estate.

Long service-life and the flexibility of buildings are not new ideas, but have gained renewed interest through sustainability principles. The major barrier to their application lies in our economic principles, e.g., the economic versus technical life span of buildings and the split responsibilities for initial costs and maintenance costs. A solution might be to split the write-off costs according to the individual building components or to draft lease constructions for building components with life spans shorter than that of the load-bearing structure.

A precondition for life-span flexibility is consumer orientation, i.e., understanding the changing needs of owners and occupants and beyond that, insight into future housing and work demands.

To enhance design for flexibility, a set of rules for interfacing between support and infill should be developed that takes into account the different technical life expectancies of the various components. The support system should be designed for a building's life span, and infills should be designed for easy repair and disassembly (reversible building process).

Energy-saving measures should focus on the construction components that have the longest life span and are least easily changed (e.g., the supporting construction) rather than focusing on the building installations (e.g., heating systems). Support structures must be designed in such a way that houses can be split up or enlarged, and so that utility buildings can be transformed to serve other functions. On the reverse side of the coin it can be shown that for houses to be really multi-functional, their floor space has to increase by 15% compared to current standards. To save nonrenewable raw materials, construction methods utilizing a minimum of raw materials should be developed, and renewable materials should be used as much as possible.

In view of our ever-increasing mobility, those taking initiatives need to give more attention to combining living and working. Tele-working may lead to smaller office buildings and changes in the lay-outs of dwellings.

4.2.3 Construction and decommissioning

In the traditional building process, construction companies do not have much opportunity to influence decisions involving sustainability. Since many public and private parties are involved in the construction of infrastructure works, construction companies could take the lead by offering complete concepts for combined transport facilities under build, operate and transfer (BOT) contract. It is anticipated that the larger companies will start taking this option while the smaller companies will specialize in specific market segments or special trades like renewal engineering.

Product accountability will emphasize the introduction of total quality management systems. In order to insure against environmental and other risks related to buildings, certification systems for buildings will be required in 2010.

Assembly techniques minimizing construction waste can be found in prefabrication and industrialization. Much of the construction work will be taken away from the construction site to the factory leaving the construction site as an assembly site only. Technical solutions must be found in the standardization of support systems and flexible infill technologies, including the use of durable and repairable components. Dry jointing systems for interfacing support and infill should be developed that facilitate disassembly when components have to be replaced or a building has to be demolished. By applying jointing and assembly techniques, construction companies should keep in mind that dismantling will remain feasible.

Logistics are still open to improvement, particularly with respect to return systems for packaging materials and used building materials.

The demolition process will be closely linked to the recycling process so that disassembly and separation into reusable and recyclable waste fractions will be optimized.

Renewal projects involving housing estates will require new construction and demolition techniques that minimize the interruption of functions and limit the amount of nuisance to occupants and surroundings (construction without nuisance). For the renewal of ageing underground infrastructures (sewage systems, ducts and cables), existing in-situ diagnosis and repair techniques that do not interrupt the functioning of the above-ground structure must be further improved.

In order to cope with existing soil pollution in cities, advanced in-situ remediation technologies are needed that combine speed with efficiency.

4.2.4 Operation

The widening gap between the environmental performance of the existing building stock and new buildings puts much emphasis on renewal engineering. Decision support systems will be needed for the purpose of assessing, within an economic and ecological context, the environmental benefits of decommissioning versus regeneration.

To prevent a depreciation in value resulting in a high tenant turnover or vacancy, housing corporations will have to adapt their housing estates to future requirements. This involves identifying tenants needs and demographic trends, and concerted actions on the part of government, municipalities and housing corporations to match supply and demand at the relevant scale levels.

Sustainability policies will put pressure on building owners to adapt or convert buildings rather than to demolish existing buildings that no longer fulfil their original function. Recommissioning for new functions (e.g., converting a hospital into a court house) saves land and minimizes use of raw materials. If demolition is inevitable, consideration must be given to stripping the building and leaving the support structure for incorporation into the new building.

4.3 Building material suppliers in 2010

Materials, components, building services

The goals set for the use of natural resources indicate that the building material industry must improve the environmental performance of its products. Important issues are:

- reducing the embodied energy of the products (renewable raw materials, low-energy recycling, increasing durability and technical life expectancy);
- low emissions from products in use (environmentally friendly coatings, pretreatment);
- reparability (design for disassembly and repair in the factory) and recyclability (used products to be returned to their producer; product stewardship).

In this scenario, designers and building material manufacturers will have to cooperate closely in developing new building concepts (lightweight components and new jointing and assembly techniques). Moreover, a better cooperation with related industries (e.g., plastic manufacturers, building services manufacturers) will promote the development of a new range of function integrated building components.

To assist in the selection of building materials, environmental labels will be introduced to identify such factors as expected service life, embodied energy, composition and recyclability.

The energy-reduction targets offer ample opportunities for innovative products in the fields of heating, cooling, ventilation, lighting and thermal insulation.

Soundproofing of buildings exposed to high external noise levels (e.g., locations near airports, highways, industry) will require new noise-reducing materials and techniques which can be easily retrofitted to existing buildings. Water-saving targets offer challenges for new technologies and building-integrated equipment.

4.4 Human resources and skills needed in 2010

Working conditions and ergonomics on the building site will profit from off-site prefabrication and new mechanized assembly techniques (robotics, computer-driven tower cranes). The workforce on the building site will evolve into multi-skilled (permanent) crews specialized in assembly techniques. Repair and maintenance will assume increasing importance and require other types of multi-skilled operators trained in nondestructive disassembly techniques and in the handling of both new and old materials.

Incorporating sustainability into the decision-making process requires new education curricula for architects, designers and construction engineers with the emphasis on: interdisciplinary education to overcome professional barriers, making full use of information technology for communication and for decision support, gaining insight into a building's performance over its entire life span (thinking in terms of life cycles), and developing technologies for adapting the existing building stock for future needs.

4.5 R&D themes until 2010

Although there is an increased awareness into sustainability issues, financial incentives are mostly lacking. This requires a whole new way of thinking in terms of costs and returns on investments.

Assessment tools are needed to demonstrate to decision-makers the returns on investments when sustainability principles are incorporated into the planning and design processes, and when facility life-cycle costs and the future value of buildings are taken into account. If environmental costs are truly to be incorporated in the economic system, the following issues will become increasingly important:

- conversion of environmental impacts into environmental costs (making ecological costs and benefits more transparent);
- integrated decision support systems based on monetary principles (weighing investment and exploitation cost against environmental costs).

The high (and still rising) costs of dumping or incineration of building and demolition waste in the Netherlands already show that benefits can be obtained through waste prevention over the life cycle of a building.

The building process itself is open to improvement. Research should focus on the feasibility of procurement combinations like design, build and operate contracts and their benefits in terms of reduction of life-cycle costs. Integrating the design and construction process will significantly improve productivity. Construction enterprises adopting these new production concepts will not design on a project-by-project basis but will offer a number of highly flexible building designs that are readily adaptable to specific consumer needs.

In the technical field, many R&D themes emerge. The most important are:

- Integral physical planning requires more insight into the impact of human activities on ecological systems and the conditions under which these systems can function in a sustainable way.
- Performance-based environmental standards for new and existing buildings, including measurement methods, need to be drafted and incorporated into the building codes
- Tools to make the environmental life-cycle performance of buildings measurable and certifiable need to be developed.
- Development of predictive models for the service life of construction materials and systems under real life situations.

- Underground drilling and constructing in soft soils needs to be studied to understand the dynamic behaviour of these constructions and their impact on the subsoil environment (e.g, ground water transport, soil settling)
- Renewal engineering methods involving non-destructive condition assessment, in-situ engineering and construction techniques, and procedures minimizing disruption of functions need to be developed.
- Energy-efficiency goals can be met through improved designs incorporating the optimum use of passive and active solar energy as well as heat/cold storage and recovery. Upgrading the energy performance of existing buildings requires new products that can be easily retrofitted into the building fabric (energy-efficient retrofitting).
- Research is needed to understand the phenomena of natural sand transport by sea water and river systems in order to take full advantage of 'building with nature' for land reclamation and sea and river defences.

5. STRATEGIC RECOMMENDATIONS

The main issues for sustainable construction are: efficient use of land (both above-ground and underground), efficient use of energy (an integrated approach), and efficient use of raw materials (service life, system repair and retrofit, improved quality of materials, components, and services).

In order to meet these requirements, the following strategic recommendations for the construction industry are given:

Area 1: Public and private policies

Draft measurable performance standards based on sustainability principles at the levels of both urban development and building design, and set long-term targets for a step by step approach for future development.

Incorporate sustainable building principles into the curricula of training courses for architects, designers and construction engineers, and promote interdisciplinary training in design, construction and exploitation processes.

Area 2: Management and business practices

Develop an integrated approach to sustainable life-cycle management that can be used by all stakeholders in the building process. For planners and developers, this means integrated decision-making tools and flexible responses to consumers needs. For building owners and managers, this involves tools to support decisions (in regard to the maintaining, repairing, refurbishing, and demolishing of buildings).

Project life cycle management offers construction companies the option to re-engineer their processes by offering their clients design/construct or build-operate-transfer projects.

Area 3: Design technology

New design standards should be developed for designers for the purpose of integrating sustainability aspects into their decision-making. The attention of designers should focus on the exploitation stage during functional design (long service-life and flexibility of the building during its use). Technical design should focus on the durability of components, as well as the reparability and (de) constructability components by adopting open systems and advanced jointing and assembly techniques.

Area 4 Construction

Efficient production in construction should be met by open industrialization and by making decisions (setting requirements) at different scale levels (open building). This creates a controlled process that is beneficial to sustainability in terms of better quality, less squandering of raw materials, and less building and demolition waste.

Large companies should take the lead by re-engineering their processes and by developing complete consumer-oriented (flexible) concepts that use standardized production methods that are universal applicable, independent of project type or size. A strong balance should be established between demand-side (user requirements) and supply-side (production techniques).

Small companies should specialize in market segments (e.g., renewal engineering) or specific trades (e.g., drilling techniques, assembly techniques), and should seek a competitive edge by standing out in terms of sustainable construction.

Area 5 Materials and systems

Designers, construction companies and manufacturers should co-operate in creating new designs (jointing/assembly technologies, flexible engineering and system modularity) for new building designs as well as for renewal projects. Co-operation with related industries (e.g., plastic manufacturers, electronics) should be attempted to develop new function integrated building components. Manufacturers should improve the durability, repairability and retrofit ability of their products.

6. APPENDIX : BEST PRACTICES OF SUSTAINABLE CONSTRUCTION IN THE NETHERLANDS

CONTENTS:

- **Urban planning project**
- **Office building**
- **Eco-balance dwellings**
- **Tools:**
  - **Eco-Quantum**
  - **National Package Sustainable Construction**

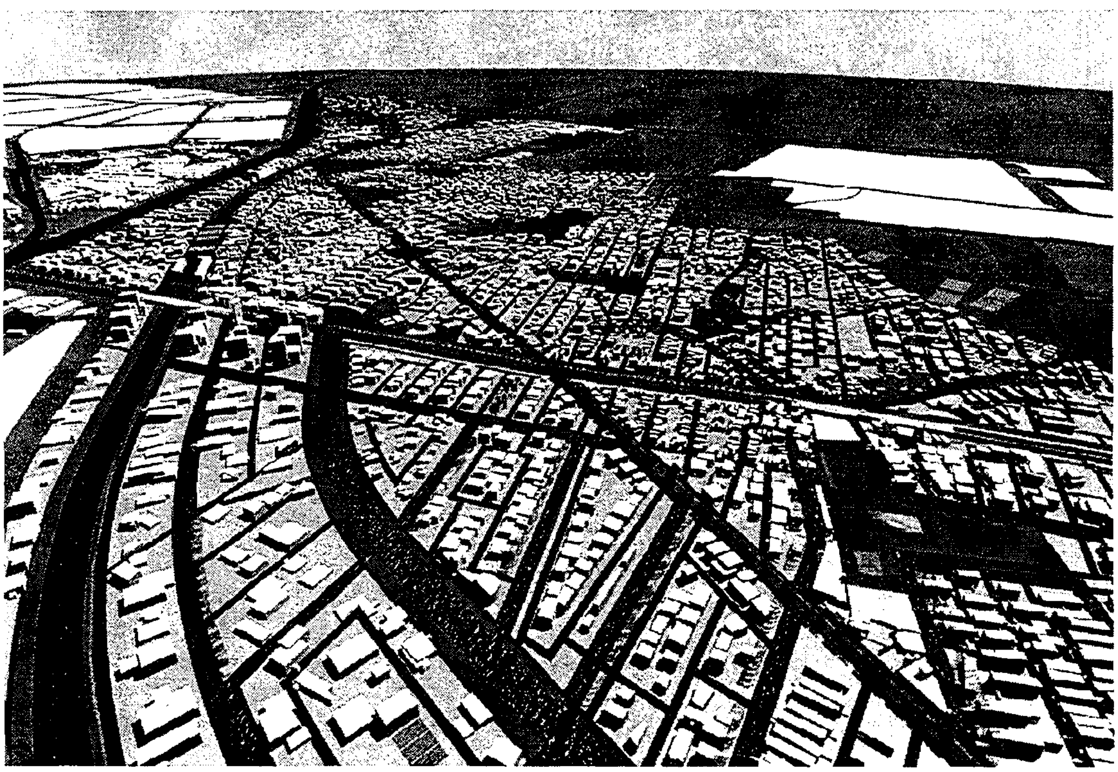
LEIDSE RIJN: development of a new medium sized town.

Description

Leidse Rijn will be a new residential district of the city of Utrecht. The area is still predominantly agricultural, but is also very diverse. The new residential development will consist of 30,000 homes, which will house about 100,000 people. In effect, it means that a medium-sized town will be created out of nothing.

Project planning

The urban planners have adopted a new approach in Leidse Rijn. The first map drawn up by Rients Dijkstra, an architect and urban planner from Rotterdam, showed all the environmental zones and sources of environmental nuisance. During the preparatory stage, the project consultant also drew up a quality map, showing all the locations which were of value to someone or other. A multidisciplinary committee then assessed all the claims, rejecting about 5%. The various members of the project team went to all the public meetings, armed with the maps. "A great deal of attention was focused on communication in the project. Listening and explaining was a very important part of the design process. The team, only two-thirds of which were local government officials, all worked together in one room, which is very unusual. Working in this way increased the range of options.



Use of land

Two international motorways pass through Leidse Rijn area, which together create a high-noise zone 17 kilometres long and 600 metres wide. At the Oude Rijn intersection, one of the largest in the country, the zone is nearly twice as wide. An essential part of the project, the bringing the motorway underground, was a result of this co-operation. It is typical of the kind of creative solutions the project hopes to generate. This is the first time in the Netherlands that motorway builders and urban planners have successfully overcome their mutual mistrust and worked closely together at the design stage. The underground motorway uses a method never used before. Because tunnel tubes are relatively light, they can be pushed upwards by the groundwater. The solution found was to leave the tube free to 'float' on the groundwater, with the result that the tunnel will require less use of raw materials and will be two and a half times cheaper than normal."
The most important effect of the underground motorway is that it brings the ideal of compact development a lot closer. It means that there will no longer be a no-man's land around the motorway, automatically cutting Leidse Rijn off from the rest of Utrecht. There will be more cycle traffic around the motorway than in the rest of the city, because the area is especially designed for it.

The space saved in Leidse Rijn by running the motorway underground can be used to build a large park in the middle of the district and an area of greenery and watercourses alongside the motorway to Amsterdam. Existing landscape features of the area and buildings already present will be preserved in the fabric of the new city plan.

Energy

The energy performance of the dwellings will be 40% better than the current legal requirements

Moreover district heating will be applied.

Transportation and mobility Another point of attention was the concurrent development of a high quality public transportation system. The transportation system will realised simultaneously with the construction of the housing blocks.

A transferium will be built between Leidse Rijn and the old city allowing motorists to switch over to public transportation. The transferium will hold parking place for 4000 cars.

Water

A 50% decrease in the consumption of high quality drinking water will be realised by using a double water supply system. One system supplying drinking water quality and one system supplying lightly treated surface water for washing, toilet flushing etcetera. The sewage system is only designed to transport domestic waste water. Rainwater is infiltrated in the groundwater or discharged in the existing waterways.

ECO-OFFICE in Bunnik

General description

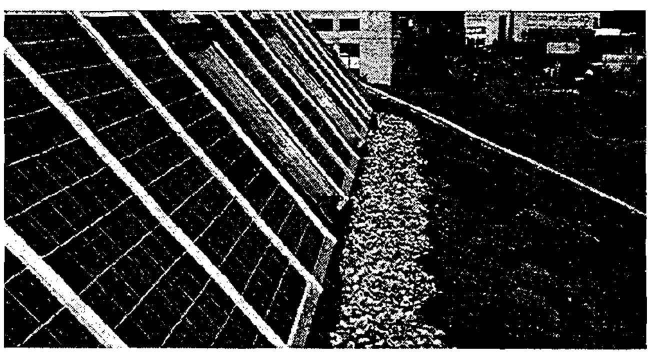
In the design of the eco-office building all the principles of sustainable construction were incorporated in a very early stage. Compared to a standard office building the eco-office use 50% less electricity, gas and water. The building was commissioned in May 1996. Building costs: 810 ECU / m2. Extra costs to incorporate sustainability principles: ± 8%.

Energy

Energy performance is 45% better compared to legal requirements. The building mass is optimised requiring no mechanical cooling during summer time. Natural ventilation is used over night to cool the building.

During winter times heat is recovered from the mechanical ventilation air.

Hot water supply relies on a solar boiler combined with 10 m2 of photo voltaic cells.



Further energy savings is accomplished by optimised use of day lighting and day light controlled energy saving fixtures.

Water

Rain water is collected on the flat roof , filtered and stored in the basement for use as toilet flushing. Any excess water is transferred to the atrium to create a small waterfall. This adds to the humidification of the indoor air.

Part of the roof construction is covered by vegetation.

Materials

As an experiment flax is used as insulation material in the north facade. Window frames are made from Oregon Pine. All drainage tubing and electricity conducts are made from poly-ethylene.

During construction, building waste was separated into five fractions. The pantries are fitted with boxes for separate collection of waste.

The parking lot is constructed with a foundation of lava stone which absorbed any oil spills from parked cars.

ECO BALANCE DWELLINGS in Nieuwland- Amersfoort

Introduction

The Eco Balance dwellings in Amersfoort have been designed to incorporate the best available technology currently available. Many measures adopted form also part of the National Package Sustainable Construction.

The main emphasis leis on energy saving and water saving (numbers refer to figure on the next page).

Energy

Thermal insulation:

- Facade: Rc = 5,0 m^2K/W
- Floors: Rc = 3,5 m^2K/W
- Roof: Rc = 5,0 m^2K/W

Glazing: U = 1,4 W/m^2K.

Glass rooms facing south (4) provide additional passive solar heating.

Photovoltaic cells (31) coupled to the mains and a solar heater for hot water supply (32) are incorporated in the roof construction. The orientation and the slope of the roof construction is optimised for solar energy collection (south orientation and slope 45°).

Vessels for storage of hot water (40) with a total capacity of 1300 litres are situated in the basement. A heat pump (42) connected to a heat exchanger in the subsoil (43) adds additional heat to the storage vessels.

Room ventilation is by means of a balanced system with heat recovery. A low temperature wall heating system (12) fed by the heat storage vessels (40) is the primary heat source during wintertime.

Water

Rain water collected in a vessel (46) in the basement is used for toilet flushing and the washing machine. The latter is of the hot-fill type. Grey waste water is stored in a vessel (41) and can be used for gardening purposes after being led through a bio-filter bed.

All water consuming equipment (toilets (51), taps (48), shower heads (47)) is specially designed for water saving.

Materials

A large raking coping (15) protects the facade. For roof and facade insulation cellulose fibres are applied. To a high extent domestic timber is used to save non-renewable raw materials. Examples are window frames (19), door frames and doors (24) floor construction of the first floor (21), stair case (26), facade cladding (27)..

The flat roof is covered by vegetation (30)

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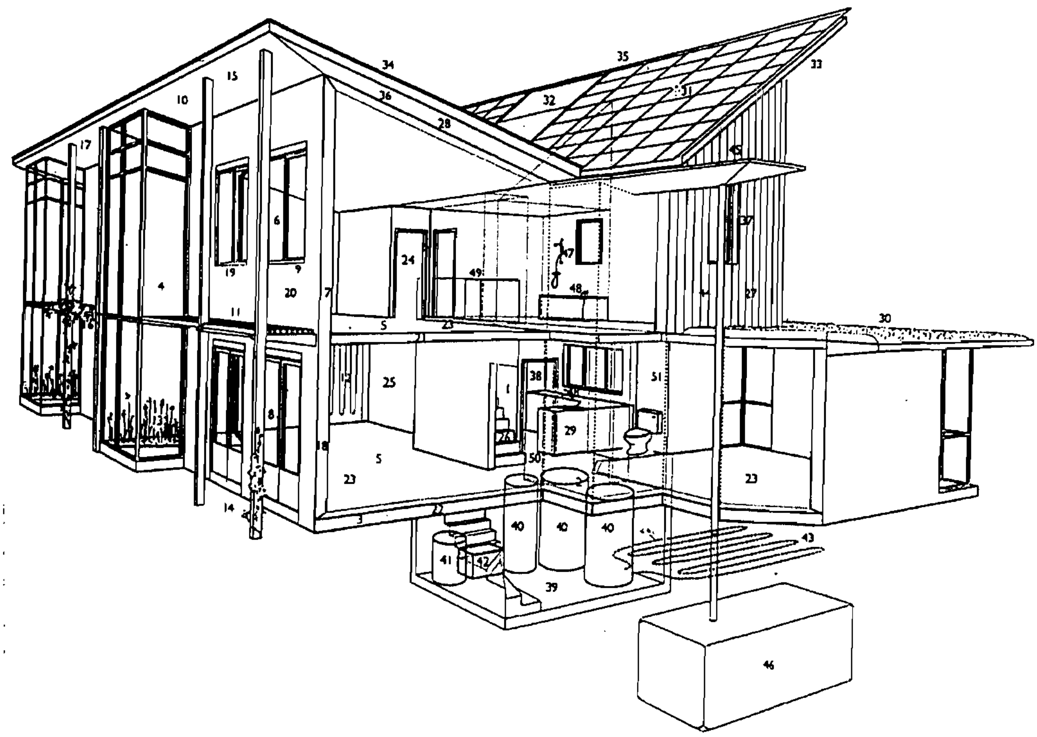


Eco-balance dwelling Nieuwland-Amersfoort

ECO-QUANTUM: DEVELOPMENT OF LCA BASED TOOLS FOR BUILDINGS

Introduction

In order to provide architects and project developers with an instrument to measure the environmental performance of buildings, the Dutch government and other organisations financed the development of Eco-Quantum (EQ). EQ is a calculating method on the basis of LCA which serves actors in the building sector with quantitative information on the environmental impact of buildings as a whole. The environmental effects during the entire life cycle of the building are taken into account: from the moment the raw materials are extracted to the final demolition or reuse. This includes the impact of the energy use, the maintenance during the use phase, the differences in the durability of parts or construction needs, like adhesives and nails. EQ also takes into account the possibility for selective demolition or renovation. The method can be used for both dwellings and non-domestic buildings.

Eco-Quantum is based on the method of life cycle assessment of products as developed by the Dutch CML (Heijungs, 1992) and the outcomes of the CCI project 'Environmental Ratings in the construction industry'.

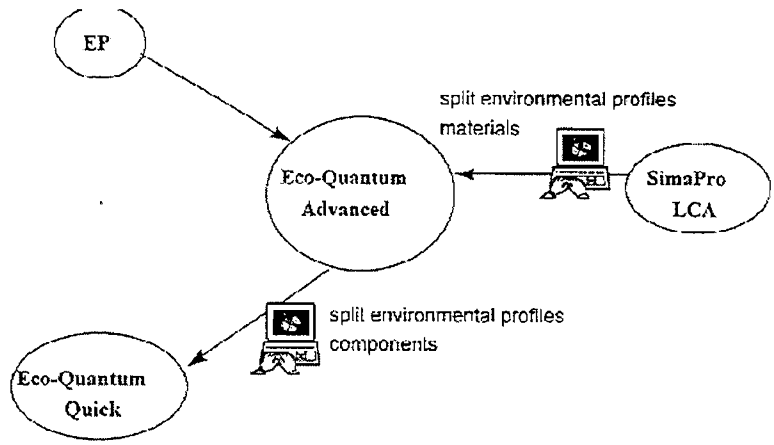
The EQ project was commissioned by the Dutch government, the Steering Committee for experiments in public Housing (SEV), The Dutch Building Research Foundation (SBR) and Stichting Milieubewustzijn. Eco-Quantum is widely accepted in The Netherlands because a steering committee, with representatives of the government, universities, consultants, industry and designers, is involved in the project.

The Eco-Quantum tools

Because of the different applications there are two customised tools: Eco-Quantum Advanced and Eco-Quantum Quick. EQ-quick is a tool for designers, with this instrument they are able to include environmental consequences of designing and of materials in their designs of dwellings and non-domestic buildings.

A customer can use EQ-quick to set (environmental) performances at the start of the design process, and to assess the design at the end of the process. Meanwhile the designer can use EQ-quick as a quick scan to determine the environmental correctness of his design. During the design process EQ-quick can be used to communicate on sustainable designing and building, for example between the customer and the designer as a means for evaluation of alternatives

EQ-advanced will be used by building consultants, (environmental) researchers and large design offices to analyse their building concepts and to reduce the environmental impact of their designs.



The tools EQ-quick and EQ-advanced can be used separately, although they are connected (see figure). EQ-advanced generates indicators for EQ-quick. These indicators are made up to date regularly.

The Dutch Energy Performance standard (EP) is applied to determine the energy consumption during the phase of use of the buildings. In The Netherlands it is obliged to measure the energy performance of a building, otherwise one doesn't receive a building permit. Because of this the data for energy use are available for every building, these are imported in both EQ-advanced and EQ-quick.

In these programmes the environmental effects caused by the production of various energy sources is calculated and added to the rest of the environmental impact of the building. The LCA programme SimaPro is applied to generate and automatically supply the environmental information of processes related to building materials, energy and transportation. Concerning building materials the environmental profile is calculated for the phases of production, use, waste treatment and recycling per kg of each building materials. These environmental profiles are automatically transferred to EQ-advanced

In EQ-advanced design data are translated into material and energy flows. Therefor Eco-Quantum comprises an extensive database *Components* which consists of materialised components of the building, with information about the life span, materials needed and maintenance. The environmental information from SimaPro is connected to the components information. Various outputs can be presented. In order to make a practical instrument EQ-advanced supplies EQ-quick with environmental profiles of various components and with other building information. The information is automatically transferred to EQ quick. The most important difference with EQ advanced is that the user of EQ-quick can adapt much less parameters. He can only adapt the parameters, which he can influence by his design. This makes the input easy and protects the user from not realistic output. The input is on the other hand made extra easy by offering, if possible, defaults and choice options.

How the tool works

The most important user group, the designers, makes a number of great demands on EQ-quick. If the instrument does not meet these demands, it won't be used in the designing process. An important demand is that the input and the output has to follow the language of the user. The next demand is that the input has to be simple. Only information should be asked which is available to the user at that moment. To obtain the input of EQ-quick, the designer hardly has to make extra effort. The data have to be collected already for the calculation of the costs.

The most important designing decisions are made in the first phases of the designing process. The problem is that the necessary information is only available in the 'Specification-stage' and at the end of the 'Final design-stage'. Namely in these design stages the entire materialisation of the building takes place. For that reason EQ-quick has more levels. By working with defaults and aggregated data it is possible to obtain results in an early phase of designing, without knowing all details of the design.

The user of EQ-quick can influence the results by varying the life span, the shape of the building, the installation concepts (energy, water) and the choice and life span of the building components. It is also possible to choose per component a more profitable waste scenario. The obligated (minimal) input consists of building sizes, energy use during the use phase (this is the result of an EP measurement) and the choice of the sizes of the components.

EQ-advanced uses the databases of SimaPro: environmental profiles per kg material. EQ-quick contains a database with data which are even more aggregated, namely the environmental profiles per unit component, which are generated with EQ-advanced. This database is also updated when changes occur in EQ-advanced and SimaPro. By this the consistency between the different instruments is guaranteed.

Developments

In Europe there is an urgent need for tools and methods which assess the environmental impacts of buildings and building materials and indicate the environmental profit of improvement options. Companies, designers, producers and clients need a common environmental language to provide each other with environmental information. While there has been no uniform and easy accessible tool and method to provide this information, building actors disagreed on the environmental performance of building and building components.

In the future it is expected that more building actors can use the 'communal environmental language Eco-Quantum'. Producers and suppliers of building products, can use EQ-advanced to determine :

i) the impact of their building products, ii) the contribution to the total environmental burden of a whole building and iii) to implement environmental improvements.

Government policy makers can use EQ-advanced to establish quantitative targets for the environmental performance of buildings, like is done with energy performance standards.

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NATIONAL PACKAGE FOR SUSTAINABLE BUILDING

More and more, sustainable building is becoming a normal part of the building process. We have made great progress in our knowledge of sustainable design methods, constructions and materials. More and more public authorities and commercial enterprises now have experience of sustainable building.

This state of the art was compiled in a national package for sustainable building drawn up by the building industry. It is aimed mainly at the residential market. The State Secretary for Housing, Spatial Planning and the Environment has added a recommendation that should give substance to the principle of sustainable building in 1996.

Why this package?

The initiative for the national package for sustainable building came from the building industry association NVOB. The organisation had noticed that there was growing confusion about the measures required for sustainable building. A product or measure that might be called 'sustainable' in one instance, would be regarded as unsustainable in another. The NVOB concluded that one uniform package was needed to put an end to all the confusion. A building research organisation, Stichting Bouwresearch, was asked to identify all the different packages in use throughout the country, and create one standard package. A wide range of organisations in the building industry have helped in the production of this package.

The following organisations were involved in drawing up the national package for sustainable building:

- The Federation of Dutch Contractors' Organisations (AVBB)
- The Association of Netherlands Architects (BNA)
- The National Housing Council (INWR)
- The Dutch Christian Institute of Housing (NCIV)
- The Dutch Federation of Building Constructors (NVOB)
- The Dutch Association of Builders & Developers (NVB)
- The Dutch Association of Construction Industry Suppliers (NVTB)
- The Association of Dutch Consulting Engineers (ONRI)
- The Real Estate Council of the Netherlands (ROZ)
- Stichting Bouwresearch
- The Steering Group on Experiments in Housing (SEV)
- The Union of Dutch Local Authorities (VNG)
- VGBouw

The national package for sustainable building consists of some 160 voluntary measures. The involvement of many trade associations and the clear nature of the package mean that it should become standard for everyone. Sustainable building is therefore also to be incorporated in the Housing Act. Those who decide to work with the national package now will therefore have an advantage in terms of experience and know-how when the measures become mandatory.

How to use the package

The national package for sustainable building is used for a wide variety of purposes. For example:

- a municipal approach to sustainable building. When planning new housing projects, all the partners involved can agree that the national package should apply to all plans;
- programme of requirements for new housing plans. A principal may incorporate the measures from the national package in his programme of requirements;
- marketing. A principal can design a house and use the national package to arouse the interests of potential tenants and buyers;
- advice during the building process. Architects and advisers can advise their clients of the environmental aspects of certain design options, using the national package.

High-quality package

Many leading trade associations and umbrella organisations were closely involved in drawing up the national package, and they therefore fully endorse its contents. This broad support means that those who use the package can rest assured that the measures meet a number of important conditions:

- they are perfectly suited for application on a large scale;
- they match traditional methods in terms of quality;
- they have a definite positive environmental impact;
- they are not too expensive, and can therefore be used in all sectors of the housing market, including the subsidised sector.

Structure

The national package deals with all phases of the building process- It contains 160 measures, arranged according to the phase and environmental theme they relate to. Some of the measures concern the immediate living environment (such as the choice of paving), but the main concern is the home itself. The measures are divided into fixed and flexible measures.

Fixed measures can be adopted as standard, irrespective of the specific nature of the project. Just how the flexible measures can be put into practice will have to be decided on a project by project basis, depending on the preferences of those involved, the availability of the materials and the type of location.

Sustainable building in 2000

Our knowledge of sustainable building is developing apace. Manufacturers regularly launch new sustainable products onto the market. Legislation and regulations relating to building and the environment are also being amended.

Life-cycle analyses constantly provide us with more information about the environmental aspects of building materials, so the national package will be updated once a year. Any changes will be decided in consultation between Stichting Bouwresearch, the trade associations and the Ministry of Housing, Spatial Planning and the Environment. Measures will also be added in the near future for the renovation and maintenance of the existing housing stock.

'An acceptable extra investment'

Stichting Bouwresearch has also worked out the costs associated with the measures. On the basis of these costs, the State Secretary for Housing, Spatial Planning and the Environment concluded that ,most of the measures can be applied with an extra investment of 1.500 ECU'. He has therefore made the following recommendations:

- apply all the fixed measures- The extra costs associated with this lie between 750 ECU and 1.000 ECU;
- apply all further measures that cost no extra or lead to investment savings;
- choose from the remaining measures a package that is tailored to the specific features of the project, so that the total extra investment is 1.500 ECU.

With this small investment it should be possible to build a sustainable home. The State Secretary plans to use the package and further recommendations in future arrangements with partners concerning the locations designated under present Dutch spatial planning policy, and in the Ministry's other activities.

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REPORT 10

SUSTAINABLE DEVELOPMENT AND FUTURE OF CONSTRUCTION IN ROMANIA

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION

1.1 Romania. General data

The National Commission of Statistics [1] issues data on Romania. The following extracts describe the main features and characteristics of the country:

- Romania is situated in the south-eastern part of Central Europe and on the lower Danube, bordering the Black Sea.
- Its access to the sea enables the connections with the countries in the Black Sea basin, in the Mediterranean basin, and therefore with all the countries in the world. The Danube-Black Sea canal favours connections with the North of Europe.
- The main features of Romania's relief are its proportionality (31% mountains, 36% hills and plateaus, 33% plains and meadows), a concentric display in amphitheatre form of the major relief forms.
- With a total surface area of 238,391 km^2, Romania ranks the 11th in Europe. Its population amounting to 22.7 million is over 2.5 times lower than the population of France, Italy or the United Kingdom and about 2.5 times higher than the population of Portugal or Sweden.
- The average density is about 96 inhabitants/km^2, and the extremes recorded by the administrative units are 31.5 and 184.9 inhabitants/km^2, respectively.
- The running waters have a radial display, most of them having their sources in the Carpathians, being finally collected by the Danube, which flows along 1,075 km of the Romanian territory.
- In the mountain areas there are numerous glacial lakes and recently, anthropic lakes used for exploiting the hydropower potential of the rivers.
- Romania is located in a strongly seismic zone particularly in the southern, southeastern part. Other natural factors with a high-risk level are: floods, hail storms, drought, landslides, soil erosion and others.
- The subsoil, although rich in important natural resources, cannot however meet (with few exceptions), the needs of the national economy. Among these we may list: oil with old traditions in its extraction, natural gas, coal, especially coke coal, lignite and brown coal; iron and non-ferrous ore; gold, silver and bauxite deposits; large salt reserves and other non-metalliferous sources. A special category of resources is represented by the more than 2,000 mineral water springs, for consuming and medical treatment purposes.

1.2 Bench mark concepts

Although the thinking trend oriented towards sustainable development became distinct at the beginning of the 70's, the concept in itself is considered to belong to the 90's when it was adopted at world scale as a supreme objective for the development of the society. Romania openly received the message at the theoretical level, and adapted its actions in the spirit of this concept but within the limits imposed by its specific conditions.

The reviewed literature used the following notions and definitions as points of reference:

> *"Sustainable development is that type of development which meets the present needs, without endangering the capacity of the future generations to meet their own needs"*
> *(cf. Brundtland Report, 1987).*

> *"Sustainable environment means to leave the world in a condition that will allow future inhabitants to enjoy the quality of life we have experienced"*
> *(cf. Charles Kibert, USA, 1994).*

> *"Sustainable development of constructions means the responsible design of a healthy built environment, based on a resources efficient use and ecological principles that can be responsibly created, managed, maintained and dismantled".*
> *(cf. CIB-W82 Proceedings, Ascot, 1995).*

Notes:

- The selected resources are: land, energy, water and building materials
- The established ecological principles are:
  (1) Minimize resource consumption (Conserve);

  (2) Maximize resource re-use (Re- use);

  (3) Use renewable or recyclable resources (Renew/Recycle);

  (4) Protect the natural environment (Protect);

  (5) Create a healthy non-toxic environment (Non-toxic);

  (6) Pursue excellent quality in creating the built environment (Quality).

> *"Built environment represents the type which includes all the lands occupied by the houses roads, mines, quarry and other facilities together with the additional surfaces of intended use for human activities. Are included also, some types of open spaces which are closely related to these activities such as waste storage, vacant land, city parks, gardens etc."*
> *(cf. UN-HABITAT, Global Report on Human Settlements. Statistical annex, 1995)*

> *"Urban sustainable development is a process leading to changing in the built environment which will favour the economic development while preserving resources and saving human, community and ecosystem integrity.»*
> *(cf. Luc Bourdeau: Sustainable Development and Future of Construction French National Report.)*

2. SUSTAINABLE DEVELOPMENT (SD) APPROACH. SOME PECULIARITIES

2.1 Classification related aspects

The classification used in Romanian for the concept of "sustainable development" was the word-by-word translation of the French "dèveloppement durable".

This interpretation does not accurately convey the meaning of the English expression [2]; "sustainable" which suggests the idea of "constant", permanent", "continuous", while in Romanian "sustainable" is translated by "durable" or "lasting". The concept of durable constructions might completely change the vision on the intended objectives, laying stress on their resistance in time and for this reason the expression "sustainable development of constructions " is preferred.

For accurately expressing into Romanian the essence of this concept, other attributes can be used such as: ""equitable", "balanced", "prudent", however, the variant "viable development" has been increasingly used, which appears to provide a comprehensive meaning similar to the English expression.

At present, specialists currently use both forms, "viable development" having a complementary role against the variant "durable development".

2.2 Meaning related aspects

The scientific community in Romania was highly receptive to the sustainable development principles, mainly due to the trend created by the works of some well-known specialists, such as N. Georgescu-Roegen. In one of his works published in 1971 [3] he maintained that "the basis of life is an enthropic process" and that "in Universe there is a continuous and irrevocable qualitative deterioration of free energy into processed energy" and "the entropy of a system generally increases faster in the presence of life rather than its absence".

The broadest meaning of the sustainable development concept is given by the definition included in the Brundtland Report which represents a reference definition. However, to be useful it should be adapted to the reality for each country, taking into account the different basic conditions such as resources, economic development, quality of life, pollution and the condition of the environment.

The situation in Romania against which “sustainable development of constructions” and/or “sustainable development” can be described is as follows:

- Resource levels are low and poorly managed. The additional resources and improved management (including environmental protection measures) result in significant expense but do not provide direct and immediate economic benefit. By using resources on environmental and sustainable issues measures in other fields are not possible. In this respect, demands exceed by far the present possibilities of the Romanian economy.

- Restructuring of the Romanian economy is a welcome process, which corresponds to the current shifting trends at cultural level, i.e.. the prevalence of development processes against the growth ones.

Unfortunately, the efforts made by the entire Romanian society, (both the political class and particularly the population) cannot be found in the usual statistics, especially in the comparisons made at international level. The introduction of some data relating to the gap covered, to the speed of structural changes, to the weight of own efforts in achieving some major objectives, etc., would represent a measure for stimulating the degree of participation and for attenuating the feeling of being left apart.

Life quality is unsatisfactory in relation to the national and European standards determining a priority orientation towards achieving European living standards.

In fact, at European level it is already recognized that the developed countries may envisage "the maintenance or improvement of life quality together with the diminution of resource consumption" as objectives of sustainable development (SD) while the less developed countries will focus on "the improvement of life quality without an exaggerated increase of resources consumption" [4] or "the "increase of the average material consumption" [5].

After almost 50 years of a totalitarian regime, the Romanian society is now undergoing a difficult period characterized by structural changes in all areas (economic, political, legal, administrative, cultural, etc.). This process, desired by the entire community incurred high social costs, which have to be supported by the present generations, in spite of their previous frustrations.

Under these circumstances, the process of establishing the SD objectives is highly delicate, as it should not introduce restrictions above the tolerable limit of the population.

The adjustment of society to the SD principles requires serious cultural shifting. Some components, such as mentality are characterized by a considerable inertia. This cultural shifting in Romania requires a long time and the phenomenon is even more difficult if the individuals are particularly influenced by distorted or extreme ideologies.

Thus, it is difficult to identify what unanimously accepted means could lead to the moderation of the tendency towards "more", when in the highly developed countries this notion represented the idea of prosperity while in the ex-socialist countries it represented privilege and in-equality.

Also, the stimulation of activities such as recycling, re-utilization and recovery may face resistance in those environments where they used to be considered as a sign of poverty.

Finally, moderate consumption, so that resources "should also be available to the next generations" is not easily accepted by those whose minimally necessary needs can hardly be satisfied.

Communication is considered as a prerequisite for creating the conditions necessary to achieve SD. There are alarming signs in Romania that this capability is lacking and substantial barriers exist at all levels of functionality. Such signals are [6]:

- At decision making level: lack of correlation between the sectoral strategies and the assessment of their feasibility;
- With reference to the legal framework: lack of a consistent activity to ensure feedback by drawing attention to those situations incompatible with the old regulations or with the concrete implementation conditions.
- In relation to research: poor connections with the final user and difficulties in providing the primary data;
- With reference to professions: insufficient collaboration between specialists (engineers, architects, economists, sociologists, etc.)
- With reference to generations: a certain lack of trust in the capacity of the current adult generations to create something new after having been educated within an obsolete system, to which a certain arrogance of the "clean" generations is added

3. PREMISES FOR CONSTRUCTIONS SUSTAINABLE DEVELOPMENT (CSD) IN ROMANIA

In order to realistically assess the CSD chances in Romania, it is first necessary to analyze the existing situation of the entire society, pointing out both its strengths and its weaknesses, in accordance with some data issued by National Commission for Statistics [1], Romanian Government [7], and Ministry of Environment Protection [8].

3.1 Non-renewable resources

These resources were exploited and processed by means of technologies that heavily polluted some zones of the country. The fossil fuels (coal, crude oil) account for 50% of methane emissions, 97% of sulphur dioxide emissions, 88% of nitrogen emissions, 50% of carbon emissions. Mining as well as the metallurgic industry contribute to the pollution of the environment with heavy metals, deposited and suspended powders and other specific pollutants such as formaldehyde, sulphide hydrogen, carbon sulphur, chlorine, chlorides, etc. The loss of useful substances due to pollution reduces further the reserves which are already limited:

- ◊ 75 - 100 years for coal
- ◊ 20 - 30 years for crude oil
- ◊ 7 - 20 years for iron, manganese, gold, silver, polimetalliferous, non ferrous, bauxite ores
- ◊ 20 years for uranium, etc.

The resources of non-renewable materials are below the needs of the national economy, and therefore imports of such materials are common place.

3.2 Renewable resources

As far as the available **water** resources are concerned, Romania ranks the 16th in Europe. Water consumption has decreased during the last years in industry and agriculture as a result of the diminution of such activities but consumption in the home has increased.

The average consumption per capita as well as the specific consumption in industry and agriculture is higher than in other countries, especially due to the high losses in the supply and distribution networks, to the waste and inefficient technologies that are used.

For example, 40-50%, of water is lost or wasted in Bucharest, the irrigation systems use 40-50% of the quantity of water pumped into them, while many populated centres are facing a severe water shortage.

35% of the hydropower potential is used although it is common knowledge that hydroelectric energy is the least polluting and potentially the cheapest to exploit. The mineral water reserves are exploited only in 40% ratio.

The water resources are limited but they are exploited in a wasteful manner with high power consumption.

The land comprises 62% agricultural land, 28% forests, 3.7% water and 4.3% constructions, roads, railways.

In relation to 1989, a diminution of the agricultural land can be noticed, being characterized by a diminution of the arable land and of the orchards, and an increase of pastures and vineyards.

The non-productive land, which includes all the surfaces covered with constructions, has increased to a large extent.

The surface affected by drought represents over 45% of the agricultural land, while the surfaces affected by acidity represent approximately 15% and those affected by salt saturation represent approximately 3%.

The productivity of the agricultural surfaces is diminished by 20-30% due to factors such as: erosion, acidification, decrease of nutritive elements, salt saturation, but especially by chemical pollution with pesticides, heavy metals, fluorides, petroleum, etc.

The agricultural production has also diminished due to the conditions occurring after land privatization, i.e. fragmentation of lots (about 2 hectares/owner), reduction of mechanized labour (only 10% of the works are mechanized), old age of the labour force (the age of most of the household owners is around 62).

Romania's flora includes over 3500 plant species, of which 1150 are grouped in the Danube Delta ecosystem. About 12% of the flora species are vulnerable or in peril of becoming extinguished. The fauna consists of over 33,800 species of which 23 of the vertebrates are in peril in becoming extinguished.

The forests mainly consist of broad-leaved trees (almost 70%) mostly covering the mountain areas (over 50%). Over 1/3 of the regions in Romania are poorly afforested.

The protected areas which include reservations, national parks or natural monuments cover a surface representing almost 5% of the national territory. Special importance is given to the Danube Delta reservation which represents over 50% of these protected areas in Romania.

3.3 Economy

Commencing from 1989, Romania's economy has been undergoing a structural reform which has influenced its entire evolution during the last 8 years.

Prior to 1989, the economy was characterized by: quasi-totality of state ownership; excessive centralization of the decision-making process; rigid planning according to ideological criteria; forced, excessive and energy intensive industrialization.

The governments democratically elected after 1990 adopted, as part of their reform programme, the pattern of gradual measures and slow changes. During this stage measures were mainly taken for abolishing the hyper-centralized economy, for opening the privatization process, social security, encouraging foreign investments.

After the November 1996 elections, Romania's Government, with assistance from international organizations (World Bank and IMF) adopted the "shock therapy" model, which results in a higher rhythm of change and a greater proportion of society affected by change. This has resulted in significant social costs. The main objective of this new stage is the restructuring of the large companies with majority state owned capital by their privatization or dissolution.

The main indicators at a macro level have evolved under the influence of the reform programme and of the limitation of the markets meant for export operations.

The phenomena associated with these processes, among which the energetic and raw materials crisis, diminution of investments, the discontinuities in agriculture further to application of the Land law, the financial blockages, the severe diminution of the export operations and the increase of import operations, etc., lead to the deterioration of the economic situation during the first transition years.

Thus, the industrial output decreased by 54% in 1992 against 1989, while the GDP had a negative trend until 1993, the year when a fragile macroeconomic stabilization occurred.

At the end of 1995 and the beginning of 1996, the following results were recorded:

- GDP increased in real terms by 6.9% against 1994, the construction industry having a significant contribution to it;
- The private sector contributed about 45% to GDP as compared to only 16% in 1990. The agricultural output was over 80% ensured by the private sector.
- The unemployment rate has decreased to 8.9% in 1995 and 6.3% in 1996.
- In 1995 the monthly average rate of inflation reached the lowest level since 1991 (2.1%) with an increasing tendency during 1996 (3.8%).
- The consumer price indices have constantly increased and in 1995 they represented 11.614 (11 thousand, six hundred and fourteen)against 1990 = 100.
    - ◊ Sale of food represents over 1/3 of the retail sales
    - ◊ Commercial services to the population have increased being with over 40% provided by the private sector
    - ◊ The gross fixed capital formation has had an ascending evolution and in 1995 it recorded an 11.7% increase against 1990. The increased weight of this index in GDP (21.8% in 1995 against 19.8% in 1990) was determined by the continuous intensification of the investment efforts, particularly by the mixed and private sector.
- The average nominal salary (May 1996) was about $ 125. Of the total number of employees, 58% had salary incomes below the average.

The results of the last year were below expectations:

- the annual inflation rate exceeded 130%;
- the unemployment rate constantly increased (7.7% in June 1997);
- the weight of the private sector in GDP decreased as a consequence of the dissolution of many SMEs;
- the deficit of the commercial balance increased due to the decrease in exports.

3.4 Construction sector

During the last eight years, the construction sector counted as one of the most dynamic and flexible areas of economic activity which is in line with the new requirements of the society, has faced some constraints caused by the process of structural reform.

The state of this sector is outlined by data published by the National Commission for Statistics, Ministry of Finance and Building Economics Problems Review, as follows :

- The share of GDP for the construction sector has increased consistently, although not spectacularly, until 1996 when it reached nearly 7%.
- Over 90% of the economic agents which operate in the construction sector are private capital firms and also more than 98% of them are small and medium size enterprises which cover over a half of the total turnover.

- The labour force of the sector represents only 4.5% of the population, having an average gross income a little bit over the average income on the national level which is still very low in comparison with the other European countries.
- The value of the construction work has generally increased, now largely carried out (over 70% in 1996) , by the private sector.
- The dominant type of construction continues to be civil engineering projects(over 50%), followed by non-residential buildings. Road and hydrotechnical projects are the most common civil engineering works and office buildings, industrial buildings and commercial buildings are the most common in the non-residential buildings sector.
- The number of residential buildings completed between 1994 and 1996 decreased, although the high proportion in the rural areas has permanently increased, reaching about 66% in 1996. Also, 86% of the respective dwellings were secured by private funds.
- The most important share of the market (over 80%) is in new construction work & capital repairs, the share for maintenance & current repairs is well below current needs.
- The quantity of cement produced in 1996 year constituted only 2/5 of the production capacity of existing cement producers, however it covered the internal consumption needs and provided an important quota for the export.
- Between 1990 and 1997, construction prices have increased more than 650 times, the highest increases being as a result of increased railway transport fees, followed by the building materials costs and labour costs.
- As a proportion of estimates for construction work buildings materials constitute about 40% of the cost, labour amounts to about 25% and transport about 11%.

3.5 Human settlements, equipment and life quality

This data is taken from the National Commission of Statistics sources [9], [10].

The human settlements in Romania have the following structure:

- ◊ 262 cities of which 81 are municipalities
- ◊ 2 687 communes which include about 13,000 villages

Actually, the urban environment , which represents only 2% of the number of localities, represents less than 1.5% of the entire occupied land and includes almost 55% of the population.

The ratio between the housing stock existing in 1995 and the number of households was 1/1. Of these, over 90% were privately owned, the most widespread type being the 2-room apartments.

As far as the structure and degree of comfort are concerned, the existing building stock continues to have a relatively low level compared to most of the European countries. Thus:

- dwellings formed by individual buildings account for 50% while dwellings situated in apartment buildings represent almost 2/5 of the total housing stock;
- the housing stock is characterized by a high degree of wear and tear with over 25% of the dwellings being situated in buildings with a life expectancy of less than 10 years;
- 45% of the dwellings are made of resistant materials (reinforced concrete, precast concrete, bricks) while a quarter are situated in individual buildings the walls of which are made from non-resistant materials;
- the average living floor area per capita increased to 11.8 sq.m. per capita, but the number of the families who live in inadequate conditions (two persons over the number of rooms) is still high (over a quarter);
- there is a large share of dwellings which are considered inadequate with: 450,000 being earthquake damaged dwellings; about 275 thousand are apartments with a low degree of comfort and facilities; another several hundreds of thousands of dwellings are considered "sick" affected by condensation and mould; and about 3 million apartments are in need of repair work mainly sanitary installations and the improvement of thermal insulation and finishing.

With reference to the supply of electrical power, almost all the dwellings in the urban zone and over 90% of the rural zones had such facilities;

The drinking water supply is not provided for about 1/10 of the dwellings and in the rural zone this network is extended over a small area

The sewerage system covers most of the urban localities and only 2.6% of the rural ones. However, less than half of the respective localities have water treatment plants.

Heating for dwellings in the urban environment is provided by district heating plants or thermal power stations which feed central heating systems. Individual heating with stoves (gas, wood, liquid fuel) is common for quite a large number of dwellings causing significant pollutant quantities.

Upgraded roads (with lasting coatings of ashlar stone, concrete, bitumen) from municipalities and cities, represent 58.5% of the total road length.

The average surface of green spaces is about 17 sq.m. per capita.

Urban passenger transport is mainly provided by buses which represent almost 60% of the public vehicle stock, while 23% is represented by trams and about 10% is represented by trolley busses. Generally, a decrease in the number of passengers using public road transportation has been recorded,

The state of health for the population is first of all reflected by the average life expectancy which is one of the lowest in Europe: 66.5 years for men and 73.1 years for women.

The national population increase has become negative due to the birth rate diminution. Although infant mortality has decreased, it is still high, while health care services are very low in number (one physician for 543 individuals).

The education system in 1995/1996 had as main features the followings :

- The school age population encompassed within the national education system (preschool, first degree, secondary and high education) accounted for 21% of the total population).
- The official statistics of the same period showed that an important part of the total school age population (over 1/3) was left beyond this education system.
- The higher education network, which is structured as public and private sector beginning with 1990, covered about 336 000 students, which means about 148 students per 10 000 inhabitants (out of which about 25% in higher private education sector).

The number of students specializing in the technical field is decreasing (1/3 against 2/3 in 1989), while the number of students specializing in economics and law as well as those in exact sciences is increasing (1/4 against 1/10).

The cultural real estate stock includes 1000 historical monuments, some of them being thousands of years old. Churches of various religions, cathedrals, fortresses, palaces, castles and statues all belong to this category with some of them under UNESCO protection (the monasteries in the north - eastern part of the country).

Regional disparities are common and, in compliance with the level of the Global Development Index [11], two under-developed zones of poverty were identified in the north-east and the south of the country.

As far as urban land is concerned, the following characteristics can be noted [12]:

- Several factors influence developments in Romania. Typically there are extensive conversions of agricultural land into urban use.
- The urban land markets represent a sector undergoing a very dynamic structuring process; the supply has rapidly grown especially due to the further application of the Land Law while the demand has exceeded the supply, especially for dwellings, services, trade, transport, etc.
- As a problem of the transition period, the market prices of the real estates are often below the value corresponding to the land development degree. In some areas, especially the central part of the major cities such as Bucharest, the land share in the total price (land + building) might represent over 50%. The use of prices under the real value, underestimate the community efforts to provide the major infrastructure works.

3.6 Global environmental quality

In Romania, the environmental quality is affected by the negative impact of some economic activities, the improper exploitation of some natural resources, an urban infrastructure which does not correspond to the development of human settlements, as well as cross-border pollution. This situation is described by the statistics provided by the National Commission of Statistics [1].

Air quality estimated as the quantity of pollutants emitted in the atmosphere in relation to the number of inhabitants, is in many cases quantitatively lower than the average of the EU countries (sulphur oxide, nitrogen oxides, carbon monoxide, carbon dioxide).
Within the pollutants emissions, the greatest share is held by: sulphur oxides from thermal-power plants (70%); nitrogen oxides from thermal-power plants and road transport (60-65%); carbon monoxide from combustion processes in industry (80%), carbon dioxide from thermal power plants and industrial installations; methane from zootechnical farms, extraction and distribution of fossil fuels (75-80%).

Water quality, although having improved since 1990, continues to be affected. It is considered that about 10% of the length of watercourses have deteriorated in quality. Underground water supplies are also facing problems, such as the relatively high nitrogen and pesticides level in some rural zones.

The **soil quality** has been adversely affected by natural and anthropic processes and phenomena. In 1995, the surface affected in this way amounted to 11 million ha of agricultural land consisting of about 7 million ha arable land and about 4 million ha forestry.

The **forest quality** has been affected by biological causes. More dramatically however, forests have been adversely affected by inadequate administrative policies which have allowed higher levels of exploitation than the forests can naturally support and also by the pollution caused by industrial activities.
The advanced defoliating percentage, especially in the case of broad-leaved trees reached 40-45% in some more affected zones, the oak being the most affected.
Globally, the forests are undergoing an accelerated deterioration process, but forests in European countries cause greatest concern.

Waste has become a major concern in the policies adopted after 1989.
The present situation is characterized as follows:

- The largest share is industrial waste representing 97% of the 305 million tons (approx. 1995 figures);
- The percentage recovered of metallic wastes, glass, wood, paper, textiles, plastics ranged between 82 and 99%. Oil wastes represent the lowest recovery percentage.
- Domestic wastes are produced in a quantity of about 0.69 kg/capita/day.
- Inadequate storage of both industrial and domestic wastes represent the main problem in relation to wastes administration.

The environment protection expenses have significantly increased during the last years, exceeding 1% of the GDP since 1995.

4. MAIN CONSEQUENCES OF THE PRESENT STATE OF THE ART ON THE DEVELOPMENT DIRECTIONS

Under the current circumstances, sustainable development for the Romanian society actually means development that should ensure the assimilation of all the present moral values, the improvement of life, quality for all the social groups and the responsible utilization of natural resources.

Consequently, each sector shall subject its development directions to the above mentioned global objectives, as results from some Romanian Government documents [13].
For example:

- For **primary energy resources**:
  - ◊ Re-engineering, upgrading and development of the hydrocarbons exploitation systems;
  - ◊ Compensation of the crude oil and gas shortage by the improvement of the recovery technologies and by the development of new exploitable resources particularly offshore (Black Sea);
  - ◊ Rehabilitation and upgrading of the national transport networks that should ensure the avoidance of losses, safety in exploitation and reduction of environmental pollution.
- For **transport**:
  - ◊ Repair and rehabilitation of the existing infrastructure network (roads, motor ways, ports, airports, etc.)
  - ◊ Modernization of the transport networks in compliance with the European standards related to safety, fluency, and comfort;
  - ◊ Development of the river, land, air transport networks together with environmental protection measures.
- For **communications**:
  - ◊ Modernization and extension of the urban and long-distance communication network;
  - ◊ Modernization and extension of the radio and TV network;
  - ◊ Modernization of mail service.
- With reference to **land**:
  - ◊ Stopping the decline in the productive capacity of agricultural land by reactivating the existing equipment (mainly irrigation);
  - ◊ Stimulation of land development by the involvement of land owners;
  - ◊ Restraining the utilization of land for purposes other than agriculture requiring justification for social and economic purposes;

- With reference to **water resources**:
  - ◊ Diminishing the gap between the available resources and demands;
  - ◊ Satisfying the drinking water demand of the population, and the needs for irrigation and industry;

  - ◊ Prevention and control of flooding by building embankments and aligning water courses. Also ensuring the use of monitoring equipment;
  - ◊ Water pollution prevention and control;
- In relation to **housing**:
  - ◊ Improving the quality of existing dwellings by rehabilitation, particularly, strengthening works, thermal insulation, and finishing works;
  - ◊ Improvement of living conditions by increasing the useful area per capita;
  - ◊ Increasing the number of social housing stock;
  - ◊ Increasing the access level of the disadvantaged categories (youth, unemployed).
- With reference to **education**:
  - ◊ Improvement of the existing base at all education levels;
  - ◊ Providing the necessary space for the development of the school programme according to nationally approved standards (26 students for a classroom in primary school and 30 students for a classroom in secondary school);
  - ◊ Restructuring of the technical and vocational education systems.
- In relation to **health**:
  - ◊ Removal of obsolete and worn out equipment and adequate equipping of the health care network;
  - ◊ Improvement of the cost/efficiency ratio specific to health care services;
  - ◊ Development of emergency health care services;
  - ◊ Development of health care services in the rural areas.
- For **culture**:
  - ◊ Development of the works for the restoration and conservation of the existing cultural heritage;
  - ◊ Repair and modernization of existing cultural units;
  - ◊ Development of existing networks in both urban and rural environments;
- For **industry**:
  - ◊ Continuation of the restructuring process so that this sector may provide the necessary conditions for economic recovery and for the improvement in quality of life;
  - ◊ Supporting those fields which have the real capacity for contributing to the fulfilment of the mentioned objectives, such as: the industries that can ensure comparative benefits and the development of export operations, i.e. food industry, wood processing, textiles, glassware, ceramics, and building materials; the industries that can provide the infrastructure programmes.

In essence, almost all of the development directions formulated so far relate to works belonging to the construction industry field (rehabilitation, renovations, modernization, strengthening, new constructions, etc.)

Theoretically, this would mean that this sector could significantly develop both in volume and in speed of delivery.

However, in reality, the estimates of investment necessary to bring this about exceed the capacity of the construction sector as well as other internal funding possibilities.

Thus, according to some estimates, the necessary investments for priority interventions until 2004 represents 11 times the 1996 budget.

5. ACTIONS FOCUSING ON SUSTAINABLE DEVELOPMENT IN ROMANIA

A sustainable development strategy as such does not exist either at the level of the entire society or at any sectoral level. However, its' principles and objectives are explicitly and to a larger extent, implicitly, conveyed in some of the already developed strategies (over 30), in the structure and content of the legislative system and in the medium and long-term research programmes.

5.1 Strategies and programmes

The National Strategy for Romania's joining the European Union envisages among other things:

- Elaboration of some national development strategies converging with the European policy for environment and life quality protection and improvement. Romania's participation in the co-operation focused on solving the ecological problems at regional or trans-European level.
- Modernization of the Romanian education and professional training system; harmonization of the education methods and study programmes applied in Romania with those of the EU member countries;
- Promotion, fostering relations and intensification of co-operation in the field of culture, audio-visual, information and communications for asserting the Romanian cultural patrimony at European level and for involving Romania in the cultural pan-European dialogue.

Within the Restructuring and Reform Strategy of the Ministry of Public Works, Regional Planning and Urban Development (1994/1995) as well as in the Sector Strategy for Romania's accession to the European Union (1995/1996) the following major objectives are stated for 2004:

- Providing the conditions for the fulfilment of the envisaged investments programme together with the creation of the general framework to favour quality and effectiveness in a competitive system;
- Improving the life conditions in localities by promoting a housing policy, as well as a policy for the development of infrastructure and urban services, and the protection of the built environment.

The Plan for the National Territory Development (PATN) which formulates development plans at regional level but with a global concept and broad vision states that the priority fields are:

- major transport infrastructure
- rational management of water and soil resources

- safeguarding of the natural and built environment
- development of localities in relation to their economic-social and cultural historical importance
- development of special zones (with a specific economic, cultural and touristic potential; disadvantaged zones from a geographical, social and economic viewpoint; zones with the potential connection to the EU space)

During 1991-1995 the studies that were used for substantiating the necessary legislation in the respective fields were drawn up.

The Environment Protection Strategy developed by the Ministry of Water, Forestry and Environment Protection (MAPPM) provides the major means and ways for meeting the proposed objectives, among which:

- Legislation relating to wastes, noxious and harmful substances, industrial hazards, pollutants emission, etc.
- Improvement of environmental factors affected by acid rain;
- Re-utilization of wastes discharged through gases and water in a 10-15% ratio by the year 2000.
- Reconditioning of land used for solid wastes storage;
- Storage of domestic solid wastes under controlled conditions;
- Increase of the forestry stock by about 200,000 ha by the year 2000;
- Conservation of the historical monuments at least in a 30% ratio by the year 2000; etc.

Numerous actions included in the Environment Protection Strategy are happening or in development. Some programmes are using their own funds whilst others use international financial assistance (World Bank, EU, EBRD, USAID, G-24 and others).

The National Agency for Environment Protection has been in operation for several years, having subsidiaries in almost all of the counties in Romania. These agencies provide the National Statistics Commission with the necessary data for characterising environmental factors in Romania.

Also, there are about 70 non-governmental, non-profit organizations operating in Romania, which represent a real ecological movement.

5.2 The legal system

During the last years, significant efforts have been made for adapting the legislative system to the principles of democracy, to the demands of the market economy and to the European norms related to life style and environment protection exigencies.

Among the most important laws in force are the following: Constitution of Romania (1991); Land Law (1991); Law for authorizing the constructions erection (1991); Law on local taxes (1994); Law for the prevention of unfair competition (1991); Law on foreign investments (1995); Law on commercial companies privatization (1991); Law on securities and stock exchanges (1994); Law on expropriation for public utility reason (1994); Law on quality in construction (1995); Environment Protection Law (1995); Housing Law (1996); Law on cadaster and real estate publicity (1996); Law on general regulations for urban development (1996); Law on public finance (1991); Law on banking activities (1991); Law on free zones (1992), etc.

In the process of development are: Law on regional planning and urban development; Law on real estate; Law on historical monuments and sites; Law on Forestry and others.

5.3 Research-development programs

The restructuring process during the last few years has had a severe and sometimes dramatic effect on this sector (diminution of funds and of R&D staff, poor equipping, difficulties in accessing documentation, etc.). In spite of these effects, the medium and long-term research programmes reflect an orientation towards the major demands of society. Thus, the main topics refer to:

5.3.1 Construction

- Establishing and adjusting policies related to restructuring and economic re-launching
- Improvement of the legislative framework and of the technical regulations
- Harmonization of regulations to European exigencies
- Improving construction quality
- Improving the construction process and construction technologies
- Efficient use of resources
- Improving the companies' operating conditions in the market economy system

5.3.2 Regional planning and urban development

- Development of specific strategies and substantiation of recommended policies
- Improvement of assistance tools for urban management at the level of local administration
- Organization of the urban land markets and rational utilization of the land
- Solutions for the rehabilitation of the rural space and the diminution of regional disparities
- Studies related to the means and methods for improving life conditions in the urban and rural localities
- Knowledge transfer

5.3.3 Energy

- Clean technologies for energy generation
- Environmental protection by the prevention and control of polluting emissions

- Increased effectiveness throughout the energy supply chain
- Renewable energy sources
- Modern management systems
- Promotion of technologies for predictive and preventative maintenance of equipment and power units

5.3.4 Environment

- Environmental quality and climatic changes
- Analysis of the synthetic and industrial products life cycle
- Environmental protection, rehabilitation and re-construction technologies
- Waste treatment and recovery
- Human dimension of environmental changes
- Environmental pollution impact on the cultural heritage
- Environmental economics

Commencing from 1996, research has been carried out within URBANPROIECT focusing on the consequences of sustainable development on construction, a project that is supported by the Ministry of Research and Technology. The main results envisaged are:

- the identification of the specific features of sustainable development;
- identification of some indicators (method) for the assessment of the SD degree or of its reverse – unsustainability of the built environment;
- some recommendations on the strategy for the sector regarding sustainable development;

At present, the Method for the Assessment of the Sustainability Alteration Degree (MEGAD) is being validated, while the recommendations and possible scenarios are re-programmed for the end of 1998.

6. OPINIONS ON PERSPECTIVES OF THE CONSTRUCTION SUSTAINABLE DEVELOPMENT IN ROMANIA

6.1 Some findings of an inquiry

At the beginning of 1996 URBANPROIECT organized an inquiry by launching over 600 questionnaires addressed to the following categories: children, students, employees, (in research, design, education, manufacturing, local and central administration).

The response rate was of about 70%, the <u>main characteristics</u> of the respondents being:

- <u>average age</u> around 36 years;

- over half of the respondents were high school and university students; within the specialists group, the greatest share was held by administrative staff (49%), followed by executive staff (25%), research-design (17%) and higher education;
- as professions, engineers held the greatest share, followed by architects and university staff;

The main purposes of the inquiries were:
- assessment of the way in which the concept of constructions sustainable development was perceived
- opinions of specialists (active or in the process of training) with reference to the future of constructions;
- identification of the main obstacles in the application of the SD principles.

The most significant results of this inquiry can be summarized as follows:

6.1.1 Sustainable development denomination and definition

The term "sustainable" is considered to be suggestive and acceptable by most of the subjects. Other suggestions, in the order of the votes cast were: balanced, continuous, controlled, moderate, viable. It is interesting that the attribute "viable" ranks the last, although it is the alternative with the most frequent utilization in the Romanian literature after "durable".

The definition of Constructions Sustainable Development introduced by the CIB-W82 Commission is considered as being suitably accurate and satisfactory by most of the respondents, although a significant number of the high school students consider it to be difficult and unclear.

Of the suggestions and proposals that were advanced we can mention:
- Definitions:
    - ◊ "The idea of a healthy built environment, based on the effective use of resources and in compliance with ecological principles, in order to achieve, exploit and maintain at a minimum total cost and to responsibly restructure the built environment on the basis of the same exigencies."
    - ◊ "An environment built in such a way as to harmoniously integrate in the natural environment within its acceptance limits".
- Ideas to be included:
    - ◊ humanization of the built space
    - ◊ the continuous, long-term meeting of essential human needs
    - ◊ flexible (adaptable) built environment
    - ◊ controlled development during and after utilization
    - ◊ utilization and re-adaptation of the built environment to the new needs
    - ◊ efficient, careful and intelligent use of resources
    - ◊ the morality component
    - ◊ influence of culture on built environment.

6.1.2 The future of construction in Romania

- With reference to the **types of construction** the following predictions prevailed:
  - ◊ in the future - buildings will be built with greater density and longer life span;
  - ◊ as types of activities - although there will be an increase in renovation and rehabilitation activities it is expected that new construction will prevail;
  - ◊ as to construction categories - although infrastructure works will prevail there will be a more rapid development of dwellings, commercial buildings and institutional buildings for services supply
- With reference to **design and construction process**
  - ◊ the demands for improved quality, increased environmental protection and improved response time (duration of designing process) will have a major influence;
  - ◊ a greater use of life cycle analysis will be required with solutions needing to be substantiated;
  - ◊ most of the responses indicated that the following issues should be addressed as a matter of urgency in the construction process: lower exploitation costs, harmonization with the environment, alternative lighting/heating solutions, wastes management, utilization of local materials and technologies, low consumption of non-renewable natural resources.
- With reference to **building materials**:
  - ◊ it is estimated that structures will continue to comprise of masonry and monolithic concrete, which means an increase in the consumption of bricks, light-weight concrete and concrete;
  - ◊ higher levels of utilization for cement, marble, asbestos, steel, aluminium, bitumen and wood are forecast.
- With reference to **skills and regulations**:
  - ◊ the role of urban planners, sociologists, IT specialists, architects, geographers and ecologists are expected to increase and expand over the next 10 years;
  - ◊ the following changes in the education system are predicted: curricula structure, trainers' training, post-graduate courses.
  - ◊ the following categories of regulations (standards) are considered to be urgent in the future: environment protection, building materials quality, urban ecology, built and natural environment rehabilitation.
- With reference to **human settlements**:
  - ◊ most of the responses were pessimistic, with the increase of population density and increase in pollution considered possible;
  - ◊ as far as life quality was concerned, divergent opinions were expressed, a significant part predicting a deterioration and an enhancement of discrepancies, while others expected the settlements to be cleaner and "greener".

6.1.3 Predictable obstacles in the implementation of sustainable development

The majority of the responses indicated that the principles of CSD had a good chance of being implemented providing they were adapted to reflect the priorities of the Romanian society.

For example:
- to build in a healthy and qualitative manner
- to avoid waste
- to ecologically rehabilitate the built and natural environment
- to use the existing stock in full awareness

The responses indicated the following possible obstacles in approaching CSD:
- poor performance of the economy
- impoverishment of the population
- state of the built environment
- absence of specific regulations
- poor political will
- state of natural environment
- lack of communication
- mentality inertia
- remote benefits

6.2 Comments on possible scenarios

Four types of scenarios formulated by the Dutch specialists [15] were used as reference:

1) Strong Together
2) Strong Alone
3) Considered Sustainment
4) Weak Sustainment

The compatibility of the four alternatives is dependent on several criteria considered as relevant, namely:
- the will and possibility to act;
- the state of capital categories envisaged (environment capital, manufactured capital, human capital and social capital) and the relations between them.

The will of the Romanian society, from the bottom to the top, to converge with the standards practised in the developed countries is indisputable. From this viewpoint, the principles of the Strong Together scenario could be adopted due to the interest in the protection of some specific ecosystems such as the Danube Delta and the Black Sea coast. Some other situations, such as the pollution of the upstream Danube would also justify the promotion of this scenario.
The restrictions imposed by such a policy relate to the effort required to bring it about

and, which currently, far exceeds the available economic resources to which also severe social problems may be added (unemployment, segregation, low purchase power). Due to these reasons the Strong Alone scenario does not seem to be adequate either.

The Considered Sustainment scenario is closer to our specific conditions as there are real concerns for environmentally related technological solutions, i.e. the diminution of pressures upon the environment. This direction also results from the international commitments undertaken by Romania.
On the other hand, the state continues to play its role of assuring minimum health care and education conditions.
The incompatibility is caused by the priority to restructure the Romanian economy and the entire Romanian society. This causes a rapid alternation of capital within the intervention priorities.

The Weak Sustainment scenario seems to be satisfactory from several viewpoints (stress laid on the increase of productivity, the increase of incomes, less ambitious objectives, the not very severe state of environment). However, some incompatibilities emerge when the market, which is now in the process of consolidation in our country, gains a basic position. Also, the prevalence of material values over the spiritual ones may be disputed.

7. CONCLUSIONS AND RECOMMENDATIONS

The Romanian society is open to assimilate the SD concept both in practice and in theory.

During the last years, remarkable efforts have been made for a fundamental restructuring at political, economic, social, legal, administrative, etc. level, which in itself is a movement in the spirit of sustainable development. The macro-economic indicators, which are now being used in international comparisons, fail to take into consideration these efforts, which are a disadvantage and even an injustice for the transition countries.

The existing strategies represent a valuable starting point for converging with the SD exigencies, but they still contain some unrealistic predictions and are not correlated. Moreover, the formulated strategies are not usually followed by the necessary actions, i.e. development of programmes, budgets, and responsibilities.

This observation wishes to support the idea of formulating a sustainable development strategy at national and sector level, which should start from an evaluation of the priorities and the existing exploitation of the SD principles.

Improved quality of life has become an absolute priority objective. Improvements in the quality of life presupposes a number of investments, which in the end represent high consumption of resources, greater pressures upon the environment, an increase in the risk of pollution, etc. For this reason, such measures cannot be conceived or implemented unless complementary actions are provided in order to reduce or mitigate the predicted negative impact.

The present state of the Romanian economy does not favour the establishment of very ambitious objectives in relation to CSD, in spite of the construction sector being among the most dynamic ones and with relatively good prospects.

The mentality burden represents a high inertia factor which may delay the society's evolution towards SD; the action of this factor may be corrected by training and knowledge transfer both among the specialists in the country and partnerships abroad. These factors require special attention because their effects do not emerge in the short term.

Communication is also a prerequisite for the new concept to succeed. If the common language is accepted as an essential means for its implementation, then there are arguments in favour of a multilingual glossary of SDC.

Also, a collection of worldwide practised methods for the assessment of construction sustainability will be beneficial.

* * *

The following were selected as examples of SDC concept implementation in Romania:

1) Rehabilitation of dwellings in a low quality apartment block

2) New technologies for the water treatment plant

3) Introducing public transport by trolley bus

4) Protection, conservation, and development of the historic heritage area

5) Delimitation of the protected areas for monuments of outstanding national heritage value

These examples are presented in a separate volume. Examples n°1 and 4 are presented in Appendix 1.

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9. APPENDIX 1: BEST PRACTICE

REHABILITATION OF DWELLINGS IN A LOW QUALITY APARTMENT-BLOCK - TARGOVISTE

Design company: PROIECT DAMBOVITA Plc. - 18, Poet Alexandrescu, Targoviste, Tel. 045 / 61 21 38

Author: Arch. Ion REGMAN

Beneficiary: CORINT Plc.

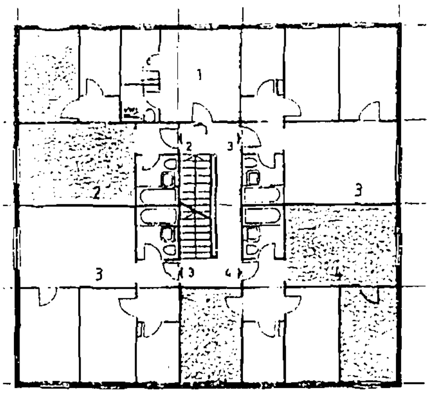
The chosen example is the block of flats no. 13 on 3, Dumitru Oprescu street, quarter VI (a residential area consisting of multifamily structures, mainly 4 storey high) in the city of Targoviste, whose population is approximately of 100,000 inhabitants. The structure of the block consists of diaphragms of reinforced concrete. It was built in 1968. Between 1965-1975 in Targoviste some 2,200 low quality apartments were built, by Decree of Government. Between 1985-1986, 125 of these apartments have been rehabilitated, including those in the chosen example.

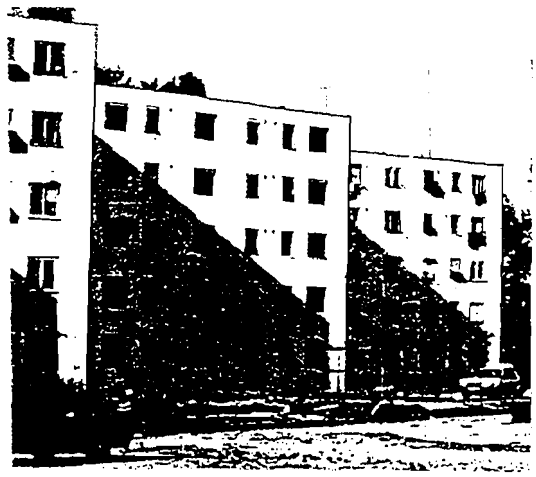
The dwellings belonged to the private domain of the state and were rented out. The 25 apartments in this block consisted of 5 one-room apartments, 5 two-rooms apartments, 11 three-rooms apartments, 4 four-room apartments, all being of the lowest level of quality IV. This level of quality was characterised by:

- very small living and usable area ($8m^2$ bedrooms, $4m^2$ kitchens);
- no room for storage and no balcony;
- no separate access to bedrooms in all types of apartments;
- finishing of poor quality (materials and workmanship);
- aggressive, impersonal volumetry;
- poor thermal insulation, generating condensation;

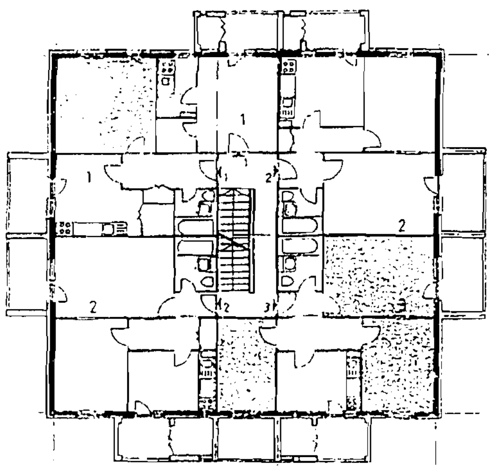
The main objectives of the intervention were to improve living comfort and the exterior out-look. By reorganising the existing space, the number of apartments was maintained, but their structure has been altered. The result consists of 10 one-room apartments, 11 two-rooms apartments, 4 three-rooms apartments, all being more comfortable. In order to improve the comfort of housing, the following works were performed:

- new interior division in order to create larger bedrooms and kitchens;
- new, higher quality interior finishing, consisting of parquet-floors, mosaic-floors, plastering, walls-veneering, faience;
- new interior carpentry;
- balconies - some including closed room for storage;
- covering of the exterior walls with a 15 cm thick wall of cellular expanded concrete, in order to improve thermal insulation;
- rehabilitation and development of the infrastructure (water, sewerage, heating, electricity);
- roof-framing covered with ceramic tiles;
- creating a clean basement with thermally insulated and ventilated storage-rooms





BEFORE AND AFTER THE INTERVENTION

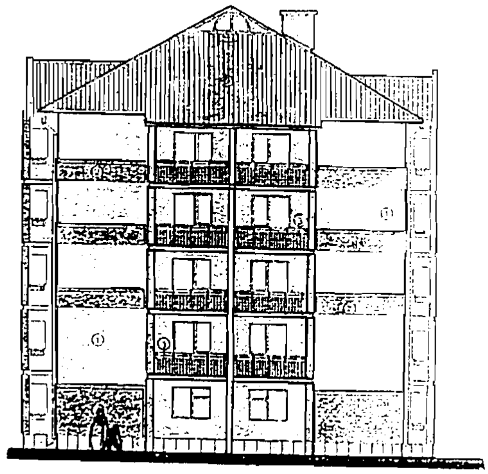


The following aspects about the dwelling's comfort have been improved:

- the living and usable area grew with approximately 25-30% for the bedrooms and 25% for the kitchens;
- the thermal insulation was improved;
- the quality of finishing was improved;
- the building infrastructure was up-dated (water, sewerage, heating, electricity);
- new storage spaces were created in the basement and storage-rooms with access from the balcony;
- the exterior out-look has been improved with superior finishing (terrasit and plating bricks), the volumetry receiving personality with the presence of balconies and hip roofs

The costs of the rehabilitation account only for 45% of the cost of a new similar construction.

After the intervention, the apartments were privatised by selling them to physical persons.



The operation did not only improve the comfort of the apartments, but also the quality of the urban framework of the residential area.

The achieved rehabilitation of the apartment-block is part of an operation that was focused on 5 blocks of flats. The result consisted of 125 apartments with improved quality.

Starting from this example, the Prefect's Office of the County of Dambovita initiated a similar project in 1990, whose development was supported by the local councils in Targoviste and other smaller localities like Titu and Pucioasa. This program is now in progress and shall be extended to the whole low quality housing stock.

PROTECTION, CONSERVATION AND DEVELOPMENT OF THE HISTORIC HERITAGE AREA OF THE CITY OF SIGHISOARA

Integrated Study for specific urban planning projects and for the structuring of the urban renewal operations

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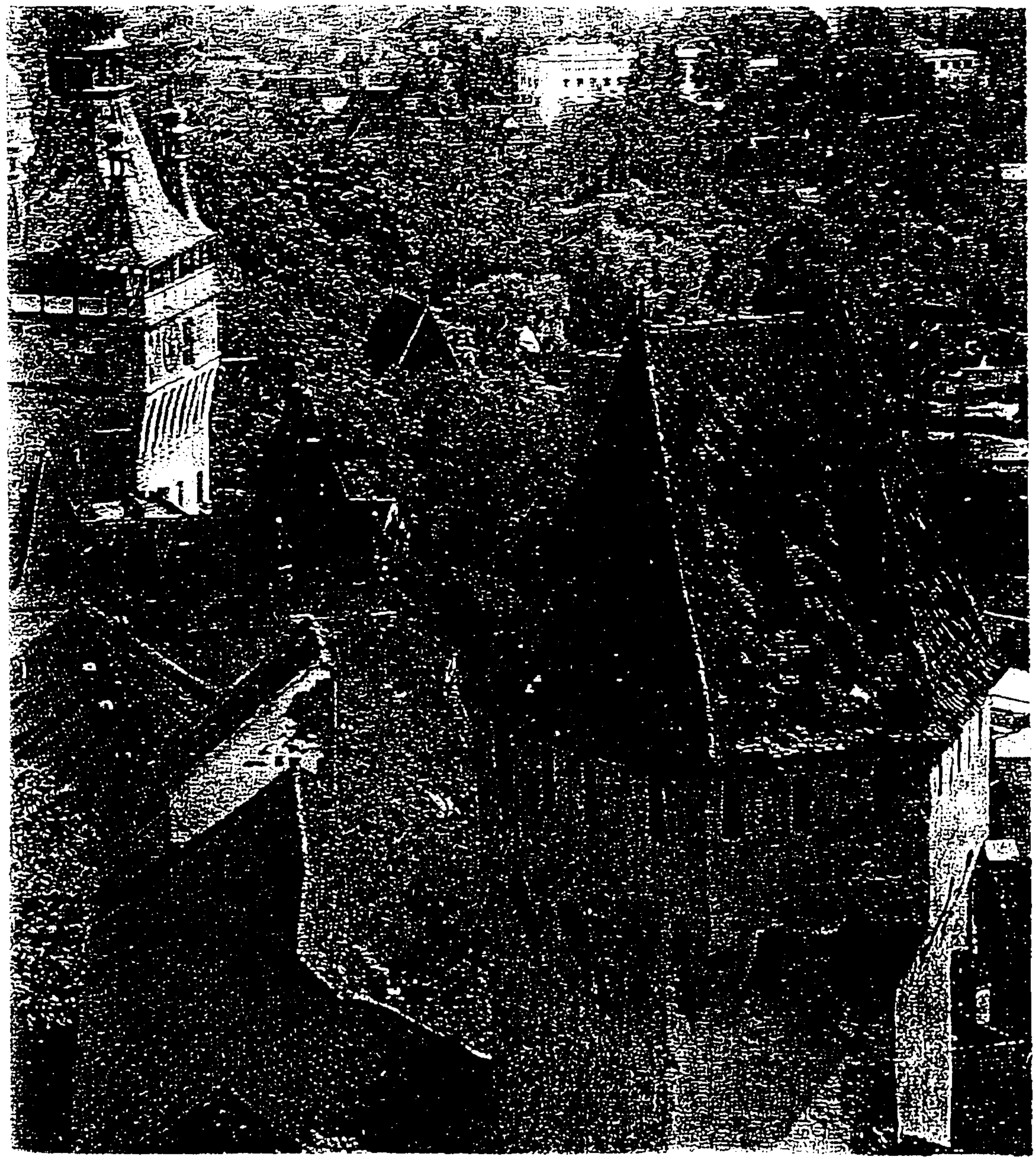
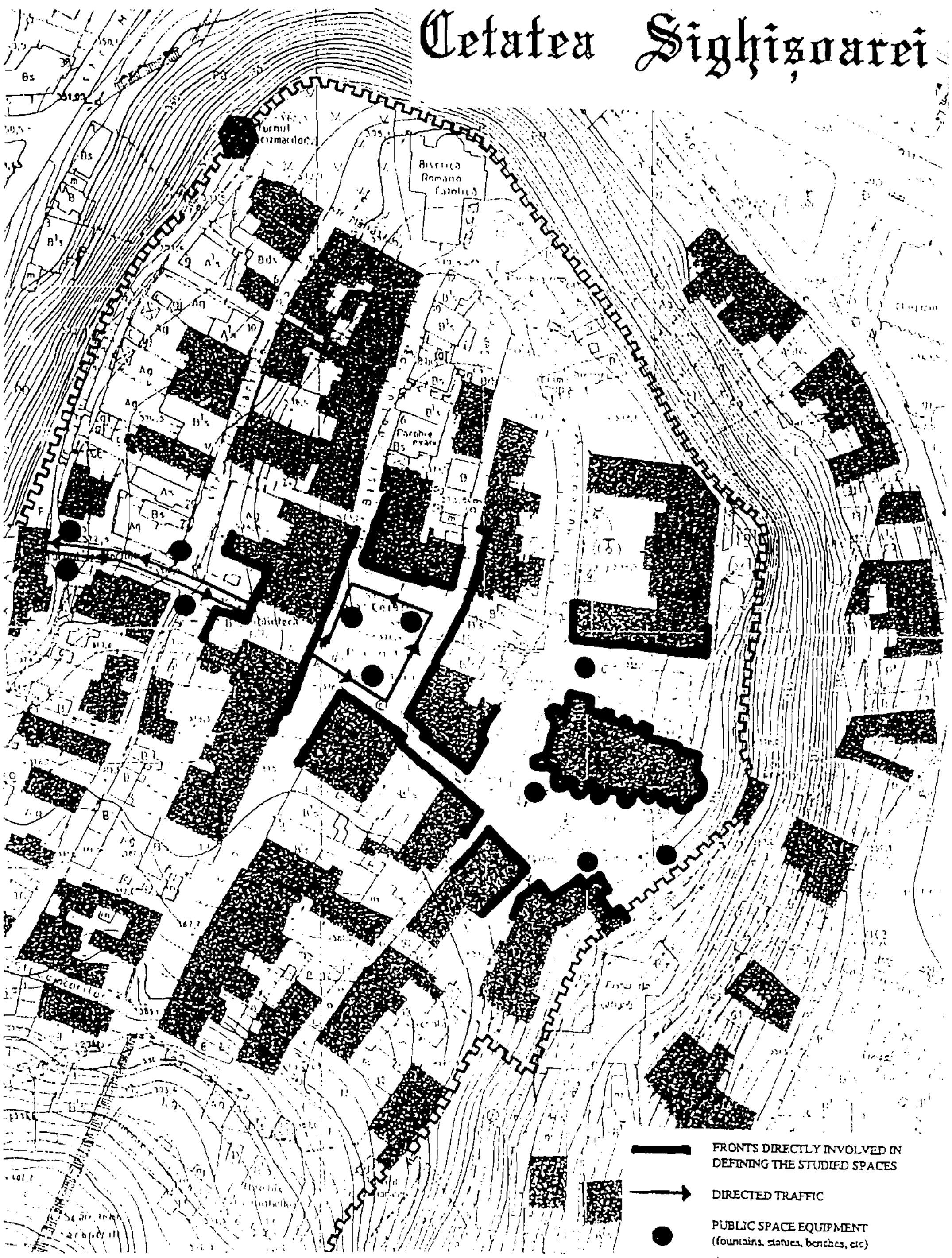
Beneficiary: Ministry of Public Works and Regional Planning upon the demand of the Local Council of the Municipality of Sighisoara

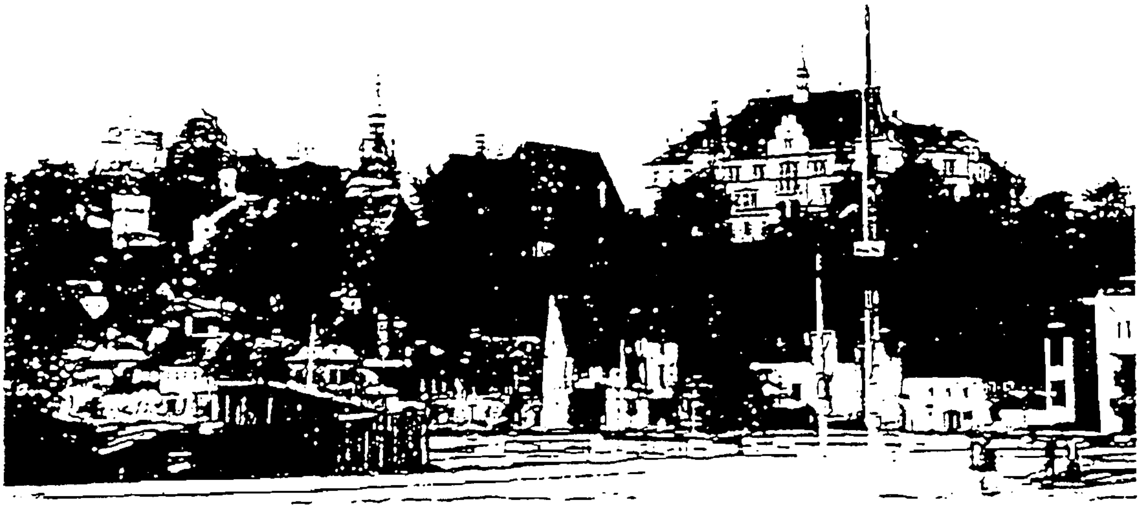


The city of **Sighisoara**, situated in the centre of Romania, has been established in the medieval period (the XIIth or the XIIIth century) and has a population of 35,000 inhabitants.

The city's history registered successive periods of flourishing and decline, during a complex evolution marked by various events: battles, fires, epidemics, floods, etc.

The city has developed around the medieval fortress built in the XIVth century on a natural promontory (the Fortress Hill) with the Tarnava river running at its feet.

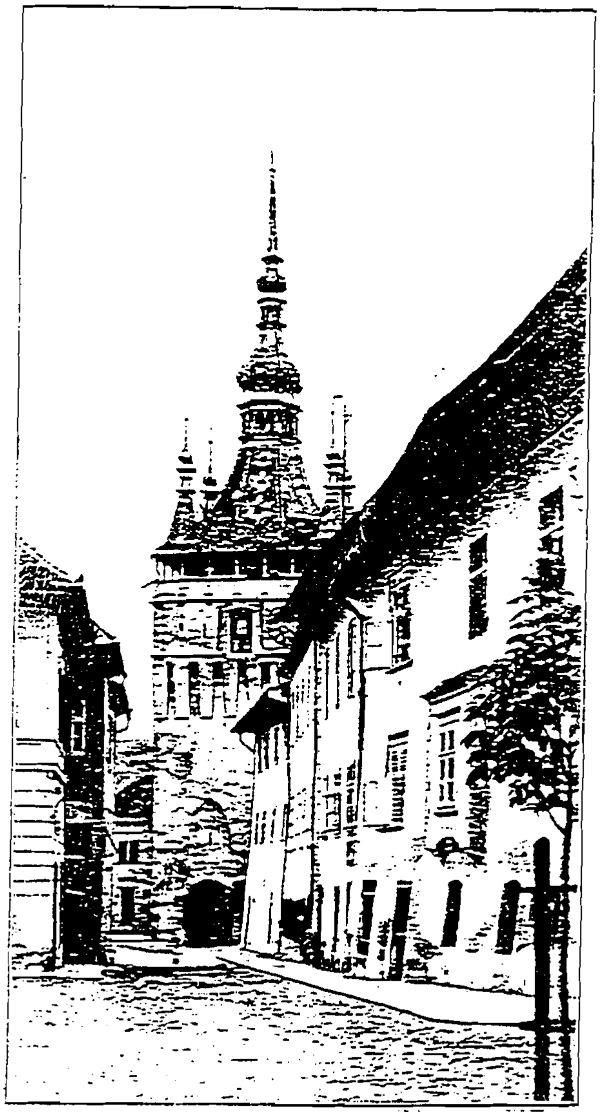




The dull urban development, the lack of concern for the preservation of the heritage values from the centre of the city, together with the depopulation lead to the decay of the built environment of the city, to destructuring interventions (brutal demolitions in the immediate neighbourhood of the Fortress) and finally the "neutralisation" of the city's specificity (site, situation, monuments, community traditions).

With a view to establishing protected areas for the preservation of the natural and built heritage and in order to re-instate the construction regulations abandoned for over 40 years in Romania, the centre of Sighisoara became in 1991 the object of a pilot-study.

The study was developed along the following steps: delimitation of a protected area for the historic heritage, elaboration of the zonal urban plan and regulations (urban management documents), elaboration of the intervention program for the area of the lower city (analysis, regulations, operational strategy) and the study for the revitalisation of public spaces within the Fortress. The accomplished works represent a "premiere" in urban planning research, having a methodological character, with the aim to establish the necessary framework for typical urban-planning projects and serving as models for the approach of the specific issues of protected areas.



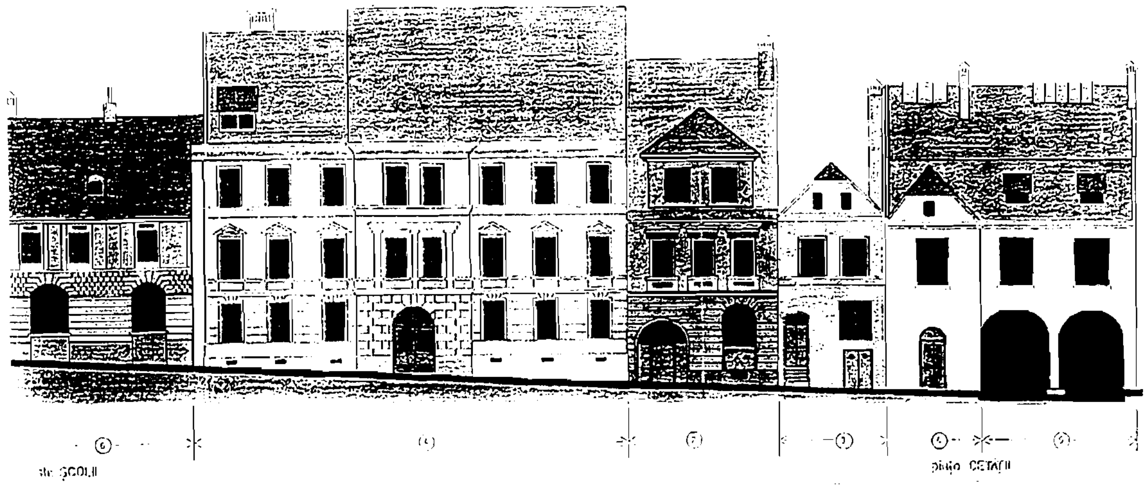
The topics of the work stages were:

1. **The delimitation of the protected area for the historic heritage** was made by multicriterial analysis, observing the historic, architectural and urban planning, functional, and visual aspects. The steps carried through have been: establishing the qualitative criteria, their hierarchy, translation of these criteria into quantitative values, determination of the level of concentration of values by superposition. The result was a coherent perimeter, delimiting an area of 145,5ha.

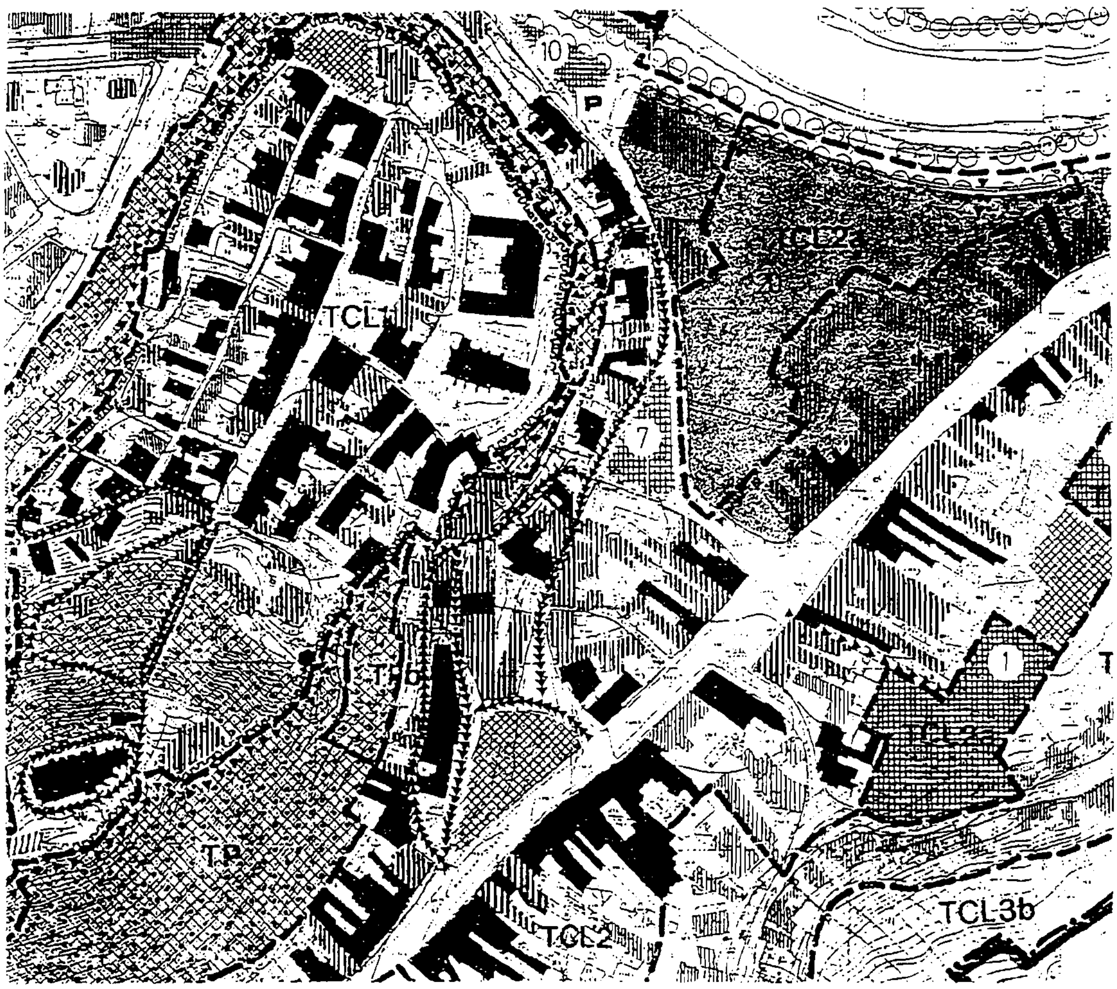
2. **The elaboration of the Zonal Urban Plan** imposed a new series of background analysis: geographic environment and reference elements at the city-scale, opportunities and disfunctionalities, analysis of the site, morphological analysis of the urban tissue, aesthetic, architectural, and functional aspects. The results of the analyses generated attitudes towards the existing situation and determined the possible zoning for the elaboration of the regulations. Finally, the elaborated building regulation contains provisions regarding:

- protection and conservation of classified buildings;
- spatial re-oganising according to the existing situation, promoting an active integration;
- protection and revitalisation of green areas and landscapes;
- improving the quality and complementary actions in high density built areas, respecting the regulations and obligations;
- functional re-organising and aesthetical regulations;
- diversity by re-structuring the plots;
- the establishment of the main pattern of public services;
- issues regarding land transactions.

According to the existing legislation, the whole project was approved by the Local Council of Sighisoara, becoming a formal urban management document (a basis for building permits).



ZONAL URBAN PLAN - THE PROTECTED AREA FOR THE HISTORIC HERITAGE - REGULATIONS



PROTECTED AREA LIMITS

SUB-ZONE OR SECTOR LIMITS

BUILDINGS OR PARTS OF BUILDINGS WITH ENVIRONMENTAL VALUE

EXISTING PEDESTRIAN STREETS TO BE MAINTAINED OR RE-DESIGNED

PROPOSED PEDESTRIAN STREETS

3. Within the zonal plan, a **subzone** was defined (the Lower City) in which, due to former brutal destructurations generated by the intention to develop a new centre, urgent intervention is needed. Because this area is the support for the Fortress and facing the river Tarnava. **The program for intervention in this subzone** (analysis, special regulations, operating strategy) had the purpose to assure the maximum coherence of the actions (areal approach), detailing certain regulations from the zonal urban plan imposed by the urgency of intervention, and finally assuring a complete answer to the pressing and precipitated demand for land in this central area. For the implementation of strategic planning by the local administration, a draft strategy for complex integrating revitalisation was elaborated, translating the study in the managerial field.

The operational part of the proposed program consists of the establishing of the long, medium and short term objectives based on the identified barriers and opportunities and suggesting the possible responsibilities, means and methods for the implementation of the strategy.

All the works regarding the protected area of historic value from Sighisoara have been handed over to the local municipality. They have been analysed, approved (the Zonal Urban Plan) and now they are the basis for the coherent management of the area and for the elaboration of the file which will include the whole ensemble in the list of international heritage (UNESCO). The complete set of works described above form the basis for a wide operational program for zonal development, whose start is already marked by the realisation of certain investment projects.

REPORT 11

SUSTAINABLE CONSTRUCTION IN SPAIN

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION: THE SPANISH TERRITORY IN A CHANGING EUROPE

1.1 Geographical framework

The organisation of the Spanish territory is an important factor due to the fact that it encompasses a lot of problems and heterogeneity's that keeps Spain at a distance from other countries, and more concretely, from the rest of the European Union.

A common characteristic seen in the varied landscapes of the Peninsula are the strong contrasts between them which creates a diversity unfound in any other country in Europe. Such contrasts in the landscape are a characteristic of the Mediterranean countries in which high mountain ranges alternate with medially high ones, with flat depressions appearing between them which have favoured human settlements. Added to this is the influence of two climatic regions so different from each other as is the Atlantic and the Mediterranean, these contrasts give, perhaps, a higher diversity in Spain than found in any other of the Mediterranean countries.

As you can see in figure 1, the areas where it is possible to establish settlements, that is, those having a slope less than 20%, are scattered over the territory overcoming the problem of the Spanish orography.

Briefly, we can say that the geological relief is articulated around a great central unit, La Meseta, which has a high average height, of 650 m., and is bordered both in the North and the South by high mountain ranges, of 2.500 m.. In the peripheral areas there are medium height mountain ranges such as the *Prelitoral Cordilleras*, as well as high mountains like the *Betic Cordilleras* in the southern sector and *Cantabric Cordillera* in the northern one. The *Pyrenees* mountains, which are situated between the Peninsula and the Continent, have an axial zone where are found the highest mountains, of over 3.000 meters.

In summary, in order to systematise the study of such a diverse and contrasted country, we can high light three characteristic features:

- the massif shape, scarcely cut, of the coastal area.
- the average medium height (only surpassed by Switzerland in Europe).
- the disposition of peripheral outstanding mountains.

1.1.1 The water problem

Spain is situated in the southern extreme of the *arid diagonal*, which crosses the West of Europe. This *diagonal*, which extends from the south-east to the north-east of the Iberian Peninsula separates the two more active zones of the country; and it is in its bordering areas, where the oasis of urban and industrial development cities such as Zaragoza, Guadalajara and Madrid, appear.

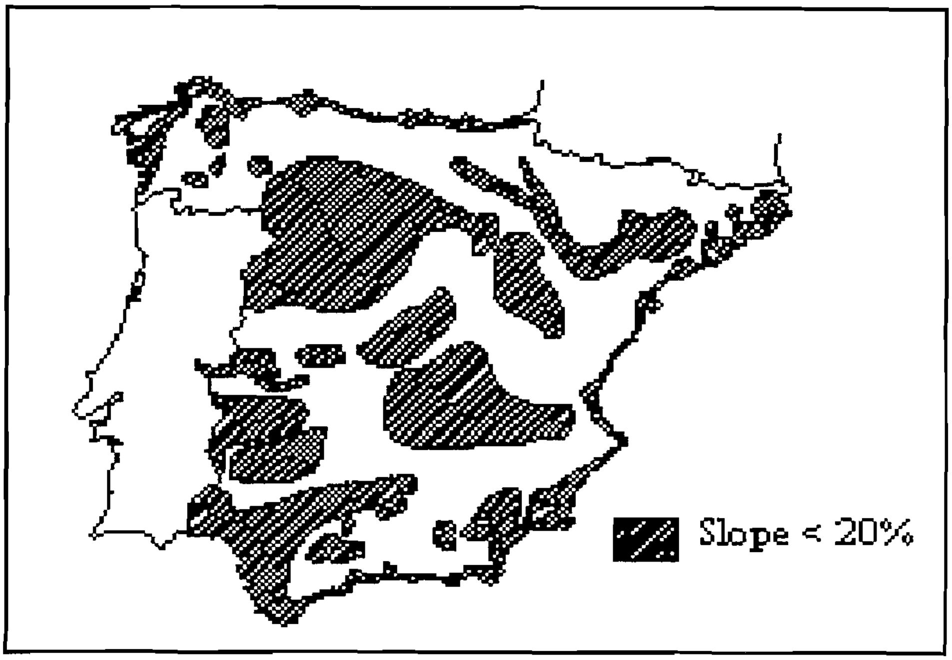


Figure 1: Areas where it is possible to establish settlements

Within the *arid diagonal* we find a common characteristic: scarce rain combined with a high level of evapo-transpiration. Another characteristic from an agronomical point of view is the bad quality of the soil, which makes this region not fit for agriculture development.

Although Spain is situated in a temperate zone, its irregular topographical relief implies two great and opposed climatic conceptions. To the north of the *arid diagonal*, we find humid Spain which coincides with one of its most developed regions, in economic terms, whilst to the south of this devide we find dry Spain, which it self is divided in two areas: a very dry zone and a Mediterranean zone.

In surface area terms, the *humid area* represents one third of the country, while the other two thirds belong to the *dry area*.

1.2 Socio-economic framework

One of the socio-economic consequences that becomes evident from the above study of the geographical framework, is the lack of balance in the Spanish Society; this is even more evident when considering the deep differences that there are between the Spanish regions. The regional unbalance shows clearly three significant aspects of facts:

- population
- gross regional product

- income per capita

The population is distributed over the Spanish territory, which exceeds 500.000 square kilometers, with an average density of 76,8 inhabitants per square kilometer, slightly higher than that of Greece, but considerably lower than the rest of the European countries.

The distribution of the population is uneven, with large areas well below the already low national average. This situation implies the existence of some "human deserts" unparalleled in other European countries. There exists high concentrations of populations in the big metropolitan areas opposed to a steady depopulation of the country areas.

The development of the population distribution in Spain is explained in the following study which pays special attention to the creation of employment. Within this study are examined two characteristic periods within the last 25 years, the 1970-1995 period (see figure 2), which shows the evolution of the Spanish economy from the end of the dictatorship until today; the deep crisis of the 70´s and beginning of the 80´s, and the expansion period between 1985 to 1995, when 1.160.000 jobs were created, however, with paradoxical results. Employment in Mediterranean regions such as Valencia and Catalonia grew by over 18%, while in Atlantic regions such as Galicia and Asturias it fell by over 11%.

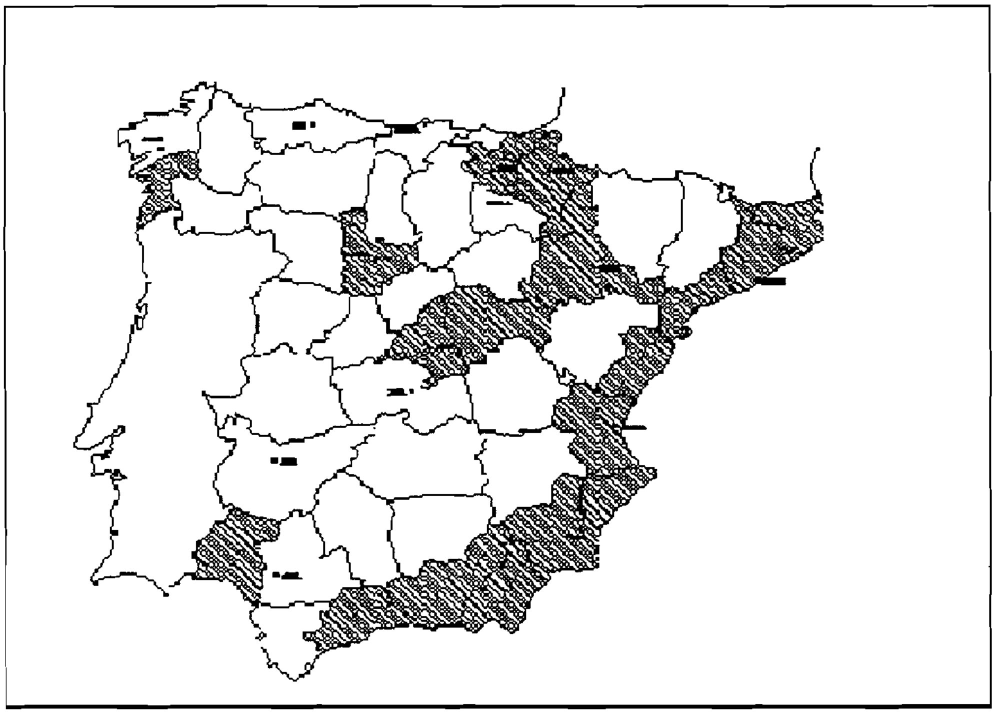


Figure 2: Provinces which generate work between 1970-1995

Employment, by industrial sectors, is organised as follows (see Figure 3):

- the primary industry; 10% of the active population works in any of the activities pertaining to this sector ;
- the secondary industry; this sector employs about a 33.1% of the population, 10.6% of which are people employed in the construction ;
- the tertiary industry, or service industry, the rest of the working population is involved with activities in this sector.

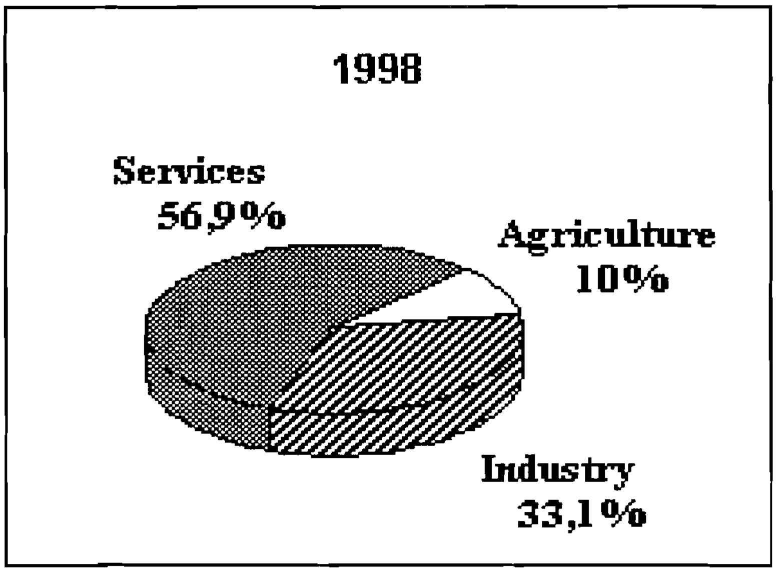


Figure 3: Employment in Spain

Not one of the regions in Spain reaches the European GDP average, even the richest ones, that is, Baleares and Catalonia with 98% and 97% of the European average respectively. On the other hand, economically depressed zones such as Extremadura in the Southwest of Spain does not reach 70% of the average.

If we analyse the income per province we can see that the Vasco-Navarra and Catalonia-Valenciana areas have the highest development, together with Madrid and Zaragoza, while the Southwest and Northwest areas do not reach the minimum income levels of the richer provinces.

In summary, if we draw the above mentioned *arid diagonal* line on the Spanish map we can see the clear division between a poor and depressed Spain in the Southwest angular region, close to the Portuguese border and the southern Mediterranean; and a rich and developed one, in the Northeast regions around the Cantabric coast and the French border.

1.2.1 The Atlantic 'arc' and the Mediterranean 'arc'

European 'arcs' are in fashion nowadays. There is a Mediterranean 'arc' and an Atlantic one, in order to counterbalance the north of Europe.

The Atlantic 'arc' has become an area where poor villages have been waiting for a long time for the central area to give them work. It has also become an attractive 'European' place for certain industrial activities because it has rural areas with available manpower at cheap prices and a high demand of temporary work from unqualified young people.

The Mediterranean 'arc' is the edge of the huge Mediterranian gulf, thanks to it the greater part of the European megalopolis is located in this front. It is a passage territory, completely open; it is not a land of refuge but a circulation corridor as it was in the past with constant comings and goings of Greeks and Romans.

These two 'arcs' seem to have common objectives. In general, both do everything that it is possible to have a permanent employment; they have a desire to have a greater autonomy with respect to the centre, and to develop local companies with less dependence on the decision of foreign firms.

Spain is one of the European countries which is more attractive for foreign firms and also one of the countries which has received more investments in the last few years, which indicates that the Spanish market is interesting and has an importance within the European context. In order to increase the attraction of the country, so that it can reach the levels of richness and employment similar to those of the rest of the countries of the European Union, several steps of great importance must be taken, with respect to transportation infrastructure and a rapid connection between the two mentioned arcs, but within the framework of the sustainable construction.

2. THE SUSTAINABLE CONCEPT IN SPAIN

Nowadays Spanish cities share many of the problems other European cities have regarding the particular qualities of their individual countries, but added to this are; the hard inheritance received from a long period of strong growth without political freedom and the recent establishment of a Democratic State (1978) with a high federal character; the relative delay and lack of equilibrium with which the industrialisation process and the expansion of the tertiary sector of the country was carried out, coexisting with a high development of the tourist trade mainly in the coastal region.

These singularities determine the own profile of the Spanish territorial and urban reality: the existence of a great territorial reserve which includes a significant percentage of biological diversity; a quite hierarchical system of Mediterranean cities around a series of discontinuous territorial axis and seventeen metropolitan areas.

There has been a certain delay in the consideration of the environmental, local and global problems found in Spain, this was wrongly put aside by the need to face the huge problems inherited from the great migrations from the country to the cities during the decade 1960-1970, as well as the consequences of the subsequent economic crises from 1975 to 1984, and the more recent one which started at the beginning of the present decade.

In order to rationalise the economic situation found within the territorial arrangement, it is important to identify the real problems that may crop up at different levels. At a local level, a lot of questions can be clearly identified; this does not mean that they are simple political questions due to the fact that there are opposing interests at work between different parties. Environmental involvement is not always compatible with urban, industrial or tourist ambition.

2.1 Environmental problems

The most important environmental problems in Spain are:
- natural catastrophes, mainly annually occuring floods and fires.
- continual process of land erosion due to deforestation and creation of deserts.
- problems derived from an inefficient use of the hydrological resources.
- progressive contamination of underground, superficial and sea waters.
- high degree of deterioration of the coastal areas and in the islands.
- progressive soil contamination due to intensive agriculture exploitation, and urban and industrial solid waste disposal.
- growing air pollution found in main metropolitan areas.

2.2 Evaluation criteria

The main obstacle to solve was the establishment of the 'evaluation criteria' with regard to the sustainability concept in urban and local environments, in order to analyse and evaluate the various proposals submitted by several cities.

Three initial general references were established in order to make up the currently found deficiencies:
- implementation of consistent intervention instruments.
- magnitude and integrated character of local management.
- consideration of the efforts carried out by local and institutional bodies.

The areas and basis of thematic evaluation have a more concrete and interesting level of consideration, provided it does not create a segmented perspective of the analysed case which is not compatible with the integrated view required by the kind of evaluation to be carried out. That is to try to envisage several concrete reference values on sustainability of urban policies in order to provide a consistent contrast which regard to the actions to be examined.

Four criteria areas have developed (see Table 1): environmental quality, spatial structure, cohesion and social life quality, and local economy.

Sustainability and urban practices in Spain. Evaluation of criteria areas and thematic values

1. **Environmental quality**
   Local programs in relation to overall environmental problems.
   Bio-diversity and local ecosystem preservation, without surpassing the load capacity.
   Prevention and actions against environmental risks.
   Minimisation of resources consumption and waste generation: quality of the environmental services and measures in key sectors.

2. **Spatial structure**

   Adaptation of the urban structure to spatial and local environmental conditions.
   Spatial solution to social needs in respect of the new growth and restoration of the built property, from a rational point of view.
   Arrangement of urban goods and services and own city space, so as to favour urban transport and pedestrians.
   Encouragement of wealth, diversity and complexity of urban structure.
   Adaptation of urban space and construction to environmental requirements and quality of life in the cities.

3. **Social cohesion and quality of life**
   Social *backbone*, support and cover of basic social needs.
   Quality of life and availability of a rich, diverse and complex socio-cultural environment.
   Acces to information, education and participation in local and global policies.

4. **Local economy**
   Scale, equilibrium, viability, stability and a reasonable level of interrelationship with local development.
   Minimisation of environmental impacts in sectors of the local economy.
   Encouragement of the ecological economy, that is, the adaptation of environmental aspects within the economic cycle.
   The sustainability of public finances.

Table 1 (Source : Habitat II)

3. THE CONSTRUCTION SECTOR IN SPAIN

Industrial construction represents about 11% of all of the activities in this sector in Spain. Employment has increased in this sector during the last few years and is now established at around 1.5 Million people. This represents an unemployment rate of between 20% and 25%, which mirrors the exactly the overall Spanish unemployment rate, which is the highest within European countries.

3.1 The structure of this sector today

The Spanish construction sector has lately benefited from a demand that started in the private sector at the end of 1996 and beginning of 1997. In spite of this , the overall decrease in public work demand prevented the sector from having the strong recovery predicted from the general economic situation.

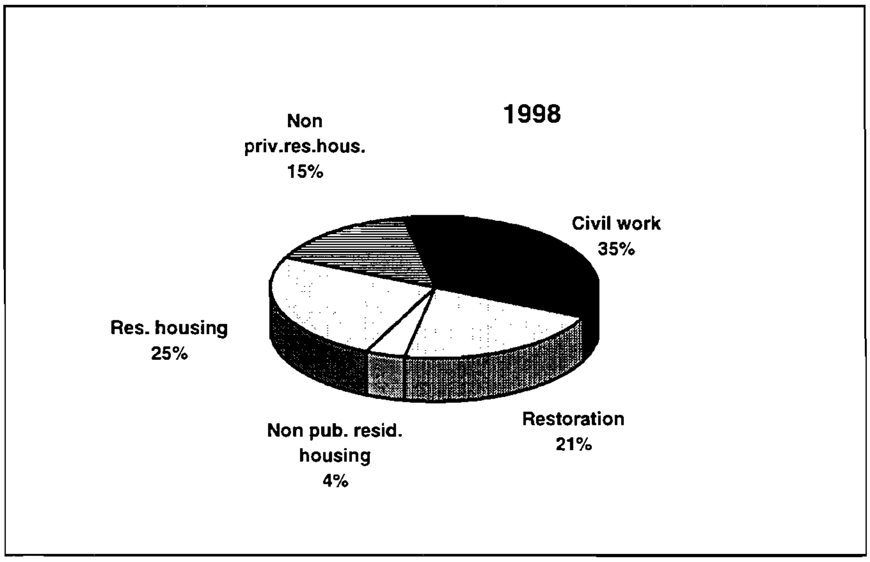


Figure 4: Structure of the construction sector in Spain

After a fall of construction activity of -1% during 1996, there is already a recovery which is reflected in the 1997 statistic and which will be reinforced during 1998 with an estimated growth of 2,8%. Housing is the most dynamic sub-sector of the Spanish construction (see Figure 4) with an estimated growth of 6,3% for this year.

The structural restoration sector is scarcely developed in Spain. It has an enormous potential but the lack of specialised companies and the use of old-fashioned methodology often turns this activity into localised craftsmanship, the housing sector is an activity strongly influenced by the individual family economic conditions.

The present economic recovery has enabled the new *Plan de la Vivienda 96-99*, Housing Plan for 1996-99, to include restoration and maintenance of buildings as two activities which will get priority attention, particularly focusing in interventions to be carried out in the old nuclei of cities and the improvement of urban structures. It is important for the Spanish restoration sector to grow year after year in order to reach the European levels which represent 34% of the whole market.

3.2 Regional evolution of the construction sector

The evolution of the different indicators of activities in this sector show the construction dynamism of the different autonomous regions. In the first half of 1996 the most dynamic regions were Canarias, Baleares, Valencia, Navarra and Murcia (see Figure 5).

Figure 5: Regional evolution of the construction sector

Nearly 125.000 applications were received requesting for the benefits of the 1996-99 Housing Plan. In absolute terms Catalonia is the region which generated a higher demand with more than 25.000 applications, followed by Andalucia and Valencia. On the contrary, in terms *per capita*, Rioja, Asturias, Murcia, Canarias, Aragon, Catalonia, Valencia and Cantabria exceeded the Spanish average.

3.3 Sustainable construction in Spain: present situation and future prospects

If we concentrate in the area of design and works execution we see, first of all, that the location of the building plays an essential role. It is not always possible to choose the site and, therefore, the most favourable conditions, but the climate, vegetation, topography and urban structure must always be taken into account either if we want to take advantage of them or if we have to protect ourselves from adverse conditions. In this sense it is imperative to be able to influence the urban planning which is where we can really contribute to give the best environmental solutions to urban construction.

3.3.1 Urban planning

If we want to go beyond the limitations of urban planning in order to get an integrated one such as the territorial disposition the following problems arise:

- the existence of several disciplines which have an influence on urban planning and act in a sectarian and fragmentary way.
- the public administration operates in compartments, they carry out sectarian plans which prevent the problems from being solved in an overall comprehensible manner.
- the habit of giving short term solutions.
- limitations of urban planning which regulates the socio-economical activities of a municipal, being incapable of handling the big environmental problems which are of an above municipal nature.
- administrative divisions which restrict urban planning and are an obstacle to the approach of environmental problems.

In the last few years there has been a significant improvement in Spain in the process of overcoming the limitations of urban planning. The laws concerning the regulation of the territory in the autonomous regions have improved in the following aspects:

- simplification in the number of plans. There are now only two or three hierarchical levels. In the first one we find the general rules for the territorial disposition, also called *Plan de Ordenacion del Territorio or Plan Territorial General,* depending on each autonomous region. In the second level there are partial rules for the territorial disposition and in the third one the specific programs and sectarian plans of some of the autonomous regions.
- diagnosis of the problems of territorial disposition.
- quickness in the process of planning approval.
- new strategies and co-ordination of actions to solve the problems of territory disposition.
- creation of a permanent information system between public administrations in order to have enough data to work out the disposition plans.
- fix the limits of the territorial units according to environmental values, such as places of ecological, cultural, scenic interest, etc.
- creation of different management areas for non-urban development land.

- incorporation of the analysis of the territorial impact in order to evaluate the incidence that the project activity or installation can have on the territory.

3.3.2 Construction aspects

From the construction point of view there are a series of negative aspects in the current situation:
- increasing occupation of land and transport networks together with incessant extraction of raw materials with the consequential environmental impact.
- presence in the existing buildings of many contaminating substances used in the constructing sector (asbestos, lead paintings, PVC, etc.). Buildings have to be therefore decontaminated before restoring them.
- lack of environmental mentality in constructors, designers and users that hinders the introduction of effective measures which are today both technically and economically possible.

In order to comply with the sustainability commitment in the Spanish construction sector, 3 complementary aspects have to be taken into account:
- economic
- social
- ecological

The economic policy should be directed towards the reduction of the global costs of the buildings, taking into account all the life cycle by using new technologies and building systems, saving energy and using better management. It should also be necessary to state the need to increase investments on restoration and maintenance.

From the social point of view a dignified house, healthy and accessible, must be guaranteed in order to promote social integration and reduce the number of conflicts. Historical buildings and sites must also be preserved as elements of local identification.

The ecological aspect must face the need to use all the planning instruments available to avoid land occupancy and landscape destruction. Also the reduction of CO_2 emissions must be advanced, as well as the saving of non-renewable resources and the avoidance of the use of dangerous materials.

4. METHODOLOGY

One of the basic conditions to write about in the present situation of the Spanish sustainable construction and give some recommendations is as follows, is to consult the different social parties directly related to construction.

We decided to consult three different levels:
- the Administration and the University.

- professionals related to big construction firms.
- autonomous professionals and small firms of building contractors.

Based on the work of Cas Richter a questionnaire was formed whereby the collaboration in three areas was requested:

1. ecological principles, where answers related to maintenance, recycling, quality or economy were given.

2. sources, where water and money as limited sources were of great importance.

3. construction phases, where all construction aspects from planning to maintenance or demolition were taken into account.

If we make a short review of the different opinions obtained in each level of the questionaire we can see different approaches.

In the first level of study, we spoke with professionals related with the Administration and the University. Generally, they understood sustainable construction to be that which is environmentally respectful.

In this level they agreed that the most important agents for a change in this regard are:
- house owners, landlords, other investors in housing and residents.
- politicians, planners, local government representatives and the educational system.
- representatives from the agencies responsible for the provision of energy and water, and the discharge of wastewater, solid waste and recycling.
- representatives of the construction industry: professionals, contractors and consultants.
- social housing organisations.

According to these agents, the most important areas of intervention will concern:
- urban planning, that guarantees sustainable cities, that is, integrated urban structures, re-use of the existing cities and adequate densities in the individual territory.
- reduction of transport demands, with adequate policies.
- water savings, including systems for the collection and use of rainwater and local drainage of rainwater.
- energy savings, including incentives to encourage the use of renewable, alternate energy sources.
- refuse handling, including the reduction of refuse production, selective demolition and recycling of building materials.
- indoor climate improvements, including the evaluation of building materials, construction and maintenance.
- development of social processes, which are required to obtain sustainability in the housing sector, by means of a participation in the planning and management processes.

At a second level, where we find professionals related to big construction firms, they considered sustainable construction as the construction of the future, and for them the most important areas of intervention are:

- maintenance and adaptation of existing housing.
- use of sustainable new building materials with lower environmental impact.
- free movement of building materials.

At the third level, autonomous professionals and small firms of building contractors identified the sustainable construction concept with sustainable development and with distribution of wealth. One of the most general comments among designers was the life-cycle of buildings. According to them, life-cycle analysis varies according to the technology, information and habits of each country; and construction materials have a very important local component contrary to bigger industrial products.

In the next section we have synthesised the experiences of the different levels in order to find an answer to the basic questions which will make us understand the sustainability of the construction at the beginning of the new century.

5. ANSWERS TO THE QUESTIONS.

5.1 Answers to the 5 questions

5.1.1 What kind of buildings will be built in the year 2010 and how will we adapt the existing buildings?

In such a traditionalist sector and with a short time view, there will not be radical changes, but the introduction of solutions focused on decreasing the environmental impact is expected. The main foreseeable advances include:

- The use of environment friendly materials (with attention to the analysis of their life cycle).
- Buildings more compatible with the deconstruction process.
- Greater flexibility and capacity to adapt buildings to diverse uses.
- Increasing the energy efficiency (especially in areas of lighting and air conditioning) by means of:
    - ◊ Incorporation of automatic control in some lighting and air conditioning systems. The optimal results are obtained by using integral management systems .
    - ◊ Taking profit of the solar power (solar heating and cooling).
    - ◊ Improvements in insulation techniques.
    - ◊ The use of new and more efficient technologies (illumination by electronic ballast for instance)
- A better management of waste materials and water .

Many of these solutions can be progressively implanted within existing buildings giving satisfactory results, although better results are obtained if all these factors are taken into consideration during the design phase of the building. The simplest and more economical solutions to be adapted to existing buildings are:

- Improvements in insulation systems. It is relatively cost effective and fast to repay.
- The use of low environmental impact materials, in the retrofit of existing buildings.
- Changing the current lighting and air conditioning equipment by more efficient systems whenever they need to be replaced.
- Considering building retrofit instead of demolition and new construction.
- To use recycling criteria when a building is demolished.

5.1.2 How will we design and construct them?

One of the main points to be considered is the need to develop a methodological process focused on integrating environmental considerations into the processes of design and building . These considerations must be incorporated into the project from its outset and carried on throughout the project phases till the final occupancy of the building. It is also important to bear in mind the possibility of the changing use assigned to a building during its lifetime, so it is necessary to endow the building with the quality of being adaptable to diverse uses.

Another basic premise in the design of a building is its correct adaptation to the environment it will be located in. Important aspects as the climate, the topography, the noise, the ground state or the visual impact the building causes, cannot be neglected.

Finally, the first measure, that we are faced with in the approach towards sustainable construction, is to design the building using a interdisciplinary approach that adopts preventive measures instead of applying corrective ones once the work has been finished.

5.1.3 What kind of materials, services and components will be used there?

As said before, the construction sector is reticent to the entrance of new materials and technologies. Probably what we will often see, from now to year 2010, will be adaptations of already existing materials to the new requirements of sustainable development. Either new or adapted, the most recommendable materials to use are those that produce low environmental impact within the different phases of their life cycle:

- the extraction of the raw materials
- processing or manufacture of the product
- their installation in the building (in phase of construction or rehabilitation)
- the operation phase
- the elimination or substitution of the product (disposal, incineration or recycled)

As far as the use of equipment as well as the ease of use of equipment is concerned, it is advisable to use standard components in order to make easy their subsequent maintenance, repair or substitution. This is especially important in standardised services like water provisions, gas and electricity.

Probably the most foreseeable innovation in the short-term will be the use of automatic control technology. The computer and sensor technology used to control the main systems of the buildings will enable improved occupation comfort as well as to increase the efficiency and capacity of lighting, air conditioning, ventilation and security systems.

5.1.4 What kind of skills and standards will be required?

The 'eco-labelling' may foster the implantation of technical improvements, that will decrease the environmental impact produced by the construction sector, promoting the use of products that have the smallest environmental cost. The 'eco-labelled' products will fulfil strict requirements related to:

- The use of recycled materials.
- Thye use of low environmental impact products.
- Energy efficiency (insulation, high efficiency lighting, the use of solar energy).
- Environmental considerations during the construction phase (noise, waste generation)

Another premise that should be fulfil by the future buildings is the capability to be deconstructed allowing the reuse of its materials and components.

In relation to the construction techniques it would be advisable to use standardised elements as well as the use of modular construction techniques. The construction elements made in the factory cause less waste and are easier to be recycled than the ones produced on the construction site.

5.1.5 What kind of cities and settlements we will have then?

Radical changes are not foreseen from now to the year 2010 because these changes are developing slowly.

Current tendency analysis in Spain indicates that the trend is to slow down the growth of large cities, even a small amount of recession in many cases, and a sharp increase in the growth of small and medium cities located in metropolitan areas.

From territorial planning point of view, several important objectives should be considered:

- Keeping construction densities between reasonable limits to prevent its dispersion, incompatible with urban character as well as increasing congestion.
- Avoid land occupation:
    - ◊ In areas with great landscape, ecological or cultural worth
    - ◊ In specially fragile areas: coasts, salt marshes, un-evennesses, etc.
    - ◊ In dangerous areas : floods , landslides.

- Minimise imbalances that take place around the large metropolitan conglomerations.

5.2 Answers to other questions that arise in Spain

5.2.1 What must be considered in special in the case of Spain?

The Spanish climate presents some peculiarities that make it different from most of the European countries. To Begin with, is the rain regime, and followed by the temperatures, these climatic peculiarities have a strong influence in the Spanish constructions characteristics that distinguish them from the ones formed in the North European countries.

Socio-economic factors should also be considered :

- low investment in investigation to solve the environmental problems
- strong industrialisation of some zones
- pressures that tourism exerts along the coast

5.2.2 How to take advantage of the Spanish climate peculiarities?

The bio-climatic construction in the South of Europe might produce savings up to the 70% of the heating energy consumption.

The passive solar design, for lighting and thermal control (heating, cooling and thermal storage), and the active solar uses of all types, especially with respect to hot water preheating and the photo-synthesis applications, providing in Spain a remarkable roll in the way towards a greater power efficiency.

5.2.3 How do we overcome the difficulties that the Spanish climate causes?

Especially, an effective water management system is necessary in Spain to help counter the effects of the small amounts of rainfall. We can go towards this in four different areas.

- Installation of rain water collection and water re-use systems in buildings.
- Protection of water supply areas
- Suitable management of sewage treatment in order to improve the quality of the water in the river system.
- Develop territorial planning with attention to the dangers of flooding.

5.2.4 How can the main socio-economic obstacles in Spain be overcome?

The need for an economic, technical and cultural evolution of the building sector is becoming evident.

Although investments in sustainability are " profitable " over the long term, the construction industry needs to obtain profit from its investments in the short term.

Therefore the efforts must be focussed on marketing of the most sustainable products by means of the eco-labelling and also increasing social sensibility towards environmental subjects.

6. CONSEQUENCES OF THESE ANSWERS FOR CONSTRUCTION IN THE YEAR 2010.

It is very clear that construction technology needs to evolve with the use of lower environmental impact solutions, so as to become more sustainable.

Several environmental factors must be considered in order to improve the environmental quality of construction.:

- Design phase:
  In this phase it is very important to foresee the solutions that will allow the carrying out of its subsequent phases with the smallest ecological footprint. This objective requires a multi-diciplinary approach.

- Construction phase:
  Several new solutions will be adopted, such as modulated construction, prefabricated elements with the use of recycled or low environmental impact materials. Other interesting techniques are focused in the reduction of noise and waste levels, and the consumption of water.

- Operation phase:
  The main goal in this phase is to improve the efficiency of power and water consumption. In this sense, the new automated systems focused on the integral management of the building will be of great help. But it will only be possible to reach a good efficiency level if the previous phases have been carried out correctly.

- Deconstruction phase:
  In this phase re-using materials and components will reduce the waste generation and the consumption of new raw materials.

7. CONCLUSIONS AND RECOMMENDATIONS

The goals to achieve in the diminishing of the negative environmental impact caused by the construction industry are:
- to protect natural resources and bio-diversity
- to reduce water and energy consumption
- to decrease air, water and sonic pollution

- to reduce solid, liquid and gaseous waste
- to promote the use of recycling.

The following recommendations are presented in order to fulfil these ecological objectives:

- Promoting the eco-labelling of the buildings, based upon:
    - ◊ the environmental quality of the materials used in construction with attention to the life cycle analysis
    - ◊ a energy efficiency certification in new constructed buildings
    - ◊ other considerations like the environmental impact in the construction phase (generation of noises, rubbish)
- Reducing the environmental impact of the construction waste through its minimisation and recycling.
- Taking into consideration the impact on the health, comfort and security of the users, during the design phase of the building.
- Promoting maintenance and rehabilitation of buildings as a strategy to enlarge their period of use.
- Increasing the degree of environmental education of technicians in order to introduce these criterias into the sector.
- Accelerating the integration of ecological constructive solutions in the construction companies by means of including them in the administration promoted constructions.
- Promoting investment in the environment by means of fiscal deductions and/or eco-tax that burden the process of contaminating or consuming.

8. GOOD PRACTICE EXAMPLES

There are a lot of good practice examples that have been developed in Spain. The following are some cases which reflect progressive integration of ecological solutions in the construction sector.

8.1 Territorial planning

Although the initiatives of territorial planning that take into consideration the sustainability principles, are numerous, the future Metropolitan Territorial Plan for Barcelona has been chosen as an example because it is the multi-section proposal that includes the most extensive territory.

Metropolitan Territorial Plan for Barcelona

This Plan, that has not yet been ratified, tries to avoid the habitual and not desirable situation that is generated in the surroundings of large cities. In these peripheral areas, the territory is occupied in a dispersed uncontrolled manner, while in the old city centres, a great degradation and congestion has been produced. The objective is not to obtain a geometric or static balance but the homogenisation of the living quality and the preservation of low or high value areas.

In order to be able to offer a high quality services and communications, it is necessary to avoid the mentioned situation of disperse land occupation added to the congestion of specific zones. The Plan proposes a solution based on distributing the territory in a system of "open spaces ", and " metropolitan islands ".

The " open spaces " must constitute an integrated assembly with its own value, beyond the mere addition of dispersed pieces of more or less protected areas. In these "spaces ", construction will be very limited but not always non existent, in order to respect existing environment situation. Its main function is to avoid that urban sprawl invades the zones that do not have to be occupied. These spaces will include the areas with great landscape, agricultural or forestall worth, as well as the areas needed for the operation of the hydrological system. They will also include zones that must be protected due to their special weakness, for example salt marshes and the lands with great slope.

The " open spaces " will be connected through a system of connector-separators that the Plan denominates as " filters ", whose mission is to avoid that these " spaces " became isolated and surrounded by densely occupied zones.

The "metropolitan islands" will be areas of high construction density. These " islands " will contain the areas of the territory with a effective provision of services and mobility as well as a fixed infrastructure of public transport.

Obviously, mainly the existing cities and settlements will be included in these " islands " that will have clearly enough defined contours to avoid yielding to the pressures of growth.

Another interesting proposal of the Plan is the system of segregated roadways, structured as a homogenous and orthogonal network, that will canalise the *passing through* traffic. This system is complemented with a net of "civic" thoroughfares and service corridors that will channel the inter-metropolitan short distance transport flows and serve, at the same time, as a backbone for the different main service networks (water, electricity, gas, telephones...)

Other interesting *good practice* examples are:

- General Urban Development Plan for Sabadell, Barcelona.
- Performance of a City Plan for Girona.
- Integral Management of water and urban waste in Navarra.
- An example of participation and urban rennewal: the district remodeling in Madrid.
- Ciutat Vella, integral restoring the historical center of Barcelona
- the application of a strategic plan in Alcobendas, a city within the Madrid metropolitan area
- Alternative home politicies in Andalucía.

8.2 Construction

8.2.1 Dwellings.

A block of six flats with solar conduit in Horta, Barcelona

The building consists of three floors and a parking storey that has been equipped with bio-climatical solutions to fulfil the requirements of ventilation, air conditioning and lighting. One of the most novel characteristics of this building is the incorporation of a solar conduit for the illumination of the kitchens, that is used at the same time to provide natural ventilation (see Figure 6).

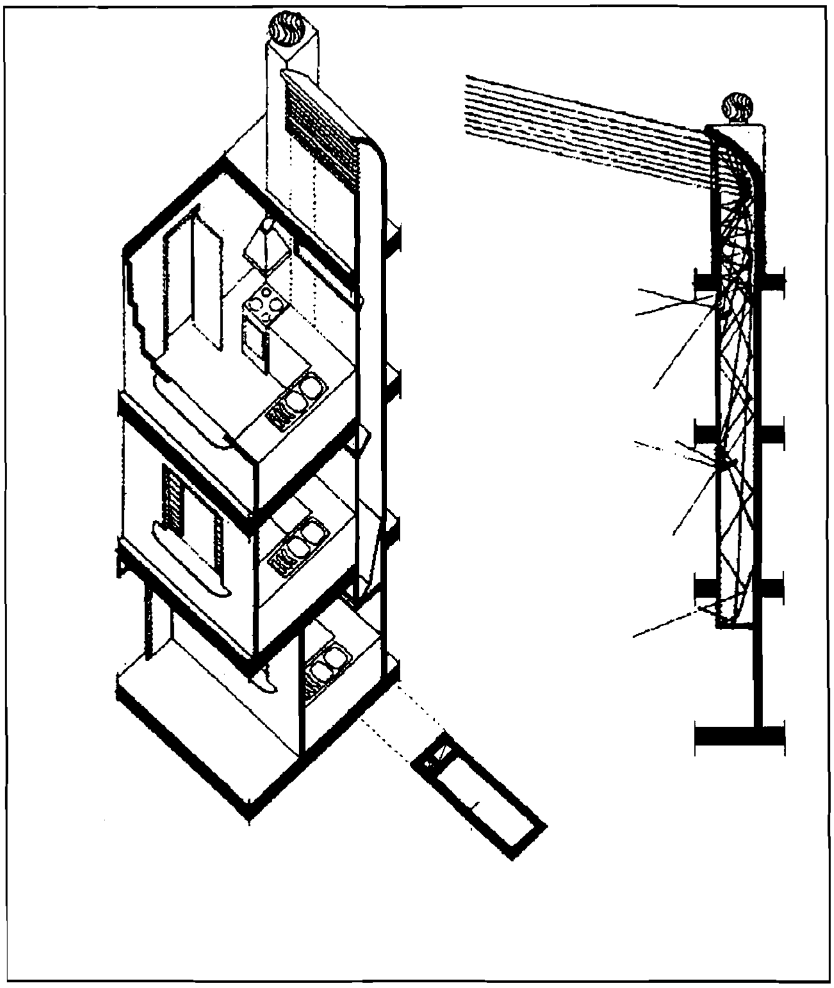


Figure 6: A block of six flats with solar conduit in Horta, Barcelona

Other bio-climatic measures have also been applied to this building. The ventilation and illumination of the parking have been arranged by using a skylight, also used in the lighting of the stairs. One of the main areas that have been taken into consideration is energy saving in heating. The walls have HD polystyrene to improve thermal inertia. In the main facade, oriented to the Southeast, there are 53.2 m^2 of double glazed windows, whereas in the rear facade there are 14.5 m^2. The improved solar lighting, reduces the thermal losses and allows crossed ventilation in the summer.

Thanks to the gains obtained from the passive solar pick up and the good insulation, the degree of energy saving in heating has reached 68%.

Other interesting good practice examples:

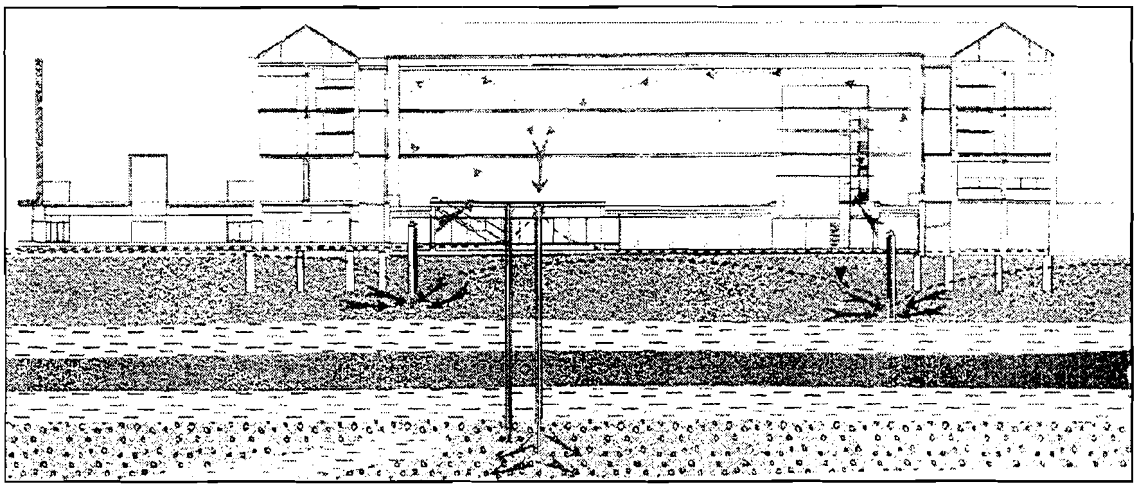
- An experimental block of forty nine bio-climatic flats in San Pedro de Alcántara, Málaga
- A sixteen flat block in Pedrajas de San Esteban, Valladolid.
- A twenty flat block including glazed atrium in Aguilar de Campo, Palencia
- A sixty four flat block in Mendillorri, Pamplona, (included in the Thermie program).

8.2.2 Public buildings

The air conditioning system in a building in the Universitat Pompeu Fabra, Barcelona

The "Jaume I" building in the "Universitat Pomeu Fabra" is the result of remodelling the old military barracks of the "Parc de la Ciutadella". The "Àgora Jordi Rubio" is located in the underground of one of the lateral streets and it will be linked with the "Roger de Llúria" building. The characteristics of the subsoil forced measures to be taken to protect the underground plant from the negative effects of the water level. The necessity of underground water pumping to maintain the water level 30 cm below the basement was considered. As a result of this a continuous pumping system was projected to protect the building against water filtration and floods.

The building has strong air conditioning requirements . During most of the year, a simultaneous provision of cooling and heating is needed. Taking in consideration the water volume extracted by the pumps which control the water level, the possibility of installing water condensed machines, that enable optimal power consumption to be obtained (because they provide cold and warm water simultaneously), was studied. After a hydrologic study of the zone, the existence of two water-bearing levels were determined, the higher one located between a depth of 6m and 12 m and the lower one located between a depth of 30m and 35m, both of them separated by an impermeable layer. It was decided that water would be taken from the higher one , and once used, inject into the lower one. With this solution the water of the subsoil can be controlled and its level maintained such that it does not endanger the building, while, at the same time, water is injected in the lower water-bearing contributing to regenerate it from the marine intrusion.



Other solutions adopted in this building are: the use of the free-cooling system, cold and warm radiating ground, individualised air conditioning system for each space and management of the air conditioning and lighting systems based on presence detectors and computer control.

Commercial buildings

System of management of the facilities in a large commercial building in Barcelona

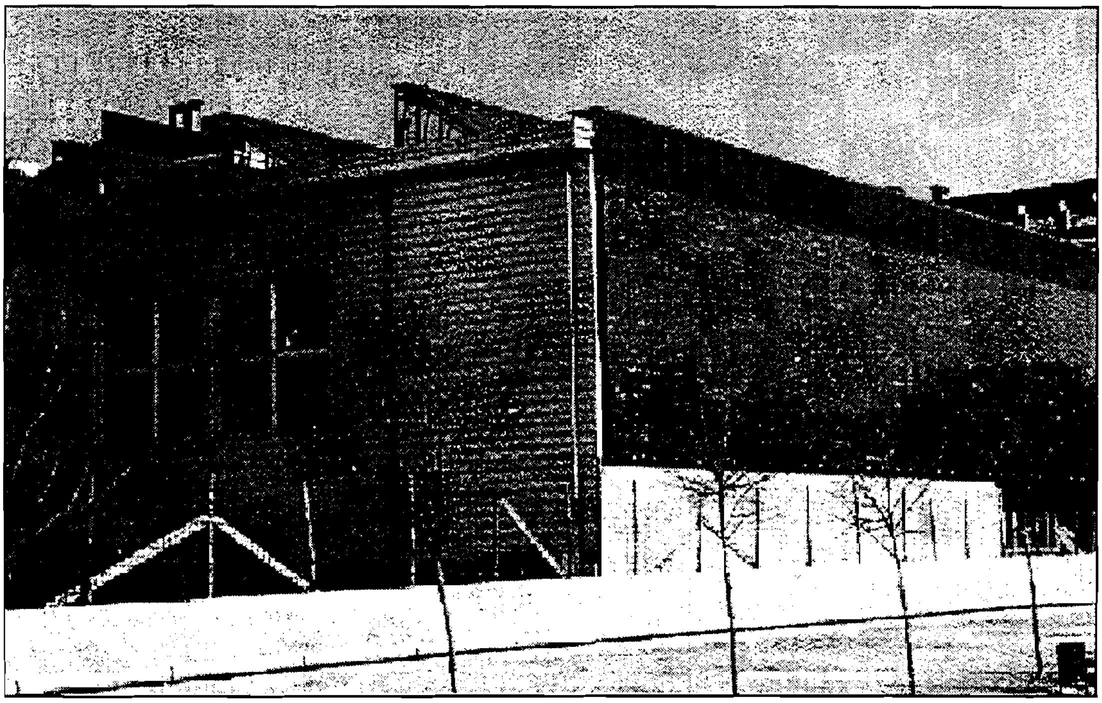
In the Barcelona-Glòries commercial centre a control and management system has been installed. This system allows to control, in unified and efficient way, the electrical consumption, the lighting system, the air conditioning, the low voltage distribution, the ventilation, the garden watering, the electricity-generating groups (used in the rush hours from consumption as auxiliary generators) fire-protection systems, cesspools and the elevators.

This centralised management system is helped by other more usual solutions: low solar factor glazing, free-cooling system to diminish the heat pumps operation at intermediate weather, the installation of time-lag switches in the auxiliary premises.

All these systems allow a power saving of 25% in relation to the electrical consumption initially forecast.

Thermal- photo-voltaic building, the Pompeu Fabra Library in Mataro, Barcelona.

The building that houses the Pompeu Fabra Library in Mataró has been designed with attention to reaching an optimal balance between energy saving, comfort, lighting, aesthetic and economy.



In order to achieve this objective photo-voltaic panels, formed by prefabricated multifunctional modules of great surface were integrated in the building.

This project has been given a subvention by the *Joule II* program. The project has served to show the possibilities that the European photovoltaic industry offers, and to show the different technologic possibilities using mono-crystalline cells, policrystalline cells and of amorphous silicon cells in their opaque and semitransparent versions.

The infrastructure is formed by a photo-voltaic system installed in the facade. This system is made up of a semi-transparent multi-functional photo-voltaic modules, formed out of solar photo-voltaic policrystalline silicon cells, and four rows of 37° inclined photo-voltaic skylights installed in the roof.

The building absorbs or gives energy to the network depending upon if its power consumption exceeds its power generating capacity or if its power generating capacity exceed its power consumption.

Another feature of the project is the use of the hot air obtained in the chamber formed between the solar modules and a transparent glazed wall. This hot air is used in winter as preheated air in the conventional heating system of the building as well as it is expelled outside of the building in summer. This thermal system allows a power saving upper than the 30%.

Other interesting good practice examples:

- Hospital of Vielha, Lleida.
- Dispensary of Perales de Tajuña, Madrid
- Music school in Almería.

REPORT 12

THE SOUTH AFRICAN REPORT ON SUSTAINABLE DEVELOPMENT AND FUTURE OF CONSTRUCTION

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION

This study was undertaken by the Division of Building Technology (Boutek) of the Council for Industrial and Scientific Research (CSIR), South Africa. It is an interim country report and reflects mainly the views of a few people within Boutek. If feasible, it will be expanded through a national workshopping process in the year. The report forms part of an international pilot study done under the auspices of the International Council for Building Research Studies and Documentation (CIB) and specifically the Working Commission 82 that deals with the future of construction.

1.1 Aim

The aim of this document is to investigate the meaning of sustainable development in the South African context and what impact it would have on the built environment and with it the construction industry by the year 2010.

1.2 Methodology

While drawing heavily on research done by the author in the course of postgraduate study, the report is mainly a synthesis of two in-house CSIR reports, a conference paper prepared by CSIR researchers in conjunction with academics at the Universities of Cape Town and Pretoria, a conference paper delivered by the author, and the government White Paper on Environmental Management. Due to time constraints it was not possible to workshop the report, but it was sent for comment to members of the Sustainable Development Forum within the Division of Building Technology at the CSIR and to selected academics at the University of Pretoria (see acknowledgements).

The following documents were used to inform this synthesis. The nature of the synthesis is such that referencing each phrase taken from these documents would have resulted in a very difficult to read document. However, where substantial amounts of text were quoted, the normal referencing procedure was followed. The author would therefore like to acknowledge the authors of these documents as co-authors of this report:

Boutek - CSIR. 1998. *2020 Technology Foresight: The Built Environment and the Construction Industry*. Report no. BOU/I103, March 1998. Pretoria: CSIR.

Shuttleworth, L. 1998. *Sustainable Construction*. Unpublicised internal draft report. CSIR-Boutek.

Hill, RC, Kusel, K, Pienaar, J and Bowen, P. 1998. *The transition to sustainability in the planning, construction and management of buildings and settlements in South Africa.* To be presented at the 1998 CIB conference at Gâvle, Sweden.

Du Plessis, C. 1997. *The Meaning and Definition of Sustainable Development in the Built Environment.* Proceedings: 1997 CAA Conference on Urbanisation and Housing, Goa, India.

South African Government Gazette (1997) *White Paper on Environmental Management Policy.* Pretoria: South Africa.
hhtp://www.polity.org.za/govdocs/white_papers/envir.html

1.3 National concerns, constraints and issues

1.3.1 Context

In many ways, South Africa represents a microcosm of the developmental and environmental issues facing the world economy. The country manifests both the environmental problems of the affluent, industrialised world, and those of poverty and underdevelopment.

The South African economy extends from the agricultural (rural) society, through the industrial society, to the information society. Economic attitudes vacillate between seeing the newly democratic country as a land of opportunity and a growth point in Africa, and seeing it as another African country full of uncertainties and a high risk investment area. Developers look for quick returns and low risks and are not willing to take the long term view that sustainable development will bring its own rewards in good time. Unless significant economic growth is achieved, economic growth alone will not be a significant driver of construction activity in the country.

Establishing social and economic equity will be the biggest driving force in South Africa over the next ten years. Social equity is as high on the agenda as environmental concerns, and therefore more thought is given to the impact of construction on social and economic sustainability. The construction industry is thus geared towards job creation and more labour intensive practices. Entrepreneurship is encouraged, with construction companies outsourcing to previously disadvantaged contractors and obtaining building materials from small, local businesses. Emphasis is also placed on skills transfer and capacity building.

Having suffered many years under the development policies of an autocratic government, South Africans are very aware of the need for public participation as part of sustainable development and have well-developed skills in this regard. For any development, a public participation process is as important as an environmental impact assessment.

The problems with building stock in South Africa centres more around the provision of housing and new infrastructure, than upgrading the existing infrastructure, although this is also a concern.

The opportunity therefore exists to create sustainable settlements from scratch, instead of having to fix existing problems. However, the pressure for delivery is such that sustainable development principles may be sacrificed in the short term and quality falls by the wayside.

South African society is very fragmented and there are vast disparities in income and educational levels, as well as complex ethnic and cultural differentiations resulting in much tension across racial, cultural, tribal and political lines. Furthermore, the conflict surrounding the country's transition to full democracy has created a development arena that is fraught with gatekeeping, political power struggles and mistrust. This calls for sensitive public participation programmes and intricate negotiations and tradeoffs.

1.3.2 Key issues and constraints

Ensuring equity

The major focus for the South African government over the next ten years will be to redress the inequalities of the past. While most of the work will lie in the field of socioeconomic development, the political ideology of apartheid also influenced the built environment. Separation of the races and oppression of the majority resulted in cities with unsustainable settlement patterns that were deliberately designed to keep a large percentage of the population poor, with no means to better themselves. Cities have no equitable distribution of facilities and employment opportunities and millions of people are housed in sprawling dormitory suburbs on the periphery of the city with grossly inadequate public transportation to where the shops, schools and job opportunities are.

One of the biggest challenges for planners, designers and the construction industry lies in reducing the imbalances in the spatial development of the apartheid cities to create more equitable city structures.

Poverty alleviation

It is estimated that 39 per cent of South African households live under the nominal poverty line. Apart from contributing to social problems such as crime and low education levels, this translates into a very small tax base. Emphasis is therefore not on social security programmes, but on job creation, entrepreneurship and capacity building. As one of the largest employers in the country, the construction industry is being geared towards job creation and more labour intensive practices, as well as skills transfer and capacity enhancement. Entrepreneurship is encouraged, with construction companies outsourcing to previously disadvantaged contractors and obtaining building materials from small, local businesses.

Catering for a young, growing population

Thirty seven per cent of the South African population is under the age of 15. It is estimated that the population of South Africa will reach 56 million in 2010 and will double within the next 30 years. The requirements of the young population will be a key driver for the demand of construction products in South Africa. Apart from education and training facilities, the youth also needs sport and recreation facilities. The growth in population will demand more health and commercial facilities and put further pressure on housing and infrastructure delivery.

A factor that may change the above population estimates is AIDS. Although the statistics are unreliable, evidence points to a large percentage of the young population being HIV positive. It is uncertain how this will affect population growth, but it will increase a demand in health facilities and care centres.

Urbanisation and housing provision

Two of the most important issues for the South African construction industry will be the construction of new settlements to house the predicted population growth, and the upgrading of old apartheid townships and the informal settlements surrounding the existing cities.

By 2010, more than 60 per cent of the population will live in metropolitan and urban areas even though the pace of urbanisation has slowed due to a lack of jobs, high levels of crime and violence and the huge backlog of housing and other services. The existing backlog stands at more than a million houses and it is estimated that an additional 150 000 houses need to be built per year to provide for the increase in population.

Political pressure for short-term volume delivery of land, housing, services and facilities, is resulting in the old pattern of low-density mass housing on the urban periphery reemerging as the only significant form of urban development right now. This is supported by personal aspirations created by liberation ideology and a popular demand for the one house one plot model of development.

Solving the problem of informal settlements is hampered by the fact that this is not a homogenous, generic type of urban form for which a model solution can be found. Each settlement has a different population profile with different allegiances and a different reason for coming into existence. Approaches will be flexible, customised and based on a proper study of the context and dynamics of each settlement.

Conservation of scarce resources

Past development has not only neglected the development of the country's people, but has also largely ignored constraints arising from the finite character of non-renewable natural resources and the ecological cycles that sustain renewable natural resources.

The most important conservation issues at the moment centre on water, land and indigenous knowledge.

Water

South Africa is classified as a semi-arid country. About 64 per cent of the country receives less than 500 mm of rainfall a year. Around 60 per cent of the country's water is used to irrigate farmlands, while 17.8 per cent goes towards domestic use. Of that, 20 per cent is attributed to systems loss because of inadequate and badly maintained systems and illegal tapping into water mains, while 35 per cent goes towards gardening. Industry uses 11.3 per cent of the country's water with power generation and mining using 4.3 per cent and 3.3 per cent respectively.

The Ministry of Water Affairs and Forestry have instituted a major water saving campaign. This campaign entails information drives on waterwise gardens and domestic water saving, and a countrywide drive to eradicate alien vegetation like Australian Hakea, Black Wattle and the Port Jackson along waterways. The upgrading and maintenance of existing water reticulation systems and the rethinking of other water-based services like sewerage and storm water collection will directly influence the construction industry.

Inadequate sanitation is a particular concern because of its impact on water quality. It is estimated that 21 million people in South Africa do not have adequate sanitation. Ill placed informal settlements have already polluted the aquifers around the large cities, and both industry and informal settlements have polluted the country's rivers.

Land

Only about 11 per cent of the country's land is arable. A large percentage of the arable land is found around cities and towns. Urbanisation and industrialisation therefore contribute to the loss of high potential agricultural land. The ever increasing needs for energy, provided mainly by coal burning power stations, are responsible for further loss through strip mining and the emissions changing the acidity in the ground.

A further concern is the scarcity of natural aggregates. Uninformed planning has resulted in many of the existing sources disappearing under township development, but this remains a largely unknown issue.

Indigenous knowledge

History has seen deliberate suppression and dismissal of indigenous knowledge on agriculture, medicinal plants, building technology and social organisation. This dismissal came from both the colonial attitude that indigenous people have little to offer in the way of technology, and from a populist movement to discard 'backwards' living models and materials in favour of the high technology of the First World. Because most indigenous knowledge was verbally communicated from generation to generation, and the younger generations were actively discouraged from continuing with traditional practices, indigenous knowledge is fast being lost to the world. The importance of this knowledge is now being re-evaluated and attempts are made to capture it on more permanent databases. It could assist with identifying drought resistant indigenous crops suitable for small scale farming, developing new medicines based on traditional herbal remedies, designing more sustainable settlement patterns and encouraging the use of appropriate technologies.

An important aspect of traditional African social relationships is the concept of *ubuntu.* This sees all people (including the people of the animal and plant world), their ancestors and their descendants as part of one organism, and all actions must be done with the good of the whole in mind. The saying that underlies the concept - *umuntu wabantu ababantu-* literally translates as 'a person is a person because of other people". *Ubuntu* lies at the heart of sustainable development.

Improvement of public transport systems

Little provision was made for public transport systems in the planning of South African cities, despite the fact that only a minority of the population can afford private transport. Public transport is mostly road based, even though an extensive rail network exists. Badly maintained vehicles contribute significantly to air pollution and one of the highest road accident rates in the world. The largest existing public transport system in South Africa, the minibus taxi industry, is mostly in the hands of unscrupulous entrepreneurs and is characterized by unacceptable safety standards, high prices and territorial violence.

The lack of affordable public transportation is contributing to increasing poverty levels, as it is not uncommon for a worker to pay more on transport than on food, shelter and clothing combined. It furthermore prevents equitable access to health and educational facilities, as well as social services.

2. SUSTAINABLE DEVELOPMENT

2.1 Meaning and definition

The concept of sustainability is not a new one. For thousands of years it has been practised by indigenous people world wide who lived by the principle that one should take from nature only that which is necessary for survival, always leaving enough for the next seven generations. However, few, if any, have managed to couple sustainability with what the Western mind set terms "development". Those cultures who have lived the most sustainable lifestyles were often also the ones considered extremely "backward" or "underdeveloped" and regarded as subhuman (consider the treatment of the Australian Aborigines, the Native Americans and the Southern African Khoi-San)

While the origins of "sustainability" lie with the traditional societies and indigenous people, the origins of sustainable development lie in science. The whole idea that a protocol for sustainable development can be defined, harks back to the ideas of the Enlightenment that Man can control nature and through science and technology address the problems imposed on human society by the "external limits" of nature.

The most popular definitions (see Box 1), such as those of the Brundtland Report (1), caring for the Earth (2) and the International Council for Local Environmental Initiatives (ICLEI)(3), are often vague and ambiguous, giving no agreement on what sustainable development may mean in practical terms.

Box 1: Definitions of Sustainable Development

1. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987, p.8)
2. Sustainable development means improving the quality of human life while living within the carrying capacity of supporting ecosystems. (IUCN/UNEP, 1991, p.221)
3. Sustainable development is development that delivers basic environmental, social and economic services to all residences of a community without threatening the viability of natural, built and social systems upon which the delivery of those systems depends, (ICLEI, 1996, p.4)

The weakness of the above definitions lies in their reliance on vaguely defined concepts such as 'basic needs', 'quality of life' and 'basic services'. These are qualitative dimensions and very difficult to quantify. It is this very need to define and measure the qualitative dimensions of sustainable development that is the biggest obstacle to its successful definition. What is happening instead is that the requirements for sustainable development are turning into an ever-growing wish list for an ideal society, instead of concentrating on the practical implementation of the sustainable development philosophy within a given context.

The generally quoted prerequisites for sustainable development, such as peace, democracy, human rights, equality, efficient use of energy resources, local community involvement, fair distribution of wealth and participation in all sectors of decision making (International Institute for Sustainable Development, Youth Source Book, 1995), are actually doing the concept a disservice. It creates the impression that sustainable development is only possible in an ideal society.

The concept of 'basic human needs', for one, is very controversial, especially in the current consumer society where human 'needs' are determined by market forces and not actual survival.

The quality of life that sustainable development aims for, has little to do with the quality of life propagated by consumerism. Before sustainable development can really become accepted practice, there will have to be a redefinition of 'quality of life'. In the end sustainable development may simply mean that the rich must live simply so that the poor can simply live.

There is as yet no universally agreed-upon definition of sustainable development that can be used by all the various interested parties in the development arena, and perhaps no such definition is necessary. The International Institute for Environment and Development (IIED), one of the first organisations to propagate the term 'sustainable development', admits that it has never felt a need for a rigorous, theoretically consistent definition beyond the notional 'handrail'. (Holmberg, 1992, p. 23) Instead, it might be more useful to define this 'handrail' that will guide the various disciplines in spirit, while allowing them to set individual requirements.

The main criteria for sustainable development seem to be agreed on as follows:
1. Development that will not do irreversible damage to the earth's natural systems, that avoid using non-renewable resources, does not pollute, uses energy efficiently, takes the 'embodied' energy of building materials into account and fits into natural cycles, not change them.
2. Development that involves the community in decision making, does not destroy social structures, does not endanger health and does not diminish quality of life.
3. Development that does not destroy livelihoods, does not reduce the value of property, does not make a community reliant on one form of income, but provides entrepreneurial opportunities, supports local business and uses true-cost pricing.

These are the common criteria to be found in all the sets of requirements, principles and strategies examined and can be taken as the basis for the criteria of sustainable development in the built environment.

The above criteria can be used as a 'handrail' for the establishment of guidelines that are specific to the time, place and culture within which the development is to take place. Given the diversity of human life and the different 'needs' of each specific society, it would be impossible to establish a set of fixed, universally relevant guidelines for sustainable development. The more so because it becomes a complex issue of negotiated takeoffs and priorities that are community and project specific.

Clearly, sustainable development in the built environment is about more than 'green'[1] construction and urban planning. It is a process that:

- evaluates not only the environmental impact of projects, but also their social and economic impact;
- integrates technical, environmental, economic and social criteria in the design and construction process;
- prioritises needs and solves conflict through discussion with the community;

- informs and educates the community about the pros and cons of each requirement;
- is transparent in its decision making; and
- has entrenched feedback loops to constantly evaluate viability, sustainability and acceptability.

2.2 Sustainable development in South Africa

As manifested in the concept of *ubuntu,* sustainable development is in harmony with deep-seated African cultural values concerning the continuity of the dead, the living and the yet unborn. South Africa has taken sustainable development as a key priority and entrenched it in legislation, various policy papers and the Bill of Rights. (See Box 2).

Box 2: Section 24, South African Bill of Rights
" Everyone has the right... to have the environment protected for the benefit of present and future generations, through reasonable legislative and other measures... that.secure ecologically sustainable development and use of natural resources, while promoting justifiable economic and social development "

White Paper on Environmental Management

The most important of these policy documents is the White Paper on Environmental Management published by the Department of Environmental Affairs and Tourism (DEA&T) in 1997. For the first time it gave South Africa national guidelines on sustainable development, and firmly established it as part of government policy.

The Minister of Environmental Affairs and Tourism, Z. Pallo Jordan, stated the importance of sustainable development in a media briefing:
"This White Paper sums up government thinking on environmental management based on an integrated and holistic management system for the environment. The concept 'sustainable development' is the centrepiece of our new policy thrust." (9 Sept 1997)

Adopting the Brundtland definition (See Box 1) of sustainable development, the White Paper states that sustainable development focuses on maintaining and improving the quality of life of all South Africans by meeting their basic needs, rather than on the quantity of economic activity. Growth and development needed to improve quality of life must be reconciled with the sustainability of natural resources so as not to compromise the ability of future generations to meet their needs. Sustainable development also requires that particular attention be given to addressing the needs of previously disadvantaged communities.

The vision of the environmental management policy is one of a society in harmony with its environment. The policy seeks to unite the people of South Africa in working towards a society.

Box 3: Criteria for Sustainable Development

The new model or paradigm of sustainable development is based on integrated and coordinated environmental management that addresses:

- people's quality of life and their daily living and working environments;
- equitable access to land and natural resources;
- the integration of economic development, social justice and environmental sustainability;
- more efficient use of energy resources;
- the sustainable use of social, cultural and natural resources; and public participation in environmental governance.(White Paper on Environmental Management, 1997)

where all people have sufficient food, clean air and water, decent homes and green spaces in their neighbourhoods that will enable them to live in spiritual, cultural and physical harmony with their natural surroundings. Short term solutions to alleviate immediate demands are cautioned in the context of sustainable development.

The White Paper also defines environment as broader than just the natural environment.[2] (See Box 4: Definition of Environment)

Other government policies

The Development Facilitation Act, Act 67 of 1995 (DFA) and the Local Government Transition Act, Act 209 of 1993 (as amended by Act 97 of 1996), both compel local government to follow bottom up planning, and include active local participation and environmental impact assessments. Both these acts are of critical importance towards attainment of social sustainability in development projects.

Box 4: Definition of Environment, DEA&T, 1997

Environment refers to the conditions and influence under which any individual or thing exists, lives or develops. These conditions and influences include:

- the natural environment including renewable and non-renewable natural resources such as air, water, land and all forms of life.
- the social, political, cultural, economic, working and other factors that determine people's place in and influence on the environment;
- the natural and constructed spatial surroundings, including urban and rural landscapes and places of cultural significance, ecosystems and the qualities that contribute to their value.

The Reconstruction and Development Programme, centrepiece of government policy, is a vision for the fundamental transformation of SA by, inter alia, creating a "...sustainable and environmentally friendly growth and development plan".

The Housing Subsidy scheme recommends that, where developers build for a community, the project must be underpinned by a social compact (National Housing Forum). A regular stipulation of such a compact focuses on the maximum utilisation of local materials and labour. (Dalgliesh, CD and Hill, RC, 1997)

The newly released White Paper on Local Government (March 1998) presents a vision of a developmental local government which centres on "working with local communities to find sustainable ways to meet their needs and improve the quality of their lives". The White Paper places the provision of basic household infrastructure as the responsibility of local government and exhorts the use of affirmative procurement policies and linking municipal contracts to social responsibility. The main importance of this White Paper is that it represents a shift in planning philosophy from physical planning to planning for economic development.

The Land Reform Programme is addressing the dense rural and peri-urban settlements, especially in the former homelands, where land tenure must be clarified before development can occur. Current tenure requirements for finance (whether state subsidies or through the private sector) prevents development on, for instance, the communal land that forms part of African tribal land ownership and that forms the bulk of land in the former homelands.

The Gauteng Provincial White Paper on Urban Regeneration and Integration addresses urban decline and underdevelopment, as well as the integration of cities, towns and townships. It outlines as principles the setting up of cooperative partnerships between the public and private sectors; putting in place strategies for conserving existing resources and energies; developing strategies that are specific and appropriate to local situations; balancing growth and development between centres and, ensuring the process is driven by full community participation.

Despite the incorporation of sustainable development in general government policy, there is little effort to coordinate the various initiatives to promote sustainable development in the country. This might soon change as, at the Rio +5 conference in 1997, the Minister of Environmental Affairs and Tourism committed South Africa to having a national policy on sustainable development in place by 2002.

The construction industry

Sustainable development in the construction sector, including manufacturing of construction products, requires that the construction process be optimised to reduce the consumption of materials and energy. Within the context of sustainable development and growth of the South African economy, environmental issues must be balanced with durability and economic viability (the Life Cycle Cost) of construction, as well as its social impact and viability. It must be kept in mind that durability and attainment of service life are environmental, economic and social priorities as poor quality will be paid for at some stage during the service life of a building, and therefore has an impact on the quality of life. The cost of poor quality can be monitored financially (initial investment and asset management) and environmentally (resource consumption).

This wider understanding of sustainable development (beyond environmental issues) is already being explored by the construction industry and other big businesses. Large companies who belong to the Industrial Environmental Forum of Southern Africa are engaged in a voluntary process which is turning from only addressing the environmental impacts of new developments in 'greenfield' sites, to a more holistic view in which the environmental and social impacts of their activities are targeted for improvements in performance.

3. ANSWERS TO THE MAIN QUESTIONS

1. What kind of cities and settlements will we have in 2010 and what does this entail for city planners and the built environment?

It is not expected that the type of cities and settlements will change much over the next 12 years, because the existing spatial patterns are extremely well entrenched and the economic power base that influences development is still concentrated in specific areas. However, their expansion, maintenance and management will see some definite changes.

Integrated spatial planning will become very important to ensure that valuable agricultural land and aggregate resources are protected, that aquifers and rivers are protected from seepage and pollution, that there is an equitable distribution of community facilities and economic opportunities and that the real needs of the people are heard through public participation programmes. Combining integrated spatial planning with integrated design methodologies and environmental management results in the identification of the 'optimum sustainable design', which can be translated as durable construction which meets the objectives of sustainable development.

Rural communities will become empowered through participatory processes that enable them to realise their own opportunities and solutions, thereby solving identified problems. Once they have neem through this process, they will be in a position not only to set their own development programmes, but also implement them in consultation with appropriate stakeholders.

Various collective approaches in the spirit of 'ubuntu' will be developed, as these will enable rural communities to utilise their own skills and time to build homes and other community projects, thereby effecting monetary savings and developing local capacity. Savings instituted by the use of local people can be used to generate other economic enterprises, which will help in achieving sustainable local social and economic systems.

The following are the major issues city planners and local authorities will have to deal with:

Compact development

Current urban design policy calls for compaction and the location of low income residential areas within the developed city limits, close to existing job opportunities, and more easily serviced by public transport, as opposed to peripheral developments with little access to job opportunities and urban amenities. Higher density residential development is proposed in all areas, whilst the focus of high density development is on points of high accessibility and high intensity of activity. This will aid in slowing down urban sprawl and shorten travelling distances.

In practice, low income residential areas would remain peripheral because of cheaper land costs, availability of land and opposition from already established communities. Aspirations towards the idealised model of 'one house, one plot', will continue to hamper drives for higher urban density. Furthermore blue collar employment is moving towards the periphery, bringing the jobs to where the workers are, but furthering inner city decline.

Integration

This is a specific concern for South Africa where cities are markedly separated on racial and economic lines, often with buffer strips of industry or undeveloped land between the rich and poor. The biggest problem confronting planners here is the eradication of this spatial segregation and the integration of the various apartheid townships in the city structure and its economy. At the same time, these undeveloped tracts of land presents major opportunities for development.

Integration on city level would, however, call for more than racial and economic integration. Factors that will have to be explored in the future are the spatial integration of employment and residence, and with it, the integration of multiple land uses; the integration of strategic, operational, sectoral and spatial planning; and the integration of various developmental processes such as planning, management, implementation, community interaction, monitoring and review.

The integration of various townships and local authorities into one metropolitan management structure will even out service delivery. This would inevitably mean a drop in standards of service delivery in the more affluent neighbourhoods, but would improve the service delivery in the previously disadvantaged neighbourhoods. Apart from contributing to social sustainability, improved service delivery would mean less direct pollution through sewerage seepage, wood fires and litter, as well as a reduction in systems water loss through water theft.

On a more physical level, activity spines and development corridors will be used to integrate the various areas. These elements are also used to intensify certain areas in order to create viable economic opportunities, as well as to spread the economic activities more equitably.

Sustainable land use

There is a definite move towards a greater mixture of land use that will allow for compact communities where housing, work, services, facilities and public transport are all within walking distance. Home-based enterprises, 'teleworking' or 'nearworking' will reduce commuter traffic and the need for high traffic roads. Mixed land use will also enhance the viability of new development on the urban periphery.

Undeveloped land like road and rail reserves, as well as abandoned military and industrial land, will be recycled and optimally used. Inner city renewal will be generated by the re-introduction of a residential component through infill development of vacant land, redevelopment of derelict areas, and conversion of unused or partly occupied commercial buildings into residential flats.

Due to the loss of agricultural land through urbanisation, urban agriculture will be actively encouraged, especially on vacant land that is not suitable for construction.

Emphasis will be placed on recycling and reuse of waste to minimise the use of land for landfill and dumpsites.

It is possible that some new settlements will be ecologically closed-loop systems in which all waste is transformed into food and recycled products, and in which food systems and settlement systems will be closely integrated. There are already some pilot eco-villages [3] in South Africa, most notably the Tlholego Village and Kuthumba Eco-village (See Chapter 5). The community of Orange Farm has also started a prototype eco-village.

Given the links between traditional African community and settlement patterns and the eco-village idea, the fact that communities will increasingly take ownership of the process of service delivery and that people will become more responsible for providing their own services and shelter as government dedicate money to education and the stimulation of economic growth instead, eco-villages provide a sustainable solution to especially rural and peri-urban development and it can be expected that there will be a number of them in South Africa by the year 2010.

Improvement of public transport

It is inevitable that the state will have to take some control over the taxi industry, probably in the form of a national taxi cooperative that can regulate and maintain safety standards, ensure vehicles are maintained to reduce emissions, control route allocation and negotiate price increases with commuters.

There will be an increase in the use of vehicles not using fossil fuels, like buses running on earth gasses or hydrogen, and the rail network might be augmented by light rail transport systems.

City planners will actively plan for the provision of non-road based public transport and its integration with road based transport to achieve a seamless network of public transportation that complements the integration of the city.

Crime

Unacceptably high crime levels are turning South African cities into a conglomeration of fortresses. The fastest growing development product is security villages that sometimes even provide schools, shops and offices within their fortified perimeters. There is little likelihood that crime levels will decrease significantly in the immediate future and the fear of crime will continue to shape South African cities and towns well into the next century.

Recent government initiatives have launched a study on crime prevention through environmental design[4], but it will be some time until its recommendations will influence the design of cities and neighbourhoods.

2. What kind of buildings will we build in 2010 and how will we adapt existing buildings?

Given the expected population growth, the backlog in housing and services and the youth of the population, it can be expected that building types will concentrate on affordable housing, educational and recreational facilities, and commercial and industrial development to provide employment opportunity.

New community buildings will be multi-functional with one building serving several purposes during the course of a day or week. This will do away with the need for several dedicated buildings, saving building costs and land and contributing to safer neighbourhoods, but will require re-education and an efficient strategy for dealing with the logistics. Money saved by designing multi-functional buildings can then be used to make that one building durable and energy efficient.

Commercial premises will be built to be highly adaptable, with a durable skin and recyclable internal divisions and fittings. Buildings will be designed with life cycle costing in mind and the constitutional right to live and work in a healthy environment will force many developers to opt for healthier climate control measures and building materials.

Industrial complexes will be rethought to allow for zero emissions manufacturing, greywater use and recycling of waste. Emphasis will also be placed on healthier working conditions, reduced pollution, resource efficient processes and energy and water savings. This will impact on the built form and materials used.

Affordable housing will either be self-built, using improved forms of indigenous construction technologies and local materials, or incremental housing based on small, mass-produced units using high-energy building systems. Although the latter is not always desirable, the technology will still be used because of pressure to deliver, perceptions on quality and entrenched interests.
The use of upgraded traditional technologies will be encouraged, where appropriate, as this will enable impoverished communities to build homes that give them greater value for money than more expensive conventional building methods. This use of local materials and methods will undoubtedly lead to cost effective and appropriate buildings being built using local materials and methods.

In general, housing sizes will decrease as families become smaller and materials more expensive. Existing large houses will be subdivided into separate living units. Cluster units in security villages will remain a popular option for those who can afford it.

Existing buildings will be retrofitted with more environmentally friendly services to produce 'healthier' buildings, and, in inner cities, many will be turned into residential units.

3. How will we design and construct them and what does this entail for initiating, designing, constructing, maintaining, operating and demolishing buildings?

Designing, manufacturing, construction, facilities management and demolition processes will in future be strongly focussed on decreasing the impact of the construction of facilities and infrastructure on both the natural and social environment.

Initiating and designing

The choice of site and development product will consider its social and environmental impact, as well as the impact on the local economy, and will be influenced by public consultation and prescriptive legislation. Both an environmental impact assessment and public participation programme will have to be conducted on most proposed development before the design can be finalised.

The design will adapt to its environment by considering the climate, the culture, soil conditions and the aesthetic impact of the building.

In building design, all free natural resources will be effectively utilised. This includes the maximal use of natural lighting, gravitation-based ventilation and the utilisation of passive and active solar energy, wind energy and the thermal capacity of the ground. The design would also allow for efficient water use.

Construction

Conditions on site will be improved to be less ecologically destructive and noise, dust and vibration on construction sites will be reduced. Water and energy consumption of construction methods will be monitored and reduced. The environmental impact of transportation to the site will be minimised. Where possible, work will be outsourced to small, local contractors and local materials will be used.

Working conditions on site will be made safer and healthier, with robots performing some of the more dangerous tasks. Where appropriate, labour intensive construction methods and improved indigenous building technologies will be used.

Maintenance and operation

The main issues for the maintenance of buildings are durability of materials, energy use and water savings. Durable finishes and fittings that are easily cleaned and repaired will be the order of the day. Smart systems will control the energy use and adjust it according to temperature, time of day and occupation levels. Water saving devices, regular maintenance of taps and toilets and drought resistant landscaping will control water use.

Demolition

Demolition techniques will be refined to allow the extraction of re-usable components with little or no damage. The already existing market in recycled components like window and door frames, structural timber and roofing material, will be expanded to include crushed concrete aggregates, recycled plastics and insulation material

4. What kind of materials, services and components will we use then and what does this entail?

Materials

It should be emphasised that materials by themselves are not sustainable, only the use of materials can be sustainable.

Knowledge about the environmental properties of new and improved construction materials will be increased. This would include information on embodied energy, noise-absorption potential, the potential release of dust and toxic substances and recyclability. The use of energy, non-renewable raw materials and other resources in the production of construction materials will be minimised. The objective is towards zero-emission manufacturing, where all by-products will also be utilised, possibly by other industries working in a network. In addition to recycling, the use of renewable raw materials will be encouraged.

Construction industries will increase the use of environmentally non-detrimental materials. New construction materials and applications will be developed utilising different by-products from other industries. The use of materials produced by the vitrification of domestic or chemical waste will be increased in secondary structures. Composite materials and products made from recycled materials, offer numerous promising new opportunities. Biotechnology will also produce new building materials, or genetically engineer existing natural materials, e.g. wood, to provide a better product that provides more value for the resource use of its production.

Box 5: Future construction materials

Future construction materials will be characterised by the following features and properties:
- full recyclability;
- resource-saving manufacture
- the increasing use of local renewable raw materials and resources;
- enhanced strength, toughness and ductility;
- enhanced durability and service life;
- increased resistance to abrasion, corrosion, chemicals and fatigue;
- initial and life-cycle cost efficiencies;
- initial and life-cycle energy and CO_2 efficiency;
- improved response in natural disasters and fire;
- ease of application and installation;
- ease of use and maintenance;
- zero emission;
- non-toxic and zero radiation;
- moisture-safety;
- tailor-made materials; and
- the ability for self-diagnosis, self-healing and structural control (CSIR Report no. BOU/I103, 1998)

Two opposing criteria will influence the choice of building material. For components that can easily be re-used, the first priority is durability and long service life. For components that are difficult to reuse the requirement will be easy biodegradibility or recycling. The reuse of components will be preferred, thereby cutting out the energy costs of recycling and further manufacture.

Capital-intensive high technology production systems, materials with high embodied energy coefficients and poor thermal (energy-saving) attributes will still be in use, especially in the mass housing market.

Guidelines for the use of indigenous building technologies and found local materials will have been developed which will allow their use in urban areas. The life expectancy of these technologies will also have been improved through the development of easy-to-implement design principles and protective technologies.

Components

Components will be re-usable, easily extracted during demolition and designed with the saving of energy and water in mind. New technologies in building services offer major opportunities for energy saving with systems optimising the use of energy according to the actual needs of the occupant and systems recovering residual heat and recycling energy within the building. Light fittings and electrical devices like geysers will also be designed to minimise energy consumption. The use of photo-voltaic cells and solar heating will increase as these technologies become affordable.
Water-saving devices such as low flow shower heads, dual flush toilets and greywater irrigation systems will be common practice and the use of self-composting toilets that use no water and do not seep into groundwater reservoirs will be acceptable. New systems will be developed in high density urban areas to utilise collective organic waste as energy source.

Services and tools

Environmental life-cycle analysis tools will be developed to evaluate designs at an early stage and present the environmental impact of different design alternatives. These would take into account the entire environmental impact of a product from its cradle to its grave, including the energy used and the waste created by, for example, the acquisition of raw materials and demolition. This portfolio of tools will also assess the life-cycle cost of construction from a technical, economic and environmental perspective and assist with sustainable development.

Although the focus to date of assessment systems has been on assessing the impact of buildings on physical environments, the focus will increasingly shift to developing an assessment tool that includes the assessment of buildings and environments from a social and economic point of view, with the aim of achieving social sustainability in developments.

Integrated project databases will provide a seamless flow of information in electronic format that will be updated during the life of the project to provide a continuous feedback loop. Such a database will provide an integrated design model consisting of both spatial and other information, enabling all project participants to work together, exchanging design information, and applying advanced design tools to optimise the design and construction process.

Facilities Maintenance and Management Systems (FMMS) will become a necessary tool for the integration of strategic and operational management. FMMS systems provide strategic planners with updated information and enable holistic strategic reviews and appropriate pro-active maintenance of a facility. They represent a key tool for ensuring optimal use of available resources and for assisting with the attainment of sustainability in buildings.

5. What kind of skills and standards will be required and what does this entail for human resources and skills needed in the construction industry?

Skills

Information technology will impact on all aspects of planning, design, construction, operation and the maintenance of construction. In briefing and planning, sophisticated computer-based, multi-criteria, multimedia, three-dimensional space simulation and virtual reality tools will routinely be used to enable the making of more informed choices. During construction and operation IT will be used to provide as-it-happens information on design changes, logistical performance, running costs and environmental feedback. It would be vital for all players in the building industry to have the skills necessary to cope with this level of information transfer.

The emphasis on public participation in a complex society calls for skills in negotiation and facilitation, knowledge on different cultures and political sensitivities and skill in creative problem solving. Building professionals will have to be skilled in combining public participation with the design process.

A further necessary skill will be the ability to interpret environmental assessments and apply life cycle thinking,

Standards

It would be necessary to keep a fine balance between quality and cost. The recent past has shown that rigorous quality standards have served to discourage the building of affordable housing. Standards will have to be adapted to suit local perceptions and environmental conditions, and should include indigenous building technologies.

4. STRATEGIC RECOMMENDATIONS

4.1 Environmental sustainability

Land

Sustainable development starts with the choice of a product and a site. Both should be chosen not only according to environmental factors, but also according to the impact it will have on the local community in terms of socio-economic factors. This would range from respecting local values and areas of cultural significance to the impact on small local businesses through, for instance, altered transport patterns, as well as the sustainable job opportunities and opportunities for capacity building that will be provided.

Environmental factors that should be included in the choice of site are the presence of scarce resources like natural aggregates or clay and the potential agricultural use of the land.

Even in small settlements, development should aim for compact land use, thus creating communities which are less reliant on mechanised transport, can provide better passive surveillance and hence safer neighbourhoods[5] and can pool resources for alternative energy production and waste recycling.

Energy

It is necessary to address the issue of energy provision for the poor. In South Africa, affordable and sustainable energy provision for cooking and heating presents an enormous challenge. Most of the fuel currently used is either firewood (which has caused major deforestation and concomitant soil erosion and changing rainfall patterns) or fossil fuels like coal or paraffin. Energy efficient design of low cost housing, using site orientation, materials that provide thermal mass and suitable insulation can reduce the need for heating. Design of houses should allow for the incorporation of solar water heating and cooking systems.

Where large housing developments are planned, the use of photovoltaic cells and methane gas as energy sources should be considered. A linked system of photovoltaic cells, placed on the roofs of houses and feeding into a communal battery bank, can provide for most of the electrical needs of a community, in effect turning the entire settlement into a power station. Likewise the organic and sewerage waste of the settlement can provide methane gas for heating and cooking.

Materials and construction technologies should be chosen for the amount of embodied energy - that is the energy used in the extraction of raw materials, manufacturing, transport, construction, maintenance, operation and demolition - they represent.

Water

With most of the world facing a global water crisis, it would be prudent to install water-saving devices in both new and existing buildings. Buildings should be designed to capture rainwater and paved surfaces should use materials like porous brick pavers that reduces run-off.

Apart from watering the garden, the biggest household use of water is flushing the toilet. Especially in arid countries serious thought should be given to using waterless sanitation systems where possible. Systems such as composting toilets had developed to the point where they can be installed inside the house and present a closed system with no seepage into the groundwater.

Grey-water should be kept separate from 'black' water so that it can be used to flush the toilet and water the garden..

Landscaping should reduce water run-off through contouring and ground covers. Drought-resistant, indigenous plants will also reduce water use.

Materials

More research should be done to increase the life expectancy of indigenous construction materials, codes of practice should be developed for these materials and their use actively promoted where appropriate.

Incentives should be put in place for developing new environmentally friendly building materials and improve the environmental performance of existing materials. Likewise, incentives can be created to limit the use of environmentally detrimental materials..

4.2 Economic sustainability

Basis for Competition

The basis of competition must be quality (defined as satisfying the clients needs), profitability and sustainability. These can be viewed as indicators of the construction industry's contribution to sustainable development. The 'real' benefits of innovative technologies and materials must be substituted for perceived benefits (or lack thereof) to demonstrate that innovation and sustainable development initiatives are not in conflict with competitiveness. Once real benefits are substituted for perceived benefits, and responsibilities for environmental management are mandated, the drivers of competitiveness will be life cycle cost, quality, environmental performance and social responsibility. Demonstration of the benefits of innovative solutions which meet the criteria of sustainable development can be achieved using integrated modelling techniques and virtual reality technology.

Quality indices and service life prediction must be applied in the building design and construction process. Prediction of service life is a prerequisite to all further life cycle analyses as this establishes the boundary conditions. The 'cost' of construction must be justified in terms of mandatory technical performance. 'Cost' embraces economic, environmental and social implications of construction. Trade-offs between competing objectives must be 'managed' at the design stage using established criteria as costs to the environment and can be counted as benefits to the economy.[6]

Poverty alleviation

Where appropriate and viable, labour intensive construction methods can provide much needed jobs. The majority of jobs created in this way are project dependent and thus not sustainable in the long term, but if they are combined with skills transfer, they provide a much needed opportunity for self-improvement and entrepreneurship.

Outsourcing to small, local contractors and suppliers, instead of importing manpower, materials and equipment, will provide a boost for the local economy and promote the social sustainability of the project. In return, local support will make the development more economically sustainable.

Finance options

When dealing with development for the poor, creative finance solutions are called for that allow for different tenure options, development on communal land, mechanisms like 'stokvels' and the cooperative use of housing subsidies.

4.3 Social sustainability

Public participation

It is necessary that a methodology for true public participation be developed. The current system of identifying stakeholders and community representatives often cast doubts on the authenticity of the representation and marginalised groups are often not heard. A major problem with current public participation processes is that they are largely driven by consultants and existing power structures and are prone to hijacking by political pressure groups. It is often difficult to identify the real needs of a community amongst all the needs identified by 'experts' and politicians. The Orange Farm community (see Chapter 5) is one of the few who managed to sidestep the political minefield and as such can provide a model for the identification of representatives in public participation.

Despite the problems created by public participation, the involvement of local communities in delivery systems is crucial if a project is to receive community acceptance. A greater degree of community participation, community contracting, and dependency avoidance is needed if a proposed development aims towards social sustainability.

Gender equity

The construction industry needs to work towards greater gender equity. In South Africa, a large percentage of self help builders, especially in the rural areas, are female, yet their skills are generally being ignored on conventional building sites. While there is a definite move towards equality at the professional level, the blue collar employment opportunities are still relatively closed to women.

Cultural acknowledgement and spiritual well-being

Acknowledgement of spiritual well-being and cultural diversity in development projects creates a sense of self-determination and ownership for the intended users and promotes social sustainability (Hill, RC et al, 1998)

Environmental management policy in South Africa is already experiencing a shift from an ecological bias towards including people and their culture and accommodating diverse cultural needs, but more research needs to be done on the spiritual well-being of people. In this regard the field of environmental psychology has been long neglected amongst design professionals, but can offer valuable insights into the effect of the environment on the human psyche.

The construction industry in South Africa should consider how it can include the concept of 'ubuntu' in its decisionmaking and operation and what this can contribute to sustainable development.

Education

There is a need for education on sustainable development at all levels. This would include the adaptation of tertiary curricula to accommodate sustainable development thinking and basic knowledge on environmental design and public participation; continuous re-education of building and construction professionals; raising awareness of the benefits of sustainable development in clients and educating the end-user on sustainable living and how to use and maintain new technologies and services.

4.4 Technical sustainability

Decision support

It is necessary to create a coherent construction development profile which matches technological choices and approaches with broader socio-economic objectives for sustainability. An inventory of all life cycle costs should be made and suitable indices for measuring technical, economic, environmental and social performance should be identified.

To assist with this, it would be helpful to create a bench marking programme which evaluates best practices and examine how they can be improved or adapted to different conditions.

Decision support systems and tools should be flexible enough to accommodate a continuous feedback mechanism that informs the design and construction process.

Indigenous technology

Methods to improve the life expectancy of indigenous technologies and materials should be developed and the use of these materials encouraged where appropriate.

5. BEST PRACTICES

SA Wildlife College (Kruger National Park)
Denis Moss Partnership Inc.

The college is claimed to be the most advanced example of sustainable architecture built in South Africa to date. Much of the design is determined by energy and resource efficiency considerations. The protection of natural systems was a high priority, given the pristine natural environment that surrounds the college. The design and construction processes involved local communities as much as possible, to ensure the equitable sharing of the social and economic benefits ensuing from the construction of the college. Locally obtained materials that can be sustainably harvested and managed (e.g. thatch) were used.

Most of the building work was contracted to the Bushbuck Ridge Builders Association, a consortium of Murray and Roberts (one of the largest construction firms in South Africa) and local builders and artisans. As far as possible local suppliers, craft workers and manufacturers were supported by the development. Unskilled labour was recruited from 11 surrounding villages.

Over the 18 month construction period, the project provided employment for an average of 200 people, of whom 40% were women.

Energy efficiency was a key criterion in the siting and design of the college. Great care was taken to shape the college around natural features, such as trees, thereby utilising existing shade to cool buildings. The buildings were carefully orientated and designed to minimise sun penetration and heat gain. Planted pergolas were provided on the north side of buildings to provide shade in summer. Natural cross-ventilation has been enhanced through the provision of raised roofs with openings; other features include seep roof overhangs and thick walls.

The College uses a ground water source according to a strict management plan that aims to ensure a sustainable yield of water. Consumption levels are managed through the use of water-saving devices and reusing grey-water and sewerage effluent for irrigation.

A number of the buildings were designed to be multi-purpose and adaptable for future uses, thereby negating the need for new buildings to house new functions.

Novalis - Ubuntu Centre (Kenilworth, Cape Town)
Johnson Murray Architects

The centre is to function as a training facility for teachers in the Waldorf system of education. The structure is to be a *building for the human soul*, and thus the main emphasis in the design was the quality of the spaces and indoor environment that are created in the building.

Physical and spiritual well-being was an important issue for the Novalis-Ubuntu Centre as part of their whole educational philosophy. A 'geomancer' was commissioned to identify 'geopathic stress spots'. These are points of adverse or negative energies that usually originate from underground water sources, magnetic grid lines and radiation, amongst others. Where buildings are sited above them, these forces become confined within the buildings and are said to cause stress and illness in people working within these buildings. Organic forms and human scaled designs further contribute to the well-being of occupants of the centre.

The client's brief also stipulated that training of local workers on site was compulsory, and labour intensive construction methods were used.

The Barn, Kuthumba Nature Reserve, Plettenberg Bay
Natural Architecture

The Barn is to provide accommodation for visitors to this private nature reserve, while further cottages are planned. The architects advocated the use of clay construction techniques, organic building forms and the use of natural materials to create buildings that are environmentally sensitive, as well as being sensitive to the surrounding landscape. A gum pole structure was used with wattle and daub infill panels.

The wattle, an alien plant, was harvested from the surrounding indigenous forest. Other materials used for the infill panels were locally-sourced clay, and straw that had been treated with old motor car oil. Thatch was used as a roofing material.

Provision was made for the reuse of grey water and a wetland sewage system is used.

The Barn also addressed the issue of deconstruction as the main construction materials used, clay and wood, are recyclable after demolition.

A 'clay building festival' was organised for the local community and friends to do most of the clay mixing and panel infill work. Local workers were trained in clay construction during the building of the Barn.

The Klein Constantia Wine Cellar
Gabriel Fagan

The Cellar provide an example of the way in which conventional building materials and methods can be used to create energy efficient and biophysically sensitive design solutions. It features passive design measures that involve orientating buildings and using materials in such a way as to make the most of natural energy for lighting, ventilation and temperature control. The cellar is partly buried, thereby making use of the insulating properties of soil. The roof is built of brick vaults filled with high mass concrete, which adds to the insulating properties of the building. These and other design features allow natural regulation of temperatures within the building and have eliminated the need for mechanical systems to maintain required temperatures. The cellar won an Eskom Design Award for energy efficiency in 1990.

The choice of site avoided damage to vulnerable farmland and vegetation that would have resulted from using the initially proposed site. The alternative site chosen was an old 'grey' site that had been used in the past to support farm sheds and other buildings. These old ruined buildings were demolished and the new cellar built on the site. Thus, no new land had to be cleared or damaged by the construction process.

House of Mr. Justice HA Fagan, Cape Town
Gabriel Fagan

Apart from design measures involving the orientation of the building and using materials in a way that makes the most of natural energy, lighting and temperature control, the Fagan house also uses passive solar design to regulate internal air temperatures. This building uses a combination of a large skylight on a north facing roof, situated above a heavy concrete floor finished in terracotta tiles. The tiled floor acts as a heat sink, absorbing the heat entering via the skylight, and releasing it at night or in winter months. The rooms were designed to maximise the flow of heat from this heat sink throughout the house. Large, adjustable blinds below the skylight prevent excessive heat gain in summer.

(First five references from Drager, L. and Hill, R. 1997, 'Sustainable Architecture in South Africa: A Review of Selected Case Studies', Architecture SA, July/ August 1997, pp.33-38)

Orange Farm Informal Settlement, Johannesburg
Orange farm Creative Action Development Forum
The Centre for Lifelong Learning: TECHNIKON Southern Africa

This settlement is an example of entrepreneurial self-governance. Lacking any formal municipal structure, the community embarked on a creative approach to develop the area. The community identified the leaders in the community, people known for resourcefulness and community concern. A self-governance structure, the Orange Farm Creative Action Development Forum was formed - an acceptable local structure for community development to improve the management and delivery of essential services. The community has since mobilised and channelled development funds through this forum and successfully developed schools and other services for the community. Several people in the forum have received national honours for their endeavours. The Centre of Lifelong Learning of the Technikon Southern Africa has made the principles established by the forum the basis for a special Integrated Community Building Programme, which encourages communities to be more self-reliant and self-responsible in their planning, decision-making and actions. (Hill, RC, et al, 1998)

Tlholego Development Project, Rustenburg[7]

The Tlholego Development Project (TDP) was established in 1991, in order to pilot research and development into sustainable technologies for rural development. These technologies include: ecological building, household food security, natural waste management, permaculture and education/training on these subjects.

The project is situated on a 120 hectare farm in the rural area 16 km west of Rustenburg in the North West Province. At present, Tlholego consists of three components:

- Tlholego Institute - the management, training and development centre for the project.
- Tlholego Village - a socially and economically sustainable model for village settlement.
- Tshedimosong School - a farm school for 300 students from the surrounding community..

The Tlholego village pilot is an important demonstration in the replacement of sub-standard housing with high quality, affordable houses which use modern techniques of unburned brick and appropriate technologies of rainwater collection, compost toilets, grey-water irrigation, solar collectors and permaculture gardens, to provide communities with food security and a foundation for the production of surplus.

One of the main objectives of Tlholego is to establish a rural settlement model, which demonstrates to South Africans real options for living sustainably in the 21st century. TDP is a pioneer for Permaculture training in South Africa, and works together with international and local networks of development specialists in housing, food security, training and village settlements.
The TDP is currently working with Brian Woodward, from Earthways, Australia, a world leader in low cost owner build housing, to develop a sustainable housing system for South Africa.

The Tlholego Building System combines the principles of sustainable building systems with natural waste treatment and the Permaculture approach for designing food self reliance to produce a high quality, low cost sustainable housing system for South Africa. Although the system was conceived as a solution to the low end of the housing market, it is in fact applicable to all sections of the housing market. It is also flexible enough to accommodate conventional building materials. The building system has succeeded in producing houses that far exceeds the size and comfort levels of those provided by the government and construction industry on the R 15 000 (± 5 000 US$) government housing subsidy. (Personal communication, Paul Cohen, Tlholego Trust)

Green Buildings for Africa Programme
Division of Building Technology at the Council for Scientific and Industrial Research (CSIR),

This is an assessment system that was developed to encourage and reward building owners who voluntarily implement profitable energy-efficiency upgrades in their buildings, i.e. to go beyond the normal requirements and to ensure sustainable development through the optimal use of non-renewable resources and the sustainable use of renewable resources with the minimum damage and risk to the environment and human health, whilst maintaining a healthy economy.

It uses the Green Buildings Environmental Assessment, the first such system in South Africa for existing commercial and industrial buildings. The system specifies a range of environmental issues covering the design, maintenance , operation and management of existing office buildings. Credits are awarded where the said issues have been addressed and satisfied. The system will be tested and refined in the 'Green Buildings for Africa' showcase programme.

Although the initial thrust of the programme is on energy efficiency, it also has the scope to address many other environmental dimensions that are reflected in the assessment system. It covers both global and local issues. These issues are approached firstly from the perspective of the Building and its services and secondly with regards to the operation and management of the building.

Facilities Management and Information System (FMIS)
Facilities Planning and Management Programme, Division of Building Technology, CSIR

The system allows detailed information to be captured on capacity, condition, suitability and the likely cost of ensuring continued functionality in existing facilities. A graphic visualisation language component enables people from different disciplines to understand and interpret data quickly, and to make informed decisions.

6. CONCLUSION

Achieving 'quality of life' and 'quality of the built environment' does not necessarily go hand in hand with sustainable development if such 'quality' is linked to gross consumerism and the use of environmentally and socially suspicious processes and materials. Pressurised by a constituency that demands quick delivery at all costs, the temptation is great for developing countries to follow the unsustainable development pattern of the industrialized world in order to achieve economic growth and First World development standards.

It must be emphasised that economic growth alone cannot ensure a sustainable future unless it is accompanied by environmental and social sustainability. Thus, while it is vital to catch up with the backlog in housing and infrastructure provision, it may be more cost-effective in the long term to provide more sustainable options to begin with.

The construction industry is traditionally conservative and loathe to adapt to new technologies, but there is a groundswell in favour of sustainable development practices that will become hard to ignore and the industry would do well to support it.

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8. ACKNOWLEDGEMENTS

I would like to thank the following people for their comments and contributions:

Boutek -CSIR

Lianne Shuttleworth :	Construction Technologies
Mark Kelly :	Construction Technologies
Vinod Singh :	Green Buildings for Africa
Nicki Coyne :	Shelter Group
Mike Bolton :	Shelter Group
Engela Brink :	Development Management Systems
Rodney Milford :	Technology Management
Jacus Pienaar :	Centre for Land Development, Housing and Construction, University of Pretoria

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1 Green construction can be defined as construction that considers only the environmental issues like energy efficiency, toxic materials and sustainable use of materials, but do not address the socio-economic issues engendered by the construction process.

2 For the purposes of this study, the more generally accepted meaning of environment as dealing with nature and ecological systems only will be used.

3 The term 'eco-village' includes more than just an ecologically closed loop system. There are various levels or degrees of eco-villages ranging from the ecologically closed loop, agriculture based village to a completely self-sufficient community with shared values and spiritual beliefs. For more information on eco-villages, visit the Global Eco-village Network at http://www.gaia.org

4 Napier, M, Du Plessis, C, Lieberman, S, Kruger, T, Shaw, M, Louw, A and Oppler, S.1998. *Environmental Design for Safer Communities in South Africa.* Pretoria: CSIR - Boutek

5 See Napier, M, et al, 1998.

6 I am indebted to Lianne Shuttleworth of the Construction Technologies programme in the Division of Building Technology at the CSIR for this section.

7 For further information on the Tlholego Development Project, visit the following websites: http//:www.gaia.org/thegen/genoceania/newsletter/december_97/safrtlholego.html
and http://dx.gaia.org/features/africa97.html

REPORT 13

SUSTAINABLE CONSTRUCTION
THE UNITED KINGDOM VIEWPOINT

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NATIONAL REPORT

CONTENTS

1. INTRODUCTION

This research project is part of an international research initiative investigating and reporting on sustainable construction and on efforts towards achieving sustainability in high and low consuming countries. The work is being carried out in collaboration with experts from around the world through the Conseil International du Bâtiment Working Commission 82 (CIB-W82), with contributions coming also from the following countries:

- Australia
- Austria
- Belgium
- Finland
- France
- Hungary
- Italy
- Ireland
- Japan
- Netherlands
- Romania
- Spain
- United States

1.1 Definitions

For the purposes of this study:

'***Sustainable development***' is defined as

'*development which meets the needs of the present without compromising the ability of future generations to meet their own needs*'[1]

The UK Government issued the first comprehensive British White Paper on the environment in 1990, entitled 'This Common Inheritance'. This stresses that 'Sustainable development means living on the earth's income rather than eroding it's capital. It means keeping the consumption of renewable natural resources within the limits of replenishment. It means handing down to successive generations not only man-made wealth... but also natural wealth...'

'***Sustainable construction***' is defined as

'*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*'[2]

1.2 Methodology

Based on the definitions outlined above, and the assumption that 'the UK construction industry will whole-heartedly embrace the concepts of sustainable construction', this report presents the responses to 6 fundamental questions in the light of a variety of four possible future scenarios that would lead to varying degrees of success in moving towards sustainable construction in the UK:

1. **What kind of buildings need to be built by 2010 and how could we adapt existing buildings?**
2. **How should we design and construct them?**
3. **What kinds of materials, services and components should be used?**
4. **What kinds of skills and standards would be required?**
5. **What kind of cities and settlements would we have?**
6. **What are the perceived barriers to the implementation of sustainable construction?**

The first five of these questions were discussed at length at an international CIB-W82 conference held at Ascot in October 1995. Each participating country is now compiling a report, following a standard format, using the same assumptions, scenarios and questions. CIB-W82 will then correlate and compare the response from each country. The sixth question follows on naturally as part of the requirements for this research project. A seventh question naturally follows on from this:

7. **How do we overcome these barriers?**

This question was considered at a second UK workshop held in Birmingham on 28 October 1996 and will be the subject of future workshops and international conferences. Some preliminary responses to this question have been included in this report, but they will feature prominently in future reports.

1.3 Commentary on scenarios for the UK

It became clear during the discussions that took place at the UK workshops on 18 September 1996 and 28 October 1996, and from reading the replies to the questionnaires, that of the four scenarios, Scenario 1 (Strong Together) is highly unlikely in the time scale envisaged. Scenario 2 (Strong Alone) is unlikely for the UK by 2010. Scenario 3 (Partial Sustainability) is most likely for the UK by 2010, and Scenario 4 (Weak Sustainability) is where the UK is now, and may still be by 2010. These are the pragmatic consensus views, and it was generally thought that for the UK to progress beyond Scenario 3 by 2010 would require a radical change of government, commercial and industrial policy, together with considerable shifts in public opinions and attitudes. It was thought that a few individual countries may have already reached Scenario 2, at least partially.

However, whichever scenario is chosen, the opinions of what the future vision of the construction industry and the type and style of future settlements may be are remarkably similar. Transport, energy and water use are the key factors in deciding the shape of our future. Education at all levels is vital to overcome the lack of knowledge and indifference to the high consumption, high waste society in which we currently live.

There are, however, some underlying doubts and difficulties with all of the scenarios and assumptions. It has been suggested that it is pointless trying to forecast the future without some futures framework which goes beyond the four given scenarios. The most obvious starting point would be the effects of the global economic shift, which will have profound consequences for the European construction industry, let alone for the UK. Other topics for serious consideration include the effects of an energy crisis in 2020/2030; potential mass migration northwards into Europe; more rapid climate change than previously predicted. In the context of such fundamentally important issues, examining sustainability a mere 15 years into the future is surely short sighted. If these issues are to be taken into account, then we are almost certainly not using the most appropriate definition of sustainability, and we should be endeavouring to define more realistically what it is that we are trying to sustain, and why.

1.4 Sustainable Development in the UK

Following the 1992 Earth Summit in Rio, the UK Government developed a Sustainable Development Strategy[3]. This included four broad aims for sustainable development:

1. a healthy economy should be maintained to promote the quality of life while at the same time protecting human health and the environment, in the UK and overseas, with all the participants in all sectors paying the full social and environmental costs of their decisions;
2. non-renewable resources should be used optimally;
3. renewable resources should be used sustainably;
4. damage to the carrying capacity of the environment and the risk to human health and bio-diversity from the effects of economic activity should be minimised.

The UK Strategy also contained a commitment to develop a set of indicators which could help assess whether our development was becoming more sustainable and whether the Government was meeting the objectives set out in the Strategy. As a result of this, a preliminary set of general indicators were published in 1996[4]. There are 118 indicators, grouped as follows:

A healthy economy should be maintained to promote quality of life while at the same time protecting human life and the environment, in the UK and overseas, with all participants in all sectors paying the full social and environmental costs of their decisions. • The economy. • Transport use. • Leisure and tourism. • Overseas trade.	*Non renewable resources should be used optimally.* • Energy. • Land use.
Renewable resources should be used sustainably. • Water resources. • Forestry. • Fish resources.	*Damage to the carrying capacity of the environment and the risk to human health and biodiversity from the effects of human activity should be minimised.* • Climate change. • Ozone layer depletion. • Acid deposition. • Air. • Freshwater quality. • Marine. • Wildlife and habitats. • Land cover and landscape. • Soil. • Minerals extraction. • Waste. • Radioactivity.

The carrying capacity of the environment for our effluent and emissions is recognised to be an important concept, but ascertaining what that capacity might be is difficult to determine. Equally, the cumulative effect and the interactions between the various components of our effluent and emissions on the environment is as yet unknown. Knowing which components are likely to have an effect on which part of the ecosystem is a key factor in the equation.

The construction industry accounts for a large share of environmental impacts including: demand for about 50% of UK primary energy supply (combined with building occupation); use of vast quantities of construction materials; and significant generation of pollution to land, air and water[5]. It is essential to determine the implications of sustainability for construction, both to reduce risks and identify opportunities. Following on from the original set of indicators for sustainable development, the UK Construction Foresight Panel has launched a project in 1997 to develop a framework and a set of sustainability indicators specifically for the construction industry. These are being developed through a series of workshops organised by the panel through BRE.

When the Sustainable Development Strategy was launched, the Government also appointed a Panel on Sustainable Development. This was set up to provide advice to Government on strategic issues relating to sustainability and other environmental issues. They have so far produced three annual reports, which cover many recommendations which affect construction and the construction industry in the UK. Comments from the latest report[6] recommend the Government to[7]:

- pursue a more proactive policy of greening its supplies and purchasing, e.g. by encouraging certification of environmental management standards;
- define a comprehensive set of principles and practices for the use of subsidies based upon the concept of sustainable development;
- develop new regulatory and fiscal measures to make it more difficult to develop greenfield sites and to encourage reuse of brownfield land.

A separate, non-government group, the UK Round Table on Sustainable Development, was also established in 1995. This brings together people from a wide range of backgrounds and responsibilities, and aims to produce agreement on major sustainable development issues. The group have also produced reports on topics identified as priorities for sustainable development, many of which are relevant to construction.

A key driver on the UK construction industry will be any framework introduced by Government to encourage more sustainable production and consumption, including regulatory controls and incentives for companies to improve environmental performance. The response to demands for sustainability in the construction industry will be crucial, and companies are likely to come under increasing political, public and economic pressures to become more sustainable. Organisations which do not adapt are likely to loose income.

Many UK organisations have investigated sustainable development, particularly from a planning viewpoint. The new government planning regulations also encompass the delivery of a set of sustainable development objectives. The draft document of Planning Policy Guidance Note (PPG) 7 supports sustainable development as a main objective. However, as no boundaries have been set, it is still difficult to determine what is a 'sustainable' development compared to an 'unsustainable' development.

There are many other non-governmental organisations in the UK who are involved with the issues of sustainable construction, and are actively working within the frameworks which have been set. The main sustainability initiatives in the UK have been detailed in the following Section of the report.

2. SUSTAINABLE CONSTRUCTION IN THE UK: ISSUES, VIEWS AND RECOMMENDATIONS

This Chapter summarises the responses received by BSRIA from the questionnaire survey and workshops. These have been discussed in relation to the five phases of construction specified by CIB: *development and planning, design, construction, operation and deconstruction.*

In each phase a number of issues relating to the UK construction community's approach to sustainability are identified. Recommendations for government, educational organisations and institutions, and research and development are indicated, alongside a list of selected initiatives relating primarily to each phase. More detailed descriptions of each initiative can be found in Appendix A3.

The discussion and recommendations contained within the following Sections are based entirely on opinions reported to BSRIA through questionnaires and workshops. Although BSRIA personnel participated in both the questionnaire survey and the workshops, the views expressed are not necessarily those held by BSRIA.

2.1 Development and planning

There are two primary sustainability concerns falling into this phase of construction. Arguably the most fundamental of these relates to the question of whether a new construction is required at all, and whether re-use of an existing structure (refurbishment) or area of land would satisfy the requirements of the client. The construction industry itself has little influence over the need for a new building, something which is most often decided by the industry's clients on the basis of financial or commercial considerations. However, the need to rely much more on refurbishment and use of brownfield sites is recognised as essential to make construction more sustainable, and incentives from government in the form of fiscal measures and proactive planning policies are cited as means of achieving this. A total requirement of 4.4 million new homes is forecast for England between the years 1991 and 2016.

Similarly, there are calls for more resources to be fed into structured and planned refurbishment and maintenance of the existing building stock, in order to both maximise its useful life and reduce its environmental impact. This type of policy has recently been enacted as legislation within the UK through the Home Energy Conservation Act 1995[8], which obliges Local Authorities to survey all dwellings within their area, of all tenures, and develop and implement a strategy to reduce energy consumption by an average of 30% by the year 2006. In view of the current concerns over water resources in the UK a similar regulatory mechanism to enforce greater water conservation may be of use.

The second key area of concern regarding the planning and development of a sustainable built environment is that of transport. Improved public transport systems, relying on a range of transport mechanisms, and developments which not only encourage use of these systems but also discourage use of the car and commuting in general are seen to be important. The increased use of information and communications technology is seen as consistent with this objective, and while it is recognised that social interaction is essential for any sustainable society, it is felt that home-working, and combining office and living space, should be increased. Again, a role for government is envisaged, with calls for incentives to reduce car use and subsidise public transport, to the point perhaps where public transport is free to the user, at least at the point of use.

2.1.1 Recommendations

2.1.1.1 Government

- Enable the planning system to promote sustainable development.
- Introduce fiscal measures to encourage sustainable construction, particularly the redevelopment of brownfield sites.
- Fund a refurbishment programme to implement HECA and water conservation improvements within existing dwellings.

2.1.1.2 Research and development

- Improve contaminated land clean-up procedures in order to minimise developers' perceived liabilities.

2.1.2 Relevant existing initiatives

- The Urban Villages Forum.
- The Home Energy Conservation Act 1995.
- Zero car housing estates.
- The Sustainable Urban Neighbourhood (SUN) initiative.
- European Housing Ecology Network (EHEN).
- Green Futures Network.
- Groundwork.
- Sustainable Cities Network.

RESOURCE	ISSUES	CONSEQUENCES
Land	• Is a new building really needed? • Brownfield/greenfield sites.	• Greater use of existing buildings and land for new developments. • Refurbishment should address changing social requirements.
Energy	• Structured refurbishment to increase efficiency.	• HECA implementation is essential, but more funding is required.
Water	• Structured refurbishment to increase efficiency.	• A home water conservation act?
Materials	• Refurbishment vs. new build.	• Much greater emphasis on planned refurbishment and management of existing stock.
Other/All	• Transport requirements. • Public involvement in development.	• New developments should give rise to minimal transport needs and should improve public transport provision. • Greater density of development along public transport routes. • Citizens' juries to preside over development applications.

Table 1: Development and Planning

2.2 Design

Again, a number of key generic issues can be identified. Possibly the most prominent of these relates to the longevity of buildings, and means of ensuring that buildings have the necessary flexibility and quality to enable them to remain useful, throughout several phases of refurbishment and under whatever social conditions we may experience in the future. Greater numbers of more durable buildings will undoubtedly lead to reduced premature demolitions and materials demands for new buildings, but will also result in fewer construction starts, having potentially adverse consequences for the construction industry in the UK (although this may be somewhat offset by increased refurbishment projects). Multi-use and communal buildings will also be important, and mixed age co-housing projects, groups of dwellings with communal facilities, and combined offices/dwellings will be required.

In all cases, the ability of buildings to be repeatedly altered to meet the changing needs of society will be essential, and technical means of facilitating this have been suggested, focusing primarily on the use of standardised building 'modules', manufactured centrally to enable efficient on-site installation. Such modules could be services packages, structures or entire elements of a building. Also important, however, is construction which is locally focused, making use of local labour and craft, using local style and aesthetics, and minimising the transport requirements and other adverse environmental consequences of large manufacturing industry. There is of course no need why these two approaches should not appear together, but work is required to indicate which is more appropriate for different areas of the country, different building types, and different social groups.

The use of timber framed construction for housing, and of more innovative construction techniques such as dynamic insulation[9], breathing walls and natural ventilation must become more widespread and acceptable to clients and users. 'Environmentally friendly' construction materials and services are also widely deemed to be important. In consideration of services, a greater level of independence from centralised mains services (energy, water and sewerage/drainage) is a viable option, alongside a significant increase in the general level of resource efficiency of the building stock. However, there is far less agreement on what constitutes an environmentally friendly construction material, with a range of specifications (such as a minimum of 20% recycled material) and means of reducing adverse impacts relating to materials (including measuring 'ecological footprints') being suggested. The use of environmental labelling to inform designers was also suggested, although there is a need for reliability of labelling to increase the confidence of the users. With reference to both services and building fabric, avoidance of over specification and waste is essential to moving towards sustainability.

The process of design itself also presents a target for reform. The nature of construction in the UK is seen as too adversarial and risky, discouraging technological and design innovation, and strengthening differences between the professions. While it is recognised that each design profession has specific skills which are valuable to the process of design, higher quality, better suited and more sustainable buildings will result from a more co-operative approach. Not only this, but a significantly greater level of client participation in the design process is essential, and experiences of the early stages of occupation of a building should be used to provide feedback to the designers. The range of environmental guides to building design should be promoted more widely, perhaps with statutory obligations to adopt particular codes of environmental design or performance measures (such as the BREEAM scheme).

2.2.1 Recommendations

2.2.1.1 Government

- Incentives to encourage the use of more environmentally friendly materials.
- Adopt measures to reduce the adversarial nature of building design.
- Increase building standards in general, with standards for longevity being introduced.
- Impose a minimum recycled material content for all building materials.
- Support the introduction of reliable labelling schemes for building materials and components.

2.2.1.2 Education

- Feedback mechanisms for building designers.
- Provide better information to building designers on how to interpret environmental labelling.
- Educate designers to adopt a more integrated approach to design, and to appreciate the
- fundamentals of sustainable building design.

2.2.1.3 Research and development

- Durable, long-lasting buildings vs. temporary buildings? Both have been cited as 'more sustainable', but this clearly depends on a range of factors, including the type of building involved. In which circumstances should one or the other be preferred?
- In which cases are standardisation, rather than local specialisation of building component production more sustainable?
- What is an environmentally friendly material?
- Total energy (water and other resources) assessment models to combine embodied and operational consumption.
- Per capita resource indices for construction projects.
- Develop usable environmental accounting tools for construction projects.

2.2.2 Relevant existing initiatives

- BREEAM
- Energy Design Advisory Service (EDAS).
- The Technical Aid Network (ACTAC).

- Action for Sustainable Rural Communities (ASRC).
- Association for Environment Conscious Building (AECB).
- Built Environment Evaluation for Sustainability Through Time (BEQUEST).
- Construction Industry Environment Forum (CIEF).
- The Green Building of the Year Award.
- HVCA (Heating and Ventilation Contractors' Association) Green Product Initiative.
- Sustainable Homes.
- Lifetime homes.
- Construction Industry Trading Electronically (CITE).

RESOURCE	ISSUES	CONSEQUENCES
Land	• Longevity of buildings. • Multiple use of buildings. • Communal buildings.	• Flexible design, both in terms of future use and current use requirements. • Standardisation of materials and components. • Increased co-occupancy of buildings.
Energy	• Independence from mains sources. • Passive ventilation (also cooling and heating) and lighting.	• Greater use of renewable energy sources. • Increased uptake of passive design solutions, shallow plan buildings and landscape techniques. • Super-insulation, sophisticated energy management systems, air-tight buildings.
Water	• Independence from mains water supply and sewerage.	• Greater recycling of water and interception of rainwater for direct use. This may be on single buildings or communally.
Materials	• Longevity of buildings. • Environmentally friendly materials.	• Flexibility of buildings, and standardisation of materials and components. • Promotion of and greater uptake of environmentally friendly materials, along with better guidelines on what they are.
Other/All	• The nature of design and its products. • Transport demands resulting from the design. • Critical assessment of new designs. • Avoidance of over-designing.	• More co-operative/integrated design and more client participation. • New buildings (and refurbishment projects) should address demographic changes. • Post completion design assessment leading to feedback mechanisms for designers. • Greater (statutory) use of assessment methodologies such as BREEAM.

Table 2: Design

2.3 Construction

There were very few responses to the questionnaire which related specifically to the construction phase. This possibly reflects a feeling amongst respondents that the construction process itself has little to contribute to making a building more sustainable, and that planning, design and operation are far more important. While much of the specification of building materials and components takes place during the construction phase of building, this is design work, and so comments relating to this have been included in the Section above. However, one theme specific to this phase can be identified in the responses received, and is described below.

The importance of making more use of human labour, in particular traditional craft skills, is widely emphasised. The self-build movement in the UK is particularly strong, and many individuals are interested in taking a more active part in the design and construction of their homes. However, it does represent a tiny part of the construction market and will remain so for a considerable period of time. There is a heavy social sustainability element to this phase of the construction process, and the increasing use of mechanical labour, both on site and in factories, is seen as moving away from sustainability. In addition, greater human labour is seen as consistent with improved construction quality, and thus longevity of the building. A converse argument is that increased 'low-tech' prefabrication of building modules with installation of 'high-tech' control systems is necessary. This may have the advantage of enabling more stringent quality control, but may also have adverse aesthetic consequences. It is likely that one approach will be more appropriate for certain building types than the other, and some research work will be necessary to determine the best solution in all cases.

2.3.1 Recommendations

2.3.1.1 Government

- Impose strict built quality standards for all building types to cover new build and refurbishment projects.

2.3.1.2 Education

- Greater information on effective and efficient building design, production, materials and techniques.

2.3.1.3 Research and development

- Investigate the social sustainability issues surrounding self-build, and determine the most appropriate circumstances for its promotion.

2.3.2 Relevant existing initiatives

- Greater use of reused and recycled materials in construction handbook: CIRIA/Scott Wilson Kirkpatrick.

RESOURCE	ISSUES	CONSEQUENCES
Land		
Energy	• Use of mechanical labour vs. use of human labour.	• Using more human labour and traditional skills could bring about both environmental and social benefits. • More self-build. • More robotic construction to increase safety and productivity.
Water		
Materials	• Environmentally friendly materials. • Modular, standardised construction vs. local construction.	• See 'Design'. • Building 'modules' make recycling of buildings easier and reduce wastage on site, but can have adverse aesthetic and social consequences.
Other/All	• Build quality. • Environmental labelling and standards.	• Standards must be imposed to ensure that build quality is maximised. • The existence and use of rigorous and believable labelling systems.

Table 3: Construction

2.4 Operation

The operation of buildings clearly has a significant impact on their overall environmental performance and sustainability. Although this can be influenced to some extent by good planning, design and construction, these early phases can only be regarded as providing the building user the means of minimising the building's overall environmental impact. The benefits of excellent sustainable design can rapidly be outweighed by the adverse impacts of poor building management.

A key to ensuring that operation does not become the weak link in sustainable construction is thus to invest heavily in education of building and estates managers, and other building users (including of course the general public) to ensure that they fully appreciate the concept and implications of sustainability. A wide change in personal and professional ethics is required.

In conjunction with this, however, there are tools and guidance which can be developed to make efficient operation of buildings simpler for the users. Many buildings, when handed over to the operators, are not accompanied by any instructions on how to operate the building in the most effective and sustainable way, and provision of 'Building Handbooks' provided for the users by the designers, is essential. Standards of resource use within buildings, to include energy, water and materials, would further encourage more sustainable operation, and excess noise also presents a major problem which should be addressed by the imposition of maximum noise standards. As well as concentrating on minimal resource consumption, building operators should also aim to maximise the useful lifetime of the building and its components by undertaking planned, strategic maintenance and refurbishment.

The operations carried out within buildings (as distinct from building operation), can of course have significant environmental impacts, but are outside the scope of sustainable construction.

2.4.1 Recommendations

2.4.1.1 Government

- Impose noise insulation and maximum noise level standards.

2.4.1.2 Education

- A wider appreciation of sustainability and its implications for personal and professional activities will lead to more efficient operation of buildings.
- Building handbooks, specific to each building, to be available to building operators.

2.4.1.3 Research and development

- Rapid development of usable environmental accounting tools, or accounting regimes may be imposed on the construction industry.

2.4.2 Relevant existing initiatives

- Advisory Committee on Business and the Environment (ACBE).

RESOURCE	ISSUES	CONSEQUENCES
Land	• Operations within buildings should minimise non-public transport requirements. • Environmental externalities.	• A wider change in personal and professional ethics towards greater sustainability. • Environmental accounting
Energy	• Minimisation of energy demands.	• Education, feedback and standards.
Water	• Minimisation of water demands.	• Education, feedback and standards.
Materials	• Planned maintenance and refurbishment programmes. • Minimisation of materials demands	• More emphasis on maintenance and refurbishment to ensure longevity. • Education, feedback and standards.
Other/All	• Minimisation of noise pollution.	• Education, feedback and standards.

Table 4: Operation

2.5 Deconstruction

Sustainable construction requires buildings to be either durable, lasting hundreds rather than tens of years, or temporary, movable and almost entirely recyclable. In either circumstances, deconstruction will be a significantly less important phase of a building's lifecycle, and the problem of disposing of, as well as the availability of, construction waste will be diminished.

However, we currently face a situation where demolition, rather than deconstruction of buildings is an important phase of the lifecycle, and significant when considering sustainability. Means of encouraging reuse and recycling of building materials and components, as well as much greater levels of land redevelopment are essential, and respondents recognise that improved reuse/recycling infrastructure is required. This could take the form of a brokering service which operates to match construction material needs with supplies of waste materials. Concerns over quality of reused/recycled materials would also need to be addressed by introducing suitable standards.

2.5.1 Recommendations

2.5.1.1 Government

- (with industry) Establish a brokering service for waste construction materials.
- Introduce quality standards for reused/recycled materials which minimise concerns over their use, but do not place undue barriers to their sale.

RESOURCE	ISSUES	CONSEQUENCES
Land	• Redevelopment of land.	• Fiscal measures will be introduced to promote redevelopment. • Sustainable redevelopment.
Energy		
Water		
Materials	• Reuse/recycling/redevelopment of buildings and materials.	• New 'brokering' services for waste building materials.
Other/All		

Table 5 : Deconstruction

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ACKNOWLEDGEMENTS

BSRIA would like to thank the following who have either returned a questionnaire or attended one of the workshops held on 18 September 1996 and 28 October 1996:

John Ahern	John Ahern and Associates
Alex Amato	Steel Construction Institute
Pat Borer	Architect
Richard Bains	Green Futures Network
Jonathan Brown	National Council for Voluntary Organisations
John Bussey	Islington Council
James Butler	The Babtie Group
Peter Charnley	NatWest Group Environmental Management
Professor Derek Clements-Croome	University of Reading
Professor Ian Cooper	Eclipse Research Consultants
Dr Tony Cowling	Builder
Vicki Elcoate	Council for National Parks
Simon Fairlie	Tinkers Bubble Trust
Andy Frew	Irish Association for Sustainable Housing
Mark Gorgolewski	Architect
Richard Grey	BSRIA
Alan Haines	Axis Design
Dave Hampton	Building Research Establishment
David Housego	PRP Architects
Catherine Howes	BSRIA
Thornton Kay	Salvo
John Kempton	Peabody Design Group
Steve Kilford	BSRIA
Keith Lodge	Ecolodgic
Gordon Malcolm	Black Country Housing Association
Stephen Mustow	BSRIA
Catherine Pinney	BSRIA
Erica Rai	London Borough of Brent
Geoff Raw	London Borough of Brent
Rosemary Rawlings	Independent Researcher
Tom Smerdon	BSRIA
Professor Martin Symes	University of Manchester
Rachel Waggett	BSRIA
Peter Warm	Association for Environment Conscious Building

Acknowledgement is also given to the following companies/individuals who have offered advice and subsequent comments used in the compilation of this report:

John Ahern
Alex Amato
James Butler
Peter Charnley
Professor T D J Clements-Croome
Professor Ian Cooper
Dave Hampton
David Housego
Keith Lodge
Professor Martin Symes

4. APPENDIX 1 : RESPONSES RECEIVED BY 20 DECEMBER 1996

Question 1

What kind of buildings need to be built by 2010, and how could we adapt existing buildings?

In order to adapt existing buildings in the UK sustainably, we should:

- Develop a properly funded refurbishment programme, with funding to implement Home Energy Conservation Act plans. Insulation improvement is simple to do, relatively cheap and has a realistic financial pay back period. A simple grants policy would help considerably. This is likely to achieve the biggest single impact by 2010.
- Develop a systematic, prioritised refurbishment programme for all building types which addresses insulation, ventilation, heating, water conservation and other needs. Ideally refurbishment needs to be simple, and flexible, without requiring major surgery to buildings, e.g. dry lining to cut heating costs. Building services should be regarded as a major target for refurbishment.
- Refurbish using environmentally friendly materials.
- Subject all buildings to pre-design procurement assessment, i.e. 'why move or build at all?' and if building or moving is considered necessary, assess new-build against refurbishment. The quality of existing buildings should be valued - we should promote the understanding that a good old building is better than a good new one. We should not adapt buildings unless refurbishment was going to take place anyway (economics must prevail).
- Use refurbishment as a means of changing the internal design to reflect changes in the population composition, working attitudes and current housing needs. Changes in working requirements might include dedicated working spaces for working from home. Multi-use areas could become more common.
- Adapt existing buildings of any type to provide greater residential capacity.
- Improve existing settlements by connecting groups of buildings and inserting living plants and water wherever possible. The important issue is how to avoid the creation of 'ghettos'.

New buildings or settlements should:

- Be made to last 1000 years rather than 20 or 30.
- Be well researched to fully understand the effect of the building process and end products on the environment. Running costs and life cycle impacts in terms of resource utilisation and emissions for new and existing buildings are not yet fully documented and they need to be.

- Follow patterns set by simple, elegant, balanced, non-extreme, single issue and composite solutions that have been developed and promoted for both the public and private sector as 'best practice exemplars'.
- Be as autonomous as is environmentally beneficial, including techniques such as on-site water collection, re-use, waste water and sewage treatment, electricity production by PV or other renewable source, solar heating to reduce the environmental impact of the buildings.
- Be long life, loose fit, low energy.
- Be flexible and adaptable. Office space will be designed into the majority of homes.
- Where appropriate, be designed for natural ventilation.
- Be constructed of local materials wherever possible. Over specification should be avoided.
- Be critically assessed for their environmental impact by using a scheme such as BREEAM or similar.
- Have a 'sense of drama and discovery' with inner courtyards, gardens, galleries and usable roofs, with 'designed-in' meditation spaces for mental renewal, and physical recreation spaces for bodily renewal.
- Have 'complex edges', that make, not destroy the spaces between them. Buildings should be connected to their environments.
- Have all rooms with natural light on two sides. The corollary of this is that new buildings would be smaller, and not deep plan.
- Be low rise (no more than 4 stories high has been suggested by one respondent), except in exceptional circumstances, and no new residential tower blocks should be built.
- Buildings should not be merely functional but glorious, charming or quaint depending on the function.
- Be community buildings, supporting local initiatives, and providing opportunities for intelligent recreation, fitness and social interaction. People may not wish to live together, but there could well be a need to rebuild communities, so the term 'community building centre', or something similar, could well replace 'social centres'.
- As the population ages, more accommodation will be needed for the retired and elderly. The corollary of this is that the workforce will be proportionately smaller, thus imposing a increasingly higher workload on a constantly reducing workforce.
- Be built to cater for changes in lifestyles. More smaller dwellings will be needed to complement and balance urban developments and changes in lifestyle due to the continued fragmentation of families.
- Be built involving the users to prevent short-term dissatisfaction, rejection and discarding, leading to unnecessarily early replacement.

Question 2:

How should we design and construct them?

We should design and build:

- Using a 'team' approach, involving the customer, architect, contractor, engineer, and also other non-construction professionals as appropriate, possibly human scientists and ecologists. There needs to be more trust between the various parties involved, with partnerships replacing the existing traditional combative approach. There needs to be more client participation.
- With commitment and a unified vision and holistic approach to the implications of sustainable construction. The team should attend specialist 'green' courses in order to assist their understanding of the issues involved. Clients, contractors, designers and planners need to use a common check list.
- With more statutory rights of consultation, access rights and tougher planning restrictions to ensure buildings are adaptable, appropriately sized, and have sufficiently high energy performance.
- Always vastly over-design.
- Using designs relevant to the local context.
- With less emphasis or provision for cars.
- To make buildings more cost effective and affordable.
- To encourage flexibility of use of the structure and/or the interior of a building. This would include designing for accessibility for the less mobile, and lifetime use, particularly in the case of homes. Include provisions for wheelchairs, pushchairs, and stair lifts. Design for regular use and maintenance by the less mobile should be encouraged, to allow for the changes in population age.
- Including super-insulation, good daylighting, passive solar design, active solar heating, PV, computerised energy management systems, and with close attention to every detail. Attention to thermal capacity and passive solar design will become the norm. Buildings will need to be as air tight as possible, reducing heat loss through excessive air change rates.
- Using correctly sized components, particularly HVAC. So-called 'safety factors' lead to inefficiencies and waste of resources.
- For correct and comprehensive commissioning, which should be carried out before occupation, and either certified or witnessed.
- Using matrix wiring systems to accommodate easy layout changes.
- Using the climate modifying properties of the structure and surrounding landscape to minimise service inputs.
- As energy autonomous as is environmentally beneficial. Operational energy is much more significant over the life of the building than embodied energy, therefore operational energy efficiency is the important factor. The possibility of using alternative energy sources in the future should be kept in mind.
- Including performance monitoring capabilities or features as a standard part of the services, and the results of the information gained should be freely and widely available.

- To allow the built space 'service', not the product, to be purchased, or leased (such as serviced apartments or offices).
- In such a way that each new design is environmentally better than the previous one.
- To promote culture and depth in human relations. Buildings with character and individuality will be required. We need to get away from the 'little boxes' syndrome.
- Use materials which weather pleasingly rather than deteriorate.
- For a small ecological footprint, (either with or without reference to Life Cycle Analysis (LCA), Life Cycle Impact (LCI), or usage conditions). To do this, we need a better understanding of the sources and processes involved in material supply. We need a better understanding of the effects on the environment of buildings in use.
- Assessing the environmental impact of the building as an integral part of the design process by choosing materials for minimum environmental impact (either benign low embodied energy materials which can be reused and/or returned to the natural cycles, or small amounts of materials which can be 'endlessly' recycled such as copper). Design for a 'reduced' material content is one way of achieving this.
- Using at least 10 % reclaimed components/materials. A specific example is the use of recycled crushed concrete as aggregate in construction.
- Using materials which are not over-specified for the intended use. Tight specifications often lead to high reject rates at source. Sensibly specified materials allow a higher raw material usage rate.
- Identify cost effective low resource use materials and designs. Develop and publish methodology to do this.
- Using LCI as a major factor in design and construction.
- To BREEAM standards as the minimum required.
- If the current trends in global warming continue, the threat of increasingly violent storms must not be overlooked. Stronger construction will be needed, particularly for roofs. As the ozone layer continues to deteriorate, UV protection in the form of increased shading either from buildings or increased planting of trees will be needed.
- Construction methods should use lots of people rather than non-renewable energy.
- For demolition/disassembly, possibly using reversible fixings. One suggestion is that we should aim for at least 20 % of the building to be reused/reclaimed. 'Take back' schemes for recycling or refurbishment will be more common.
- Using or encouraging self build where appropriate, to allow people to have more control of their environment. However, larger integrated companies are likely to develop, with more capital backing.
- Using maximum labour, minimum capital. Traditional construction methods will become more highly valued.
- Using building 'blocks' in a variety of long life forms. Buildings can then be kept for ever by periodic replacement of the modules.
- Using modular construction utilising prefabricated factory made units (possibly imported), reducing wastage on site. Past attempts at prefabrication have resulted in complex assembly methods due to excessive bureaucratic control. We need to aim for 'low-tech' prefabrication whilst maintaining quality. Robotic construction could become more widely used, eliminating or at least reducing repetitive or dangerous tasks. Both customisation and standardisation will become more widely accepted.

- To ensure buildings are more visually attractive and appealing.
- Using much better (more efficient/effective) use of available land. Landscaping will be more popular.
- With regard to the 'spiritual' dimension of a building.
- Using simple, robust technology, to enable people to understand and relate to a building's form and design more easily. Simple technology, intelligently applied, can yield complex living and working spaces. Technology should be subservient to the users, not dominate or intimidate them.
- To encourage social intercourse and interconnections, not exclude them behind sheet glass and concrete. Individuals' needs for privacy must also be respected.
- Incorporating local shops and services to reduce travel needs, increasing the density of local developments along public transport routes.
- Acknowledging that new types of family groups may emerge, entailing a more diverse range of both uses and locations for dwellings.
- With communal facilities. Design factors should encourage multiple use to create a shared 'family resource centre'.
- For multi-generational occupation, such as mixed age co-housing projects.

Question 3:

What kinds of materials, services and components should be used?

We should use:

- The modular construction concept, with factory built washrooms, bathrooms, and kitchens. These would have advantages of commonality, standardisation and economies of scale.
- Materials which are identifiable, and traceable, with more liabilities on suppliers.
- Materials which are not harmful to people or the environment. This will be brought about by both popular and client demand, due to the problems caused by materials such as asbestos, or CFCs.
- Avoid anything plated, spray coated, laminated etc. Use solid 'all-the-way-through-to-the-back' materials such as stone, wood, thick metal, and even thick plastic.
- Materials and components which will be more easily recyclable, and will be designed for re-use and recycling. Existing redundant buildings should be regarded as a source of materials provided that suitable deconstruction methods are used.
- Building materials which are locally sourced and renewable, such as wood, (untreated is preferable), or alternatively plentiful non-renewable materials. like local stone, minimum metals and plastics. Locally supplied minerals should be adequately specified for the intended purpose, without excessively stringent requirements. Fossil fuels or their derivatives are not intended to be considered in this connection. Many materials will be conspicuous by their absence, especially tropical timbers, HCFCs, PVCu.
- Durable materials. Materials which do not require regular refinishing during their lifetime reduce maintenance costs and long term resource consumption.

- The materials content of services reclaimed during refurbishment, for re-use. Old style, inefficient kit should not be perpetuated.
- Timber construction where appropriate, and the necessary investments in appropriate research should be made. Timber should only be used from certified sustainable sources.
- 'High-tech' materials, but in small, carefully controlled quantities. Current advanced materials technologies should be researched for their contribution to construction. Whatever high performance materials are used should be designed to be reusable or easily recyclable.
- Strong price incentives to use services as sparingly as possible.
- De-centralised service supplies, such as waste disposal, water treatment, energy supply.
- PV, together with wind and solar (active and passive) power, and local hydroelectric supplies. Local climate changes could be a factor in the increased use of solar power.
- Local, simple on/off controls for lighting, heating, and fresh air supply.
- Maximum use of natural ventilation and light.
- Design for reuse/recycling of water and heat.
- Pulsed services systems, such as intermittent heat, fresh air and cooling to offset boredom and discomfort.
- Built in flexible infrastructure for IT communications so that if there is a move away from large conurbations, work can be done elsewhere. The possibility of a 'centralised service control network' built into the building has been suggested, which would use standardised interface analogous to the UK three pin plug, to control a range of systems such as windows, lighting, heating, ventilation, computers, communications and entertainment systems.
- Standardised services packs for water, electricity, gas, IT. These could conceivably consist of modules or plug-in packs for quick, easy installation or modification.
- Landscaping to incorporate natural shade and/or shelter wherever possible.
- Roofs suitable for the installation of gardens or landscape features.
- Energy and/or eco-labelled products. This should rely on a rigorous and believable labelling system which is in force to inform the consumer, not just provide more marketing material for the manufacturer.
- EMAS/7750 or a similar, rigorously applied Quality Assessment procedure in the construction industry for materials, services and components.
- Components (doors, furniture, windows) should be solid, built to last and not screwed to chipboard.
- Small scale services and specialist components such as high efficiency boilers or heat pipes, chosen with an emphasis on the environmental cost of manufacture, including raw materials extraction, transportation, processing, and post fabrication distribution.
- Standard kits of parts for refurbishment of standard types of installation. (for example Victorian plumbing, change sealed, fully A/C to natural ventilation).
- Visual energy consumption indicators for users.
- Minimum mechanical devices to minimise maintenance requirements.
- Weather/climate control adaptable facades; awnings for shade or rain protection.

Question 4:

What kinds of skills and standards would be required?

We will require:

- Changes in planning procedures and associated legislation to encourage sustainable construction. Legislation and professional standards will be pulled along in the wake of 'popular' approval. Health and Safety legislation could be extended to cover people generally, and not just those at work.
- Design and construction standards for durability.
- Design standards for low ultra low energy usage in operation (at the cost of possible high energy component production processes).
- A constant push towards tougher limits, higher targets, minimum environmental impact levels.
- Performance standards and third party guarantees are likely to be used to restrict the use of low quality products and installations.
- Materials specifications, particularly for natural products, to be lowered, consistent with safety and longevity of the finished product.
- A 'Home Water Conservation Act'?
- Better standards of construction.
- Design for low water consumption and waste output.
- Environmental issues to be linked to Health and Safety issues in building design.
- Mass produced, high technology buildings, with first class quality control, high reliability and high performance.
- Standard sizings and fixings for new component design (such as radiators, windows).
- Citizens juries (as already in use in Germany and Canada) with Local Agenda 21 remit.
- Considerably better environmental education at all levels from children to practising professionals (both supply and demand oriented).
- BREEAM and other assessment skills and systems for all building types to be developed and used. These systems should be continuously updated and improved. Whatever methodology is used for quantifying environmental impacts must be coherent.
- To develop new total energy assessment methods to combine embodied and operational energy.
- Design skills for building disassembly and reuse of all component parts.
- A change towards a much more multi-disciplinary and cross disciplinary approach in the construction industry.
- A greater holistic awareness and understanding of both the scale and rank of environmental effects.
- Architects who are not driven by ego.
- Designers who are prepared to 'go it alone' in setting the highest standards, finding allies in the client body.

- Designers with a wider breadth of knowledge of environmental concerns specialisation will no longer be sufficient.
- A more labour intensive construction industry, both physically and intellectually. Better design takes time, and natural materials often are not regularly shaped.
- A return to the traditional skills of carpentry, metal work, thatching, lead work, brick laying, water engineering, together with more modern skills such as reed bed technology, energy systems management, solar and wind technology. This would be combined with more use of a local work force. Workers are likely to be multi-skilled.
- High grade skills for increasing factory production; low grade skills for site preparation and installation/assembly.
- A flexible application of technical skills at all levels for refurbishment programmes, which can conflict with a drive for system building. However, design for disassembly can assist in a later refurbishment program.
- Increased levels of maintenance, security, space management and traffic management as a result of changes in city structure.
- Less reliance on centralised large scale plant, with a much greater level of local human knowledge and skills.
- Better product information in respect of environmental parameters such as embodied energy, CO_2 data, environmental impact assessment.
- Per capita resource use indices to assess projects.
- Components broking services for reclamation.
- 'Rules for the environment' for building operators in order to minimise the environmental harm caused by buildings.
- Building handbooks, as issued with cars, explaining operating principles, as well as the details.

Question 5:

What kind of cities and settlements would we have?

It is likely that:

- Most cities will spread further in to the countryside, continuing the present tendency towards urban sprawl.
- Dependent on demographic changes and local working practices, some cities may actually shrink, becoming more dense.
- The trend towards 'them and us' will become much stronger. Those with wealth and/or knowledge will separate or isolate themselves from the rest; private quality will restricted to the few, whilst the majority will remain in need of the basics, with minimum resources.
- Better use should be made of existing urban space, including the use of derelict land and buildings before the use of green field sites is even contemplated. Infill sites should be used in preference to green field sites, with the proviso that some infill sites should be used to create open green spaces instead of buildings.

- Brown field development might become a more preferred option, particularly if suitable encouragement is given in the form of tax breaks or concessions. The natural reluctance of investors to become involved in brown field sites due to the possibility of consequential damages and liability as a result of contaminated land or ground water needs to be overcome. Better clean up and risk liability procedures would help.
- As communications technology improves, there could be a move away from the present large city centre clustering. This would result in a trend towards a more mixed industrial/services base in most settlements.
- New developments are likely to be 'compact' (greater density, mixed use developments, with more co-housing projects).
- High rise buildings would be demolished instead of being refurbished, and the materials recycled for reuse.
- There are likely to be examples of sustainable *re*-development.
- The NIMBY (Not In My Back Yard) attitude will strengthen considerably, with the result that direct action from lobby groups will increase.
- Underground buildings may become more popular.
- There could be a change towards shared facilities in new housing developments, such as waste disposal, cooking, washing facilities, water collection and treatment.
- The existing UK tendency (and preference) towards ownership, particularly in the domestic market, could change towards renting, or lease/hire agreements.
- There will be increased use of teleshopping and teleworking. This is likely to be forced as an economic necessity rather than as a desire or wish to do so. Transport difficulties could be the driver.
- Permanent need for cleaner air which doesn't corrode and dissolve buildings.
- Citywide water recycling and waste minimisation/recycling.
- Need to rethink zoning and promote mixed development.
- Cleaner production facilities.
- There will be reduced noise levels, both internally and externally.
- The use of renewable energy sources will increase, including wind, solar, PV, biofuel powered CHP, and there are likely to be more community based energy generation systems.
- There will be more self-build, car free zones, low impact settlements in open country, with a significant increase in the acreage under woodland.
- Transport will remain a major environmental issue, and any transport changes will therefore have a significant impact on our development style. Specialised settlements may develop ('cycletown', 'pedestriantown').
- Low energy, low pollution mobility systems.
- City centres will still be a focus of business, so transport infrastructure will need to be improved. It is likely that city centres will become increasingly pedestrianised, with very limited/restricted vehicular access.
- The most significant single improvement to the quality of life in the majority of areas could be gained by subsidising free public transport. Companies which provide free car parking are in effect discouraging the use of public transport by subsidising

and encouraging car use. The true cost of car use (including road construction costs, parking, pollution, CO_2) should be passed on to the users.

- The regular use of bicycles will become more common, heavily influencing settlement designs.
- Light, low cost, tramway systems will be introduced.
- Flexible public transport systems will be combined with cars being banned from city centres. Monorails and luggage links could be introduced.
- By connecting the living place and the work place, either by teleworking, or some other means, commuting, as we know it now, could become an anachronism, greatly reducing non-renewable fossil fuel consumption, and improving quality of life.
- Increased and improved local facilities should reduce local road journeys by car.
- A reduction in commuting could mean that social interaction within local communities could begin to re-establish itself. It is possible that special interest communities or trading groups may establish themselves as transport changes occur.
- It is likely that travel for leisure activities will increase.

Question 6:

What are the perceived barriers to the implementation of sustainable construction?

The barriers to the implementation of sustainable construction in the UK are:

- Construction is demonstrably not sustainable, so all that can be done is to make it less unsustainable.
- The initial assumption that the construction industry will adopt sustainability is questionable.
- The construction industry can/will only provide what clients demand.
- It is unclear what constitutes 'the construction industry'. Additionally, the participants in the life cycle of a building are many, varied, and may change many times.
- Short-termism. Economic evaluation favours cheap, short-lived solutions.
- The service life of building materials is typically very long, which means that a significant part of the environmental burden from building components occurs for many years after the production and construction process.
- Virtually every commercial building (with the possible exception of modern out-of-town supermarket buildings) is a prototype.
- The residual organisational patterns and habits deriving from the easy availability of fossil fuels will hinder the adoption of appropriate energy strategies at a local level.
- Central government departments are dominated by energy intensive economic interests.
- There is little public information available on the state of the UK sustainability indicators.
- Materialism. We live in a heavily consumer oriented society. People perceive themselves as 'poor', and therefore the struggle for an 'improved' lifestyle,

involving increased consumption, overshadows the long term care for the environment.

- ◊ Modern day values promoting individual survival result in reactions of
- ◊ 'Why should I tighten my belt?'
- ◊ 'Why should my standard of living reduce?'
- ◊ 'It's someone else's way of life that is at fault and causes all the problems, not mine!'

- The impact on the environment of human lifestyles and attitudes is not properly understood.
- Many existing products are not 'green' labelled, and those that are labelled are labelled for marketing rather than environmental reasons.
- We have a market driven economy. The definition and meaning of 'economic growth' needs to be re-interpreted.
- Insufficient evidence of the benefits of sustainable construction.
- Lack of high quality, robust, demonstration projects.
- Inadequate measurement techniques to quantify environmental impacts.
- Conflict of system boundaries between clients, designers and Local Agenda 21.
- There is a public perception that environmentally friendly buildings are somehow 'odd', or 'strange'. The association with 'hippie communes' still exists.
- There is a perception that sustainability is elitist, and that only the rich can afford it. The difficulty is raising sustainability standards for all, at minimum 'real' cost. A suggestion is massive investment in technological 'fixes' which would then become available to all.
- Undervalued/cheap resources and energy, particularly non-renewables.
- Priorities are as yet unidentified. Which is most important, water or energy, global or local? This tends to confuse the issues and makes decision making difficult. All decisions are context dependent.
- Demographic shifts taking place in the UK may hinder the effectiveness of sustainable development:
- Some predictions indicate that the UK population will increase to some 65-70 million by 2030.
- There is a population shift towards the South of the UK.
- The average age of the population is increasing. The result is that the proportion of the population working is decreasing, and the financial burden of supporting the non-working population is increasing.
- Household size is reducing, leading to an 'unnecessary' demand for more individual dwellings.
- We live in a 'Technofix' culture.
- We have adversarial construction industry contract law.
- Sustainable development will not happen; people do not want it, because it costs, and people who need to pay for it cannot afford it.
- It has taken 25 years for the simple concept of energy efficiency to begin to be taken seriously in the UK. Even now, many houses in the UK are poorly insulated. How long will it take for the relatively complex issues involved in sustainable construction to be accepted and then implemented?

- Lack of awareness that there is a problem and an urgency to address it. This is probably due to ignorance. There is a lack of awareness of sustainable construction, and a lack of answers. Poor education and training may be blamed for this. There is a lack of serious interest in sustainability in schools of architecture.
- The environmental perceptions of the general public, and probably most of the construction industry contains virtually no sustainability element at present.
- Lack of a democratic/populist mandate for sustainable construction. Whilst people may be concerned in some way about the issues in general terms, there is a general perception that 'Nothing can be (or should be) done. There are other priorities'.
- Short termism. Indifference to today's actions causing environmental problems 'in the future'.
- Lack of conviction. Individuals do not believe that their own individual actions can make a difference.
- Nobody feels particularly responsible. However, one respondent has suggested that when a client/design team does feel responsible, a sustainable development can be achieved.
- Lack of 'ownership' or responsibility for environmental impact. However, 'take back' schemes are gradually being introduced in the car, electronics and white goods industries. Similar schemes could be adopted in the construction industry.
- Conservatism. Unwillingness to accept new or what is perceived to be 'controversial' knowledge. The construction industry is conservative, tending to use traditional methods and designs.
- Resistance to change attitudes and perceptions.
- Environmental problems are seen as insurmountable problems rather than opportunities.
- Lack of a sustainability culture.
- Lack of demand from the general public and construction clients.
- Adverse publicity associated with extreme fringe groups activities. Environmental pressure groups tend to cloud the issues and distort the true environmental picture. Whilst a result may be achieved, is it the best one?
- Cynicism in politics, business and hence in the general population discourages any moves towards sustainability.
- The environment is not seen to provide a marketing advantage.
- Sustainable construction is perceived as 'risky'.
- The perception that environmental aspects of construction are expensive. Sustainable construction is considered to be too expensive.
- Lack of financial incentives to achieve sustainable construction. Financial institutions minimise their risk. Capital costs are still too important. Intangible future environmental benefits are not costed against immediate financial costs.
- Environmental externalities are not accounted for in conventional accounting systems.
- Professional indemnity insurance encourages 'safe' designs which are over specified to ensure minimum risk to the designer.
- Building procurement methods are dominated by large developers and building companies motivated by profit at all costs.

- Lack of 'drivers', incentives, enforcement, legislation.
- Insufficient public involvement in Local Agenda 21.
- Lack of sufficient public participation in sustainability initiatives or the sustainability debate.
- Unimaginative Local Plans which discourage sustainable settlements.
- Existing planning laws, technical standards and attitudes conspire against experimentation, alternative approaches and low technology solutions.
- Insufficient use of existing guidance.
- Policies led by forecasts. For example, predictions of increased road traffic have been used to justify more and bigger roads, which then encourage more road traffic.
- More respect and support by Government for moves by Local Authorities to adopt sustainable policies is required.
- Modern democratic government is a block to sustainability, because once it has accepted re-election as its overriding determinant, it will only implement short term measures.
- A cultural shift is needed by government and individuals.
- Lack of 'internal' construction industry consensus on what sustainable construction is, or means.
- Lack of public consensus on what sustainable construction is, or means.
- Achievement of consensus by Trade Associations and the public is likely to be an unachievable goal.
- Long time lags are needed for changes in attitudes towards and understanding of sustainability.

5. APPENDIX 2 : SUSTAINABLE CONSTRUCTION INITIATIVES AND RELEVANT ORGANISATIONS IN THE UK

UK GOVERNMENT COMMITTEES

ADVISORY COMMITTEE ON BUSINESS AND THE ENVIRONMENT (ACBE)
This forum was established in 1991 to promote dialogue between businesses on environmental issues. Membership is made up of business leaders from across a wide range of sectors and the Committee reports regularly to Government on sustainability related issues.
Contact:
Gavin Costigan
Department of Trade and Industry
151 Buckingham Palace Road
LONDON
SW1W 9SS
Tel: 0171 215 1882, Fax: 0171 215 1621

GOVERNMENT PANEL ON SUSTAINABLE DEVELOPMENT
The panel comprises a small group of individual experts, appointed by the Prime Minister in January 1994, to give authoritative and independent advice on areas of priority relating to sustainable development to the Government.
Contact:
Mrs K V Cavill, Secretary
Floor 23, Portland House, Stag Place, London, SW1E 5DF
Tel: 0171 890 4962/4963, Fax: 0171 890 4959
Email: 106174.2501@compuserve.com

LOCAL GOVERNMENT MANAGEMENT BOARD (LGMB)
Local Agenda 21 involves a process of consultation and consensus between local authorities, citizens, local organisations and business enterprises. Although not a statutory requirement, the majority of UK local authorities are now establishing Local Agenda 21 programmes. The initiative is being co-ordinated by a steering group supported by the Local Government Management Board (LGMB), based in Luton.
Contact:
Arndale House, The Arndale Centre, Luton, Bedfordshire, LU1 2TS
Tel: 01582 451166, Fax: 01582 412525

UK ROUND TABLE ON SUSTAINABLE DEVELOPMENT
The Round Table brings together representatives from central and local government, business, environmental organisations and other groups in society. It began work in

January 1995 and aims to identify the agenda and priorities for sustainable development, as well as to develop consensus on difficult issues.

Contact:

Round Table Secretariat,
Floor 23, Portland House, Stag Place, London, SW1E 5DF
Tel: 0171 890 4966, Fax: 0171 890 4959
Email: 106174.2501@compuserve.com

UK NETWORKS & ORGANISATIONS

ACTAC - THE TECHNICAL AID NETWORK

The Technical Aid Network is a national network of centres, groups and individuals who provide a range of professional and technical skills in support of community improvement to land and buildings.

Contact:

Ray Georgeson - Director
64 Mount Pleasant, Liverpool, L3 5SD
Tel: 0151 708 7607, Fax: 0151 708 7606

ACTION FOR SUSTAINABLE RURAL COMMUNITIES (ASRC)

The aim of this organisation is to generate sustainable rural communities through community-led partnership development based on ecological principles. A national network of individuals, agencies, and organisations with a commitment to the above is one of the ways in which the organisation seeks to operate an information network and a technical project group in order to achieve this aim.

Contact:

Rod Hughes
Lowe Rae Architects, Three Crowns Lane, Penrith, Cumbria, CA11 7PH
Tel: 01768 863812
E-mail: nal@dial.pipex.com

ASSOCIATION FOR ENVIRONMENT CONSCIOUS BUILDING (AECB)

AECB acts as an information centre within the construction industry, persuading the trade and suppliers to give more consideration to environmental matters. It promotes awareness through publications, audio-visual talks, displays and exhibitions to both the trade and the general public. Members are encouraged to develop green policies and to work together. AECB liaises closely with Friends of the Earth, Greenpeace and other conservation groups.

Contact:

Keith Hall
Windlake House, The Pump Field, Coaley, Gloucestershire, GL11 5DX
Tel: 01453 890757, Fax: 01453 890757

BEQUEST (BUILT ENVIRONMENT EVALUATION FOR SUSTAINABILITY THROUGH TIME)
This network was set up as a result of the first International Workshop on Environmental Impact Evaluation of Buildings and Cities for Sustainability, held in September 1995 in Florence, Italy. An E-mail network has been set up as a discussion forum on the title topics, mainly involving the delegates from the original workshop. A new topic for discussion is presented each week.
Contact:
Prof. P S Brandon
Research and Graduate College, University of Salford, Salford, MS 4WT
Tel: +44(0)161 745 5164, Fax: +44(0)161 745 5553
E-mail: P.S.Brandon@surveying.salford.ac.uk

BUILDING RESEARCH ESTABLISHMENT (BRE)
The BRE carries out research, provides technical consultancy on construction problems for the public and private sector, and disseminates results via publications and seminars. Current projects on sustainable development include the identification of key issues concerning sustainable development, recycling and reuse of building materials.
Contact:
Technical Consultant - Advisory Service
Garston, Watford, WD2 7JR
Tel: 01923 664000

BREEAM
The Building Research Establishment Environmental Assessment Method (BREEAM) has been developed by BRE to provide an independent and comprehensive assessment of the environmental performance of a new building. It is now a tried and tested scheme and currently covers offices, superstores, industrial units and homes. BREEAM covers issues ranging form global atmospheric pollution, the local environment of the building through to the comfort and health of occupants. A BREEAM assessment will give the building a 'rating' of its environmental performance which can then be used for comparisons or improvements.
Contact:
The BREEAM Office at BRE (see above)

BUILDING SERVICES RESEARCH AND INFORMATION ASSOCIATION (BSRIA)
BSRIA is a co-operative and collaborative centre for research, technical information and advice for the building services industry. The Centre for Construction Ecology within BSRIA provides services and undertakes research into all environmental issues relating to buildings and construction.
Contact:
Dr Stephen Mustow
Old Bracknell Lane West, Bracknell Berkshire, RG12 7AH
Tel: 01344 426511, Fax: 01344 487575
Email: stephen.mustow@bsria.co.uk

CONSTRUCTION INDUSTRY RESEARCH AND INFORMATION ASSOCIATION (CIRIA)

CIRIA is the independent private sector research association, carrying out research and disseminating information relating to all areas of construction. CIRIA focuses on providing best practice guidance to professionals, covering construction practice, building design and materials, management and productivity, ground engineering, water engineering, and environmental issues. This guidance is disseminated widely through networks, publications, newsletters, and events.

Contact:

6 Storey's Gate, Westminster, London, SW1P 3AU, England
Tel: 0171 222 8891, Fax: 0171 222 1708.

CONSTRUCTION INDUSTRY ENVIRONMENTAL FORUM (CIEF)

CIEF is managed by CIRIA in partnership with BRE and BSRIA. The objectives of the Forum are:

1. to promote awareness and understanding of environmental issues relating to construction through fortnightly discussion meetings throughout the UK;
2. to identify available guidance for practitioners;
3. to identify barriers to good environmental practice, particularly in respect of information shortfalls;
4. to promote collaborative studies to produce guidance information.

The Forum has been developed to act as a focus on environmental matters for all those involved with construction including developers, material producers, design and other consultants, builders and contractors, property owners and managers, lending institutions and insurers.

Contact:

Jon Bootland at CIRIA (see above)

CONSTRUCTION INDUSTRY TRADING ELECTRONICALLY (CITE)

This is an initiative set up in 1995 by some of the leading contractors in the UK to develop and encourage the use of electronic trading in the UK construction industry. The tools and standards have been developed to enable member companies to transfer data in common electronic interchange formats. The membership, comprising contractors, major suppliers of building products and quantity surveyors, creates a community that allows trade to be carried out extremely efficiently, using the latest communications technology. Contractors are able to deal with their suppliers using 'paperless communications', and quantity surveyors can now tender for new contracts electronically. This initiative illustrates the industry's increasing acceptance of and uptake of electronic communication mechanisms.

Contact:

PO Box 5432, Redditch, Worcestershire, B96 6JN
Tel: 01386 763300, Fax: 01386 793306

ENERGY DESIGN ADVICE SCHEME (EDAS)

The Energy Design Advice Scheme is a discretionary initiative sponsored by the Department of Trade and Industry. It provides access to advice on energy conscious design of buildings by regionally based experts for those professionals commissioning or executing the design of new-build or refurbishment projects. Subject to the availability of funds, the Scheme will consider helping any project which meets the criteria for support.

Contact:

Tadj Oreszczyn, Regional Director
Energy Design Advice Scheme, The Bartlett Graduate School, University College London, Gower Street, London, WC1E 6BT
Tel: 0171 916 3891, Fax: 0171 916 3892

ENVIRONMENT AGENCY

The Environment Agency is one of the world's largest environmental regulatory organisations. Its overall aim of protecting and enhancing the environment contributes to the world-wide environmental goal of sustainable development. The Agency is required to place its activities within the context of sustainable development, based on government guidance.

Contact:

Head Office, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, BS12 4UD
Tel: 01454 624400, Fax: 01454 624409
Email: enquiries@environment-agency.gov.uk

EUROPEAN HOUSING ECOLOGY NETWORK (EHEN)

A European network of housing bodies and consultants established in order to develop partnerships for THERMIE funding. A number of such awards have been made.

Contact:

Ken Walker, Secretary
Chart Cottage, Graftham Nr Petworth, West Sussex, GU28 0PX
Tel: 01798 867609, Fax: 01798 867413

FRIENDS OF THE EARTH

The Sustainable Development Research Unit (SDRU) is part of Friend's of the Earth campaign department. It supports Friend's of the Earth campaigners through research and information provision and deals with issues like trade and aid; employment and environmental policy; health impacts of environmental degradation; environmental taxes and regulation. It commissions and manages consultancy research and undertakes it own projects. It produces between ten and fifteen reports, briefings, journal and conference papers each year.

Contact:

26-28 Underwood Street, London, N1 7JQ
Tel: 0171 490 1555, Fax: 0171 490 0881
Email: webmaster@foe.co.uk

GAP - GLOBAL ACTION PLAN

Global Action Plan was founded in 1989 to develop structured support for people wishing to adopt sustainable lifestyles. A worldwide organisation, GAP has focused its work on the most affluent countries of the North because of the high levels of consumption. It runs 'EcoTeams' encouraging local people to optimise their lifestyles and reduce the amount of resources consumed.

Contact:

Trewin Restorick
Global Action Plan UK, 3rd Floor, 42 Kingsway, London, WC2B 6EX
Tel: 0171 404 0837/405 5633, Fax: 0171 831 6244
Email: trewin@gapuk.demon.co.uk

GREATER USE OF REUSED AND RECYCLED MATERIALS IN CONSTRUCTION

Through recent research, CIRIA (see above) have identified that there are several barriers to reuse and recycling in the construction industry. In collaboration with Scott Wilson Kirkpatrick, they are producing a handbook that provides guidance on the use of reused and recycled materials in construction. This work will include a literature review of existing knowledge and guidance in the UK, and also consultation with clients, designers, material manufacturers and a wide range of other people in the field. This consultation is being carried out through a series of workshops.

Contact:

Claire Woolveridge
Scott House, Basing View, Basingstoke, Hampshire, RG21 4JG
Tel: 01256 461161, Fax: 01256 460582

GREEN BUILDING OF THE YEAR AWARD

This is an annual award for which any new or refurbished building in the UK can be entered for, with the exception of residential properties, as long as it has been operational for a whole year. The award aims to encourage all concerned with the built environment to think 'green', from the original concept, through construction to future maintenance needs. Nominations may come from architects, developers, building owners/operators or contractors. The judges consider the overall environmental impact of entries, taking into account design, materials, transport and planning implications, etc. The awards are usually given in the autumn of every year.

Contact:

Caroline Horne
HVCA, ESCA House, 34 Palace Court, London, W2 4JG
Tel: 0171 229 2488, Fax: 0171 727 9268

GREEN FUTURES NETWORK

A unique initiative for the co-ordination of academic research, design, business development and housing construction in the midlands.

Contact:

Richard Baines, Project Co-ordinator
Black Country Housing Association
Tel: 0121 561 1969

GREEN INITIATIVE PRODUCT AWARDS

This award is open to any manufacturer or supplier exhibits at one of a number of trade shows, and who believes that they have a building services related product or service which makes a positive contribution to the environment. The judges consider innovation, overall design quality and contribution to a healthy, safe and sustainable environment.

Contact:

EMAP Business Communications, (organisers of the National HVAC Show)
Maclaren House, 19 Scarbrook Road, Croydon, Surrey, CR9 1QH
Tel: 0181 688 7788, Fax: 0181 686 7224

GROUNDWORK

Groundwork is a national network of local initiatives committed to working with others to tackle the problems of dereliction, to restore landscapes and wildlife habitats and to make positive use of wasteland in and around Britain's towns and cities. Established in 1981, Groundwork is the leading UK environmental partnership organisation active in 120 towns and cities throughout the country, operating through an expanding network of local trusts. Groundwork delivers high quality cost effective programmes which help people improve the environment and economic prospects of their area.

Contact:

Ken Davies - External Relations Director
85/87 Cornwall Street, Birmingham, B3 3BY
Tel: 0121 236 8565, Fax: 0121 236 7356

INTERNATIONAL SUSTAINABLE DEVELOPMENT RESEARCH NETWORK

An interdisciplinary non-profit making network organised in association with the Centre for Corporate Environmental Management (University of Huddersfield), ERP Environment and the journal Sustainable Development. The aim is to promote research into and the practice of sustainable development. Dissemination of information on research and best practice is by e-mail.

Contact:

International Sustainable Development Research Network
c/o Centre for Corporate Environmental Management
School of Business, University of Huddersfield, Queensgate, Huddersfield, HS1 3DH
Tel: +44(0)1484 472262, Fax: +44(0)1484 472852,
E-mail: isdrn@hud.ac.uk

LIFETIME HOMES GROUP

The idea of lifetime homes is to design all housing so that those who become moderately disabled can continue to live in their existing homes. Also those homes can be more readily and cheaply converted if disability does become more severe, say for wheelchair use. Implementation comes through adopting a set of 16 house design standards.

Contact:

The Joseph Rowntree Foundation

SUSTAINABLE CITIES NETWORK
This network is intended to allow the interchange of ideas and experience with regard to urban sustainability. Aims of the network include the establishment of a database of academics, practitioners and policy makers in the field of urban sustainability, in order to promote best practice in this area.
A database of network members and interests is to be constructed and made available. The network is funded by two UK Research Councils and will also be used to disseminate the findings of certain similarly funded research programmes.
Contact:
Dr David Gibbs
School of Geography & Earth Resources, University of Hull, Hull, HU6 7RX

SUSTAINABLE HOMES
Sustainable Homes works to promote environmental policies in housing, and is supported by an Innovation and Good Practice Grant from the Housing Corporation. The group will shortly produce a Sustainable Homes Directory (due in autumn 1997), which will contain case studies of recent projects, as well as details of relevant publications and useful contacts.
Contact:
Wendy Shaw
7 High Street, Teddington, Middlesex, TW11 8EL
Tel: 0181 943 4433, Fax: 0181 943 2163

SUSTAINABLE URBAN NEIGHBOURHOOD INITIATIVE (SUN)
The aim of the Sun initiative is to develop a broadly based network of organisations and individuals interested in sustainable urban development. The initiative is managed by URBED from its Manchester office.
Contact:
David Rudlin
41 Old Birley Street, Hulme, Manchester, M15 5RF
Tel: 0161 226 5078, Fax: 0161 226 7307
Website: http://www.urbed.co.uk/sun/

SUSTRANS LTD
Sustrans plans, builds and maintains safe non-motor routes, primarily for walkers and cyclists but also often for horse riders and less able people. It lobbies on behalf of those who prefer to use sustainable forms of transport, and for whom heavily trafficked roads represent a very hostile and dangerous environment. As the Sustrans route network grows, the possibility of safe, low-pollution travel is extended to more and more people.
Contact:
John Grimshaw
35 King Street, Bristol, Avon, BS1 4DZ
Tel: 0117 926 8893, Fax: 0117 926 4173

TWEED HORIZONS: INTERNATIONAL CENTRE FOR SUSTAINABLE TECHNOLOGY

This international Centre for Sustainable Technology is based in Scotland. Within the Centre there are 18 individual companies all having sustainability central to their business philosophy. The aims of the Centre are to:

- raise awareness of sustainable technology and provide international exchange of information and ideas;
- support companies working with sustainable technologies; and
- demonstrate sustainable technologies and their relevance to economic development.

Contact:
Website: http: www.scotborders.co.uk/horizons

UNITED NATIONS ASSOCIATION SUSTAINABLE DEVELOPMENT UNIT (UNA SDU)

The unit was set up prior to the Earth Summit in Rio in order to popularise the work of the UN in the area of sustainable development. It co-ordinates the work of non-governmental organisations on a UK National Sustainable Development Commission. The unit produces regular briefings and organises conferences and seminars on the implementation of Agenda 21 and the UN conventions. It advises local councils on the production of Local Agenda 21 and sustainability indicators.

Contact:
Felix Dodds
3 Whitehall Court, London, SW1A 2EL
Tel: 0171 930 8169, Fax: 0171 930 5893

URBAN VILLAGES FORUM

The Urban Villages Forum aims to investigate and promote the concept of planned mixed-use, mixed-tenure developments which would provide a more civilised and sustainable environment for the people living and working in them. Members of the Group include leading developers, housebuilders and representatives of financial institutions, as well as architects, planners and environmentalists.

Contact:
David Lunts
70-77 Cowcross Street, London, EC1M 6BP
Tel: 0717 490 2702

WALTER SEGAL SELF-BUILD TRUST

A national charity which helps people to build their own homes, promoting and facilitating self-building.

Contact:
Martin Field, Development Worker
57 Charlton Street, London, NW1 1HU
Tel: 0171 388 9582

6. APPENDIX 3 : UK CASE STUDIES

1. Eco Centre - Groundwork South Tyneside

Designed to lead by example, this building (completed in 1996) was originally intended to be totally self-sufficient, creating the UK's first truly autonomous office. Cost considerations have prevented this vision being wholly fulfilled, but the combination of low energy design, water conservation and on-site electricity generation means that the Eco Centre places only a small burden on the local utility supplies. The building obtains its heating and cooling via a ground source heat pump, recycles human waste via composting toilets, recovers rainwater for fire sprinklers and toilets, and uses greywater for site irrigation.

The £800,000 two storey, naturally ventilated building contains 1400 m^2 of usable floor area, arranged as large cellular offices around a triangular lightwell. Its site was a plot of derelict, contaminated land, chosen after a rigorous study of local wind regimes. It was also a good location for the 60m borehole which supplies water for the ground source heat pump and various non-potable water needs. The building is a net exporter of electricity to the National Grid via an 80kW wind turbine which is expected to generate 100,000 kWh/year for a capital investment of £76,000.

The construction materials were obtained where possible from renewable sources and recycled materials were used. The building is timber framed, with timber supporting the roof structure and internal brickwork supporting the intermediate floor slab. The reclaimed bricks came ready cleaned and palleted. The building is 30% double glazed, with the timber window frames from a sustainable timber source.

Other materials in the building were also chosen for their environmental qualities. Linoleum floor coverings are used, and acrylic (almost totally recyclable) is used for kick plates and door handles. The plasterboard is made from a gypsum residue which is a by-product of the flue gas desulphurisation process of a power station.

The basement contains the borehole, heat pump and three Clivus composting toilet chambers. Each toilet is flushed by a single pint of recycled rainwater. The liquid effluent is siphoned off and mixed in a holding tank with the building's greywater, which dilutes the effluent and then supplies an irrigation system to improve the condition of the soil around the site. Domestic hot water is generated by solar panels on the glazed roof, with storage temperatures being maintained or raised by a calorifier powered by the wind turbine.

2. Straw Bale Farmhouse, Wales

This straw farmhouse, costing in the region of £15,000, is situated in a small village in mid Wales. It is built with large bales of tightly compacted straw, and sits on a concrete foundation. The bales are held in position by wooden stakes, which reinforce the rigidity of the building. Once the walls were built, the whole building was tied by wire wrapped horizontally around it and then fixed into the foundations. These wires are regularly tightened during the months following construction.

The exterior of the building has been treated with a coat of lime-based rendering plaster. This was used instead of the usual sand and cement mix as it allows the straw to breathe, and will also act as fire protection. The final coat will be a lime and pea gravel mix.

The house will be centrally heated by a solid fuel stove attached to a boiler, but as the straw bales are estimated to provide ten times more insulation than manufactured blocks, the house is very energy efficient. The building's roof will be insulated with wool, supplied by the farm's own sheep, and is built from wood cut from a nearby forest and machined by a local supplier. The owner hopes to finish the roof with timber shingles, again made out of the local wood. All of the windows and most of the other timbers used in construction were reclaimed.

3. Car Free Housing Development - Edinburgh

This scheme is being developed on disused rail land in Edinburgh, and is due to be ready for a mixture of rented, bought and social housing by 2000.

It will consist of 121 flats which will provide energy efficient homes in a car free environment. People wanting to buy or rent flats will have to sign an agreement not to own a car and have no plans to buy one. Edinburgh City Council plans to extend its 'car club' to the development, allowing residents to hire vehicles preferentially. Two new bus routes and a possible new suburban railway station, will provide sufficient public transport services for the residents.

The land that would have normally been allocated for parking will be used for terraced gardens, allotments and reed beds. The site is to be developed to a density of around 50 units to the acre, a high density compared to typical developments.

The Canmore Housing Association has secured funding from Scottish Homes and the private sector, and has already received enquiries from many interested people who insist that they do not own a car. The architect was trying to design something that would not look out of place in Edinburgh but included technology for the next century. Houses will come complete with solar power and water recycling, and other features include:

- breathing wall timber frame construction using Warmcel recycled newsprint insulation;

- ◊ reed beds to treat greywater;
- ◊ an agreement in principle with the neighbouring North British Distillery to use excess industrial heat to provide cheap hot water for every flat;
- ◊ solar cells to provide electricity for stair lighting.

4. Holy Island Retreat Centre

This project, yet to be started, is intended to be a truly sustainable development on an island off the west coast of Scotland. It will house a Buddhist community, who desired to be part of a sustainable environment and a wholly self-sustaining community. Thus, the design had to take account of agricultural needs, integration of water and crops, waste management and disposal, and rigorous energy efficiency strategies. The overall objectives of the project were:

- ◊ to be energy self-sufficient
- ◊ to be water self-sufficient
- ◊ for all waste to be processed on site or recycled

Holy Island was bought by the Rokpa Trust in 1992, and has limited sunshine and severe exposure to Atlantic storms. In the subsequent winning design the overall complex is built into the hillside, in layers close to the ground. It has been developed in the following ways:

- ◊ orientated to face south for maximum solar gain;
- ◊ glazing sloped to maximise winter solar gain;
- ◊ buried in earth and well insulated to minimise heat loss;
- ◊ thermal shutters to reduce heat loss at night;
- ◊ trombe wall and thermal mass to provide 24 hour heating;
- ◊ sunk in ground and shaped to reduce wind exposure and heat loss whilst maintaining views and solar exposure.

The majority of the project's floorspace consists of 108 individual retreat rooms. The rooms are designed to ensure that views can be enjoyed if the occupant is standing, but are restricted at lower levels to prevent distractions while the retreatants are meditating. This is done by using the roof of the room in front as a barrier to the outside world.

The retreat also has a sustainable strategy for water use. Rainwater for washing and cleaning is to be collected along a gully at the upper perimeter, and stored at the highest point of each individual retreat. Fresh water for drinking or for food preparation is to be taken from natural springs. Most wastewater will be filtered through reed beds and fed into a pool lower down the slope.

Energy conservation is a key part of the Holy Island project's sustainability aims. As the buildings are covered in earth, energy losses will be minimised and internal temperatures will remain relatively stable. Energy use will be comparatively low so that heat absorbed from passive solar gain can provide almost half of the space heating requirements. Overall predictions for the energy consumption of the retreat are expected to be in the region of about a third of the consumption for an equivalent conventional hotel design.

The community plans to self-build a part of the project on site soon. Although for some parts of the construction precise finishes are required (such as for the back walls, roof and facades), other less critical areas present the possibility of self-build for the community.

5. The Oxford Photovoltaic House

The house was designed by Dr. Sue Roaf of Oxford Brookes University and has the only UK example of a domestic photovoltaic roof. The aim of the project was to demonstrate that by creating a superinsulated low energy house a photovoltaic array is a technically feasible method of supplying a significant proportion of the energy required.

Several features of the design have contributed to ensure the usefulness of the PV system, including the following:

- the roof upon which the PV array is mounted faces south and is not obscured by trees, allowing the 4kW array and thermal collectors for the heating of water to operate using peak sunlight exposure;
- gas is used for cooking and instant heating of hot water for the washing machine and dishwasher (hot water for direct use comes from the active solar water heating system), and the majority of heat is provided by warm air circulating by convection to the rest of the house from the south facing double height conservatory. Energy efficient appliances are used throughout the house;
- the house is highly insulated, with 150mm of cavity insulation and an internal concrete block wall. There is 350mm insulation in the roof and a further 150mm under the ground floor. The windows are triple glazed with evacuated cavities ('U' value approximately 1.8 W/m^2K). Doors in the south side are buffered by the conservatory and in the north side by a porch.

These energy saving measures lead to a reduced electricity demand, so that the PV array is able to produce a greater percentage of the energy needs of the occupants than would be possible in a typical situation. During the winter approximately 44% of the total average 24 hour load is met by the array. The area in which the house is situated receives approximately 4 hours of sun per day in the summer, but only 0.6 in the winter. A major problem of domestic rather than commercial building PV systems is that the times of peak energy production (daytime) are times of minimum load. Maximum loads occur in the evening and in winter, when production is low. In this case, a system of battery storage of the excess production was rejected in favour of a importing and exporting energy to the National Grid.

The electricity consumption has been calculated as 2131 kWh/yr. During the summer, the PV array supports the daytime load, producing a daily surplus of typically 12kWh, which is exported to the utility supply through an import/export meter. In the evening this can be reclaimed, with typically 2kWh being reimported. The surplus that is exported to the grid is greater than the deficit created in winter.

The photovoltaic arrangement was based on 24v dc in order to be high enough for good inverter conversion energy (approximately 90%) whilst avoiding hazards during installation and maintenance. The wires from the array pass in series parallel arrangement to a distributor box which is in turn wired to a 4kW inverter, converting dc to ac.

The PV modules are sited low upon the roof with an air gap behind to avoid overheating of the modules and the roof lining. The placing of the modules was designed to allow easy access for cleaning and to incorporate two skylight windows in addition to the forty evacuated tubes thermal collectors which provide hot water for the house.

The proportion of electricity demand met by the PV array would be considerably reduced had the house not been designed to minimise it's electricity load. In fact it is unlikely that the PV array would have had the effect of producing enough electricity to meet all demands had this not been the case. This is an excellent example of demand side management effectively reducing the capital requirements of the autonomous system.

The total cost of the PV system is estimated at £22,000 including the cost of installation, grid supply connection (including import/export meter), the inverter and VAT. However, the PV cells were supplied by BP Solar at a price of £3/Wp, around half what would normally be charged.

An array surplus of 1000 kWh/a is produced, which is exported to the grid. Therefore if the cost of installing the system is set against the cost of each unit of electricity generated by solar energy a payback period can be calculated. For example, if the unit cost is set at a minimum of 10 pence/ kWh then the system will have a payback time of 66 years. However, it is reasonable to assume that the cost of PV equipment will continue to fall in the future. In addition to this, possible increases in the price of grid electricity could make the system cost effective.

The current cost per year of running the solar array based on a consumption of 2131 kWh/a is calculated as £375. This is approximately double the cost of the conventional utility supply, but this can be expected to decrease considerably as the price of electricity increases.

6. Autonomous House, Southwell

This house, designed and occupied by Brenda and Robert Vale, is the only example in the UK of a fully occupied urban autonomous dwelling. It is of a conventional appearance, located in a medium density country town. It is extremely energy and water efficient, and uses a range of autonomous technologies. External wall U values are 0.14 W/m^2K, and that of the windows is 1.1 W/m^2K.

Energy needs for the Southwell autonomous house are met entirely by solar gains, heat production from inhabitants, a wood-burning stove, and a 20 m^2 bank of photovoltaic panels. This generates around 1800 kWh of electricity per year, which passes directly through an inverter when being used within the house. Surplus electricity is sold to the grid, which also provides extra power to the house when needed. For the first year's occupation, electricity was generated on all but three days of the year[1], and the PV panels generate more power than is required. Battery storage of power is required for the water pumping system in the house, as rainwater is collected and stored in tanks in the cellar. An electric immersion heater is also used to provide hot water, although this is supplemented by active solar collectors.

The cost of the PV panels was approximately £20,000. They save around £175 per year, giving a simple payback of over 100 years. As an isolated element, the PV panels are therefore not cost effective. However, the £20,000 costs were included in the overall building price of £500/m^2, typical for a house of this size (there are no architect's fees). The PV panels need cleaning very occasionally, but this is normally adequately performed by the rain.

The demand for water use within the house is reduced by the inclusion of a chambered composting toilet connected to two ground floor toilets. All of the water for the house comes from rainwater collection. The water is stored in 20 recovered orange juice containers which together hold enough water for 300 days supply. The capacity of each container is 1,500 litres. In the summer of 1995, only one third of the available water was used, and this was quickly replenished by rains in early September. When required to top up the header tank located in the roof, the water is screened and passed through a slow sand filter. If the water is required for drinking, it is passed through a charcoal filter located under the sink. This filter needs cleaning occasionally (approximately every three weeks) when it gets blocked. The ceramic filter needs to be replaced every year (maximum) and costs approximately £25.

The house requires very little extra maintenance than a conventional, utility served house. The composting toilet needs no cleaning, but has to be stirred every six weeks. Most problems which do occur can be sorted out as normal, by an electrician or plumber.

7. Ebworth

The Ebworth Centre is a National Trust property consisting of woodland and six farm buildings. When the property was donated to the National Trust in 1989, the buildings were very neglected and in need of extensive renovation. They are now in the process of conversion into an Education Centre, offices and countryside workshops, with the inclusion of several environmental features.

As the buildings are listed, the local planning authority has been closely involved with the conversion to date, and rigorous conditions have been associated with the planning permissions granted so far. The visual aspect of the estate has also been of great consideration, which has limited the technologies appropriate on the site, as has the need to restore the buildings in a vernacular style.

There is no mains water connection to the buildings and fresh water is sourced from a nearby stream by means of a hydraulic ram pump.

Water conservation on the site is maximised by use of composting toilets which serve the main visitor area. The model used has three toilet cubicles whose waste pipes all connect to one main chamber. The chamber has a capacity based on 60 - 80 solid uses per day. The toilets have proved easy to maintain, wood shavings are added weekly and the waste is raked every couple of weeks. Liquid waste is removed from the base of the chamber every month and transferred to the reed bed. No compost has yet been removed. The cost of the toilet amounted to approximately £7000, the majority of which involved the import of the system from the USA. Feedback from members of the public has generally been very favourable.

Greywater from the hand basins in toilets, the kitchen sink and the workshops is discharged into a soakaway via a grease trap. Several problems have been experienced with this system due to the clogging of the perforated pipes with grease and other substances, however these have been rectified by slight structural changes and the careful consideration of the type of substances disposed of in the sinks.

The on-site warden's house has conventional plumbing, however all the waste from the house is treated in a system of bark rings and reed beds. The steeply sloping nature of the site is ideally suited to a gravity fed system of this nature. Waste water leaves the site and enters one of two concrete rings filled with bark, which is contained within a netting bag for easy removal. The bark acts as a filter, trapping most of the solid waste. Water is discharged from the rings into the first of two vertical flow reed beds and from there into a horizontal flow reed bed. Finally the treated effluent enters a manmade pond before final discharge to land.

The cost of this system was approximately £7000, but would have been greater had not much of the work been carried out by National Trust staff. It is designed for continuous use by eight people, with occasional use by up to fifteen. Maintenance involves the emptying of the bark from the rings, which is required around once a year. As only one of the rings is in use at any one time, this allows one ring to be used whilst the other composts prior to removal. The maintenance of the reed beds is minimal.

Future modifications are planned, including the direct linking of the liquid effluent from the composting toilets with the reedbeds. The greywater from the kitchen and workshop may also be connected to the reedbeds, eliminating the problems which have occurred with the soakaway.

8. Allerton Park, Leeds

This development is a terrace of three self built houses in Leeds. One of the priorities of the self-builders was to attain total autonomy from water and sewage mains systems. This is enabled by the use of a composting toilet in each house, which means that there is no sewage effluent to be disposed of.

Grey water from all remaining discharge sources is passed through a grease trap and collected communally in an underground storage tank. The water is then discharged to a vertical flow reed bed and from there to a pond via a submersible pump. The pond water is also supplemented by rainwater draining from the surrounding land. The reedbed and pond system overflow directly to a soakaway. The water is finally pumped to a storage tank through a mesh filter and then a 12.5 micron filter (which has an automatic backwash facility).

Additional treatment is required before the water is pumped to each of the houses for use in bathing and washing and for the heating systems. A 40W UV steriliser has been connected to the tank such that incoming water is treated and a timed circulatory motion provides further treatment.

The grey water equipment is stored in an insulated pump house under the houses. The heat generated by the pumping and treatment equipment should prevent freezing of the system, and a 100W light connected to a frost-stat provides a fail safe back-up.

Rain water is collected from the roof of each house and is stored separately (rather than communally) to avoid disputes as to use in periods of drought. The water is treated before being used for drinking and cooking.

As rain water drains from the roof it is collected in wooden gutters, backfilled around plastic land drain piping with gravel. Water drains via downpipes through a double filter and into a storage cistern of food grade plastic under the house. Water is pumped from the cistern through a 25 micron pre filter and then a 0.5 micron carbon/ceramic filter. Both filters are direct in line to the drinking water supply. Voluntary water quality tests are being carried out by the Environment Agency, and this system is not being used until these are complete. It may be necessary to install a UV treatment system in addition to the carbon/ceramic filter.

A maintenance schedule and servicing routine has been drawn up by the residents and will be written into the freehold deeds of the properties to ensure correct care and maintenance of the systems.

REPORT 14

SUSTAINABLE CONSTRUCTION IN THE UNITED STATES OF AMERICA A PERSPECTIVE TO THE YEAR 2010

GODFRIED AUGENBROE

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CENTER FOR CONSTRUCTION AND ENVIRONMENT
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NATIONAL REPORT

CONTENTS

0. PREFACE

This report is part of a series of national reports produced by the CIB-W82 (Future Studies in construction), subgroup on Sustainable Construction 2010. This report is the United States contribution to that effort. The information in this report is a compilation of material that was obtained from most of the known sources on sustainability in the United States of America (USA). This report is used as a contribution to a global assessment of sustainable construction in a synthesis report, which will be presented by CIB-W82 at the next CIB World Congress in June 1998.

"The future always comes too fast and in the wrong order"
Alvin Toffler in Future Shock

1. INTRODUCTION

This chapter introduces the concerns, constraints and issues that are particular to the building practice in the USA. It also introduces a variety of national initiatives and programs that have been put in place to confront these issues and it points to the shift in paradigm that this will require.

1.1 National concerns

Both globally and in the United States of America (USA), the construction industry is one of the main contributors to the depletion of natural resources and a major cause of unwanted side affects such as air and water pollution, solid waste, deforestation, toxic wastes, health hazards, global warming, and other negative consequences. And although the traditional attitude of having unlimited resources and space is still dominant in the USA, the awareness of environmental impacts is growing and many movements seeking to address sustainability concerns are gaining momentum.

Buildings represent more than 50 percent of the nation's wealth in the USA. In 1993 new construction and renovation activity amounted to approximately $800 billion, representing 13 percent of the GDP, and employed ten million people. [1] Buildings account for one-sixth of the world's freshwater withdrawals, one-quarter of its wood harvest and two-fifths of its material and energy flows.[2] Nearly one-quarter of all ozone-depleting chlorofluorocarbons (CFCs) are emitted by building air conditioners and the processes used to manufacture building materials.[3] 54% of U.S. energy consumption is directly or indirectly related to buildings and their construction.[4] Urban settlements affect the local ecosystem, air quality and transportation patterns of communities, thus having additional impact on the sustainability of our society. It is paramount that the building industry adopts 'environmental performance' as one of its leading principles alongside economic efficiency and productivity principles.

Specific national concerns in the USA are many. The nation has a wide diversity of climatic zones, and traditional building technologies vary from region to region. Severe winters, hot summers, and variations in climate from northern sub-arctic to

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[1] National Science and Technology Council, Washington, 1993

[2] Roodman, D., and Lenssen, N. (1995). «A Building Revolution: How Ecology and Health Concerns Are Transforming Construction,» *Worldwatch Paper 124*, March.

[3] Energy Resource Center. (1995). *Sourcebook: A Guide to the Energy-Efficient and Environmentally Friendly Features of Sustainable Design.* Southern California Gas Company, Downey, CA.

[4] Kirsten Chiles, in Loken, S., Miner, R., and Mumma, T. (1994). *A Reference Guide to Resource Efficient Building Elements, 4th ed.* Center for Resourceful Building Technology, Missoula, MT.

desert and subtropical present different sets of bio-regional sustainability issues. Because of this diversity and the legal domination by individual States in controlling construction practices, building codes vary from state to state. There are more than 76 million residential buildings and almost 5 million commercial buildings in the USA, with an additional 15 million buildings projected by the year 2010[5]. Existing buildings use more than one-third of all primary energy consumed in the country, and account for two-thirds of the total electricity use. Lighting accounts for 20-25% of the electricity used in the U.S. annually.[6] Offices in the U.S. spend 30 to 40 cents of every dollar spent on energy for lighting power, making it one of the most expensive and wasteful building features.[7] Over 30% of the total energy and 60% of the electricity use in the United States is in buildings.[8] This energy use produces nearly one-quarter of the country's total carbon emissions, a significant contribution to climate change. In addition to energy considerations, many regions suffer from air and water pollution. Despite the seriousness of present impacts, considerable progress has been made and both air and water are cleaner than they were a few decades earlier.

Another national concern is the inner cities. Urban infrastructure has steadily deteriorated in recent decades, causing a focus on the revitalization of the nation's inner cities. These blighted inner cities represent a cross section of socially and environmentally unsustainable communities, with decreasing property values and declining neighborhoods. Present inner city problems may be a harbinger of the problems of the «megacities» of the future.

Other local and national issues are worth mentioning:

- *An estimated 400,000 brownfield sites nationwide.* These sites were once productive factories, warehouses, processing plants, and other operations, but are now abandoned facilities with perceived contamination. Sources estimate that cleanup of these contaminated sites will take 75 years and cost about $750 billion.
- *A wave of deregulation that is sweeping the country.* This political trend has made it hard to press for more federal government control.
- *Sustainability in the USA as a community-driven, grass roots movement.* Although broader support is building, expectations are that most improvements will have to come from bottom-up initiatives, carried out by local communities.

A typical and long debated concern in the USA, especially in the context of sustainable communities, is the effect of urban sprawl. Sustainable communities are concerned with the physical layout of their land and activities and the fundamental effects of land use on sustainability. Three factors have converged to generate haphazard, inefficient, and unsustainable urban sprawl:

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5 US Census Bureau; http://www.census.gov/

6 Energy Resource Center. (1995).

7 ibid.

8 Barnett, D.L. and Browning, W.D. (1995). *A Primer on Sustainable Building*. Rocky Mountain Institute, Snowmass, CO., p.59

- *Zoning ordinances* that isolate employment locations, shopping and services, and housing locations from each other
- *Low-density growth planning* aimed at creating automobile access to increasing expanses of land
- *Low cost fuel for automobiles*, recently observed at 71 cents per gallon in Atlanta, GA, resulting from federal and state subsidies of social and environmental costs

The complex problems shared by cities throughout the USA are evidence of the impacts of urban sprawl: increasing traffic congestion and commute times, air pollution, inefficient energy consumption and greater reliance on foreign oil, loss of open space and habitat, inequitable distribution of economic resources, and the loss of a sense of community.

1.2 Constraints

The American economy is capitalistic and consumer- and consumption-oriented. The general result is people buying things they don't need, with money they don't have, creating waste that they leave to the next generation to worry about. This attitude is also reflected in the way that society has arranged its public spaces. It has led to (sub)urban areas with uncontrolled and unsustainable growth patterns dominated by short term economic indicators. Decaying urban areas have been the inevitable result. Only recently have government and the private sector begun to address the vital issues of land-use decisions, environmental contamination, and the need for durable and adaptable buildings. The road to (sub)urban revitalization will be a long and painful one, although the present economic climate has never been more favorable to make a significant breakthrough.

Constraints related to government involvement are evidence of the general mistrust of federal intervention that seems to be prevalent in local communities in the USA. Energy and pollution taxes, although extremely minor compared to most European countries, meet strong public resistance. In a society where fossil energy prices are among the lowest in the world and space is not a scarce commodity, public awareness of sustainability issues is low. Inevitably, it is hard to get broad public attention and support for these pressing issues. Moreover, since the private sector has traditionally had a minimalist view on buildings as the facilitator of the core processes of enterprise, their facilities typically offer less than satisfactory conditions to the average worker. For lack of proper guidelines and broadly accepted non-economic indicators, many assets in the private sector are not being managed for optimal use.

In the public sector, in spite of the ongoing debate, society does not seem to be able to properly fund, maintain and expand the public infrastructure. Another constraint, not unique to the USA, is the fact that there seems to be no 'stakeholder' acting on behalf of the building stock or the workers that spend a great deal of their productive lives in them. The litigious climate inherent in both the public and private sectors inhibits even the most beneficial actions. For example, law suits against remediation agents in the USA have resulted in only 700 of the estimated 75,000 Superfund (special government funding dedicated to cleanup activities) sites being cleaned, with litigation resulting from failure of the sites to meet arbitrary environmental quality standards.

Other constraints are operational in nature. For example, while use of innovative materials is growing, many liability-conscious designers and contractors are reluctant to try materials which are not yet "tried and true," particularly in civil engineering projects where public funding is involved and where failure could mean the loss of many human lives. Building codes, environmental legislation, and other regulatory restrictions impose further limitations on the use of recycled or innovative materials, often taking years to catch up to changes in materials technology. Finally, the sheer number of potential resources available to designers and contractors in the USA makes sustainable design and construction a nearly impossible task.

These constraints to U.S. sustainable construction, ranging from a national scale to the scale of individual building materials, compound each other to make adoption of sustainability principles a slow and often arduous process. The following chapters will deal with indicators of change motivated by the need to overcome the above constraints.

1.3 Issues

In 1997, the USA Building Futures Council (an independent, nonprofit corporation composed of senior executives representing all built environment stakeholders) issued its list of environmental issues facing the building and construction industry. They have identified eight critical elements:

1. *Superfund Reauthorization and Risk sharing:* a new approach to sharing risks of cleanups is needed as remedial action contractors and their insurers have voiced concern over liability issues associated with the performance of cleanup contracting.

2. *Cleanup standards:* selected standards must be based on positive comparative determination and be in the best public interest

3. *Brownfields:* Redevelopment of the estimated 400,000 brownfield sites nationwide can be critical to urban revitalization efforts

4. *Environmental justice:* (may need to define for the international audience) Leaders of cities, states and federal agencies need to establish new policies to begin to address and correct past environmental practices, while preventing future injustice

5. *Environmental infrastructure privatization:* the water/wastewater industry has the potential for significant growth, providing the required legislative and regulatory framework is put in place. DOE (Department of Energy) believes privatization will provide substantial savings over traditional contracting approaches.

6. *Navigation improvements:* There is an urgent need to provide channels to accommodate a new generation of container ships that are now in operation and capable of carrying 6,000 container units

7. *Environmental protection during the construction process:* The control or prevention of environmental pollution and damage requires consideration of air, water and land resources

8. *Water minimization and recycling:* Environmentally sustainable construction can be achieved to a significant extent if the proper studies, guidelines, technology dissemination and incentives are developed.

Other institutions councils have published similar lists, such as the President's Council on Sustainable Development list.

Many of the issues recognize that a refocus has to occur on commercial buildings as important productivity assets, with a focus on durable, user centered performance criteria, adding to the overall and long lasting utility of the building. A shift towards maintenance, adaptation and refurbishment and new (modular) construction technologies is the key to improvements in these areas. In the residential sector, a community and life cycle centered approach to the residential fabric is needed, taking into account all dimensions of public space, mobility, energy, waste, public and private satisfaction.

Better control over the export of construction technologies to the developing world is another issue that deserves careful attention. The construction industry is exporting its current practices in increasing volumes to the rapidly developing parts of the world, most notably parts of Asia. How to stop the ongoing export of unsustainable technologies to developing nations is a global concern.

1.4 The future building stock

As a point of departure, we must acknowledge that the future of our building stock is determined both by what we built in the past and what we are building today. Creating a more sustainable future is a long and ongoing process, and the short-term visibility of results is typically poor. Whatever tools, policies and new technologies we adopt in the construction industry, if they are not embedded in proper environmental policies on national, state and community level, they will not work

Trends in Design and Construction Practices

De-construction and re-use of building components is expected to be a big challenge on the near term. These strategies involve open building approaches and modular building systems during design and construction, allowing flexible infills and adaptation to changing requirements and occupancies. Short-term use of disposable buildings such as strip malls is a uniquely American problem. A re-thinking of the service life of a facility has to happen soon.

Destining building for a longer service life and easy adaptation will create a need for lightweight materials, new assembly and disassembly techniques, and flexible re-modeling of building services systems. These techniques will also be deployed in refurbishment of existing buildings. Open building is an approach to design, construction, and long-term adaptation of buildings based on principles at work in historic environments that have stayed vital.[9] It applies to both residential and non-residential architecture: a base building, designed to last, but without specific interior fit-out designed to have a life related to individual households and other kinds of occupancy. Open building practices represent a long-term trend to prevent early obsolescence.

Trends in Facility Uses

Alternative officing strategies are being adopted, enabling more intensive use of office space and reducing the need for more space, and mobility of office workers.

Trends in Resource Needs of Facilities

DOE has set a target for the energy saving in the built environment. In meeting its energy-efficiency goals, Buildings for the 21st Century will reduce the annual USA energy consumption in the year 2010 by one and a half quadrillion Btu, cutting carbon emissions by 32 million metric tons per year. It will reduce the consumption of the earth's natural resources not only by reducing energy usage, but also through more efficient use and recycling of building materials.

Trends in Building Materials and Technologies

Construction materials technology has changed rapidly in recent years, with significant changes including increased reuse and recycling of construction and demolition waste materials like timber, steel and concrete, improvements to traditional products such as fiber-reinforced concrete and plastic-reinforced wood, and development of completely new technology such as geotextiles. New materials such as engineered wood products are being widely employed to make use of materials formerly perceived as waste. Increased attention is being paid to the needs of environmentally sensitive individuals with the development of a new generation of environmentally benign finish products such as low-VOC paints and water-based adhesives.

Trends in construction practices include increased automation and off-site fabrication of components, leading to less waste generation on site. Alternative contracting strategies and organizational environments, and an overall reduction in adversarial relationships among construction stakeholders, are resulting in more cost-effective

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[9] Stephen Kendall, Open Building, an approach to Sustainable Architecture. To be published.

construction projects with more flexibility to incorporate sustainable building practices. Collaborative relationships such as partnering and cost-sharing among construction stakeholders are resulting in cost savings, reduced conflict, and lower levels of risk for all parties involved.

1.5 National organizations, programs and initiatives

American efforts in sustainable construction are not driven by the federal government. The federal government does participate, largely on the sidelines, by setting an example of what can be accomplished. The result has been several highly visible projects such as the Greening of the White House, the Greening of the Pentagon, green construction efforts by the National Park Service, the creation of a draft green building guide by the Air Force, and a wide range of other programs designed to reinforce the general trends in the country.

Among the national programs there is presently an emphasis on energy efficiency programs.

US Geen Building Council's LEED rating system

The Leadership in Energy and Environmental Design (LEED) green building rating system is one of the most significant recent initiatives The LEED Green Building rating system is a priority program of the US Green Building Council. It is a voluntary, consensus-based market-driven building rating system based on existing proven technology that evaluates environmental performance from a 'whole building' perspective over the building service life. LEED is intended to be a definitive standard for what constitutes a 'green building'. The system is designed for rating new and existing commercial, institutional and high rise residential buildings. It is a feature oriented system where credits are awarded to applicants that earn different levels of available credits and meets all prerequisites. LEED is expected to be expanded in the future to cover all types of buildings and include the full range of life cycle assessment criteria.

Buildings for the 21st century

Buildings for the 21st Century is an effort by the Department of Energy, Office of Building Technology, State and Community programs to increase the energy efficiency of new homes by 50%, and existing homes and new and existing commercial buildings by 20% by the year 2010. In a series of workshops, key stakeholders were brought together to help accelerate the adoption of the whole buildings or systems integration approach to achieve this objective.

Passive Solar Industries Council

The Passive Solar Industries Council (PSIC) has developed passive solar design guidelines for both new construction and remodeling projects. The manual provides climate-specific design information, worksheets, and examples. PSIC also offers for sale "BuilderGuide," a PC-spreadsheet-based design tool that automates the design guidelines. One-day workshops, combining residential design information and the use of BuilderGuide software, are offered to builders, homeowners, architects, utility representatives, and engineers.

Million Solar Roofs Initiative

Responding to President Clinton's call to unleash creative power to meet the challenge of climate change, Secretary of Energy Federico F. Peña has announced the administration's "Million Solar Roofs Initiative." The initiative calls for the Department of Energy to lead an effort to place one million solar energy systems on the roofs of buildings and homes across the USA by the year 2010[10].

EPA Programs

EPA's Energy Star and Green Lights Programs are voluntary program that provide technical assistance, resources, and tools to businesses, institutions, government agencies, and other organizations to produce energy efficient buildings and replace inefficient lighting with new, high-efficiency lighting systems. These programs have helped participants save an average of 30 percent on energy costs.

EPA's Energy Star Residential Programs aim to promote residential energy efficiency. For example, the Energy Star New Homes program works with builders to provide new homes that are at least 30-percent more efficient than the 1992 Model Energy Code. Energy Star Programs and Products works with utility, product distribution, retail, and government procurement partners to market, sell, and purchase Energy Star products. Energy Star Financing provides long-term equipment financing and innovative mortgage options, with no additional down payment to consumers. The Energy Star Heating, Ventilating and Air-Conditioning Program helps consumers find more efficient heating and cooling equipment for their homes.

Note: EPA is also heavy into pollution prevention (P2), whereby they or their contractors help manufacturers optimize their production processes to eliminate potential pollution at the source. Benefits realized from EPA's P2 programs include reduced environmental liability, particularly for processes involving hazardous or toxic materials where waste can be prevented. More importantly to US businesses, however, is P2's potential to save money not only on disposal costs but also by reducing the requirements for input materials.

The American Council for an Energy-Efficient Economy (ACEEE) program

ACEEE offers several publications related to energy-efficient buildings, including Consumer Guide to Home Energy Savings, which discusses the entire spectrum of

[10] DOE's fact sheet, "Million Solar Roofs."

home energy savings and residential appliances, including a list of the most energy-efficient equipment and appliances available; and Guide to Energy-Efficient Office Equipment, which offers recommendations about the types of equipment to purchase and how to best operate it for maximum energy efficiency, as well as energy-use characteristics of microcomputers and displays, printers, copiers, and fax machines.

Home Energy Rating Systems (HERS) and Energy-Efficient Mortgage Programs (EEMS)

HERS programs rate the energy efficiency of new and existing homes, and offer recommendations for energy improvements. These energy ratings are often used in obtaining energy-efficient mortgages (EEMs). Several states have HERS programs, which operate under Energy Rated Homes of America, a national nonprofit organization.

The US Department of Energy, in accordance with the Energy Policy Act of 1992, published a set of voluntary HERS guidelines. DOE is encouraging utilities and the mortgage industry to adopt them. The new guidelines rate new and existing homes according to how closely they follow the insulation requirements of the Council of American Building Officials' Model Energy Code, as well as other requirements. The homes are then awarded an energy efficiency rating between 0 and 100, with 100 being a home that is completely energy-self-sufficient.

In 1995, the National Association of State Energy Office Officials and Energy Rated Homes of America founded the Residential Energy Services Network (RESNET) to develop a national market for HERS and EEMs. An EEM is a type of mortgage that allows energy-efficiency features to be included in a mortgage loan. EEMs can also allow a buyer to qualify for a higher mortgage, because the reduction in utility bills allows more debt.

National R&D programs

In spite of recent funding opportunities such as DOE's CREST program[11] and the National Renewable Energy Lab program[12], there is a need to intensify broad national research programs that specifically put sustainable construction on the national funding agenda. In a study by CERF[13], a global research agenda for the construction industry was established. Sustainability in the 21st century was declared as the main mission. The R&D themes were divided into 5 focus areas:

1) management and Business practices

2) Design Technology and Practice

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[11] CREST: http://www.crest.org

[12] NREN lab: http://www.battelle.gov

[13] CERF, Construction Industry Research Prospectuses for the 21st century, (1996) Civil Engineering Research Foundation, New York, NY.

3) Construction and equipment

4) Materials and systems

5) Public and government policies

The CERF initiative could serve as the template for any future national initiative in sustainable construction, especially in the civil engineering sector. Its strong emphasis on engineering and construction management is an important parallel track that needs separate attention in an industry wide approach to sustainable construction.

1.6 The need for a paradigm shift

It goes without saying all of the above initiatives of section 1.4 as such are not sufficient to bring about the change that is needed. Aiming for a sustainable built environment requires mire than that. It requires a paradigm shift in the way we approach time, cost and quality constraints, as depicted in Figure 1[14].

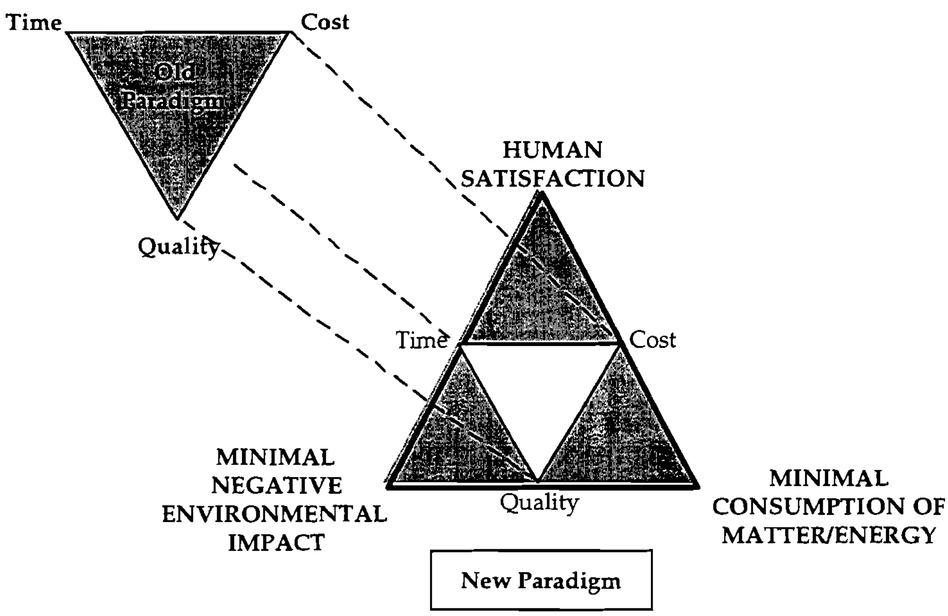

Figure 1: Sustainability calls for a new paradigm

The paradigm shift forces us to take a much broader look in both time (full life cycle assessments), space (the object in its wider system settings) and costs (greener cost metrics than pure monetary), than we used to do in traditional engineering. This wider perspective can be made operational through the introduction of a suite of sustainability indicators, as part of a framework that will be introduced in chapter 2.

[14] Vanegas, J.A., DuBose, J.R., and Pearce, A.R. (1996). «Sustainable Technologies for the Building Construction Industry.» *Proceedings, Symposium on Design for the Global Environment*, Atlanta, GA, Nov. 2 - 4.

2. METHODOLOGY

Given the broad range of issues and challenges facing the USA in its quest for creating a sustainable built environment, stakeholders desperately need a consistent framework of indicators to measure progress and set research agendas. This chapter introduces one possible framework to classify sustainability indicators. The framework is used to define indicators of change and position them properly in the wide context of sustainable construction. Its purpose is to support the causality that needs to be established between the current situation, expressed by a set of indicators, the momentum created by new initiatives and policies, and indicators of change.

These indicators of change can also be used, through proper measurement and extrapolation, to forecast opportunities for improvement and priorities for change through new policies and incentives.

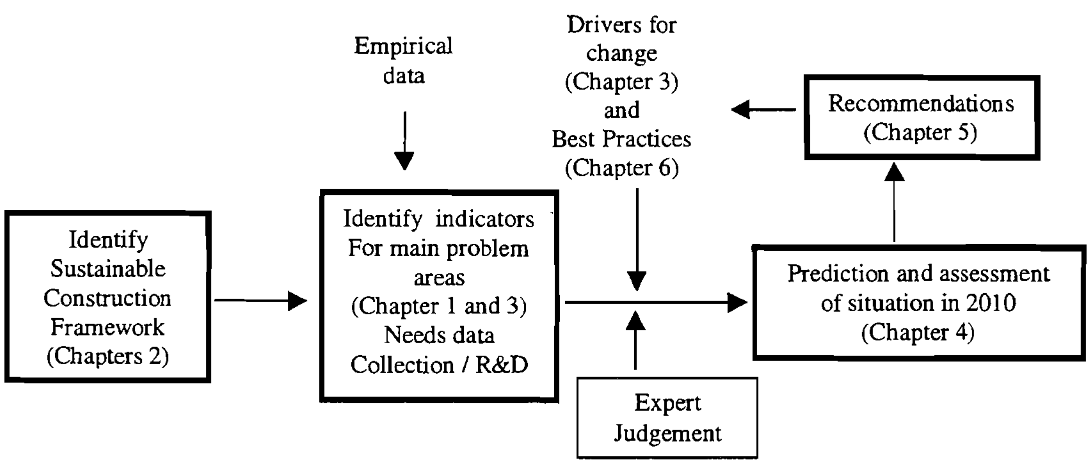

Figure 2: A methodology to predict and measure change in sustainable building

The figure explains the approach in detail. Within the framework (this Chapter) it is easy to identify the problem areas discussed in Chapter 1. Chapter 3 will attempt the definition of drivers for change, such as new policies, funding initiatives, new styles of process management etc. These will be presented to a selected forum of experts in order to arrive at a prediction of change by the year 2010 (Chapter 4). Based on these predictions, a number of recommendations (Chapter 5) will be formulated.

The approach will be primarily applied in a qualitative manner, as proper metrics for most indicators have not been defined yet, and what is more, empirical data is lacking to quantify the progress that we hope to make between now and 2010. In fact, it is of the highest priority to provide the empirical evidence in order to establish the contribution of the different drivers for change to improved sustainability of the built environment.

2.1 A framework for sustainable construction indicators

Figure 3 defines sustainable construction in a methodological framework, consisting of three main axes: System (boundary), Process (actor) and Aspect (sustainability).

It expresses that in different *life cycle phases* of a building, different *actors* are dealing with the designed or built artifact, each of them within distinct *system boundaries*, while responsible for different *sustainability aspects*.

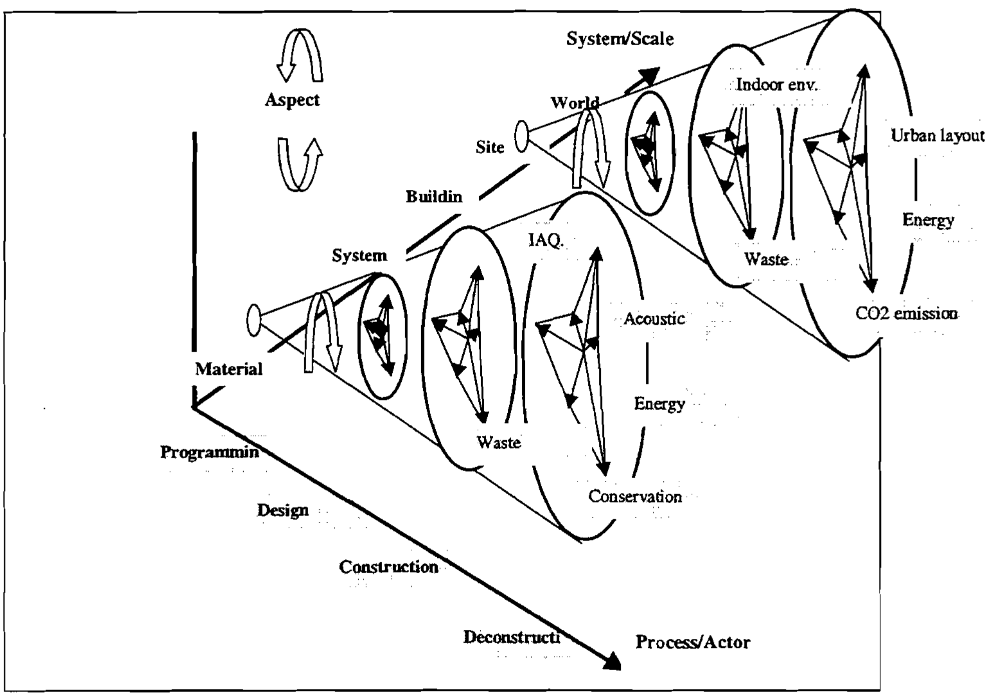

Figure 3: A framework to identify process/actor and system boundary versus Performance Aspect

The *system* axis spans building-internal composition levels (from material to assembled components whole building systems) to building-external macro and meso levels (building, city, ecosystem, world)

Along the *process* axis, clusters of actors are connected in collaborative tasks. Depending on the scale of the observation (system boundary), different actors (individual owner, design team, regulatory bodies, government) fade in and out of focus.

Aspects are depicted as radar charts that evolve through the life cycle stages of the facility. Certain aspects are decided upon in a particular life cycle stage. They fade in and out of the design/construction/maintenance process over time. The complexity of a construction project is apparent and one should realize that sustainability is just one of many performance requirements that the design, engineering and construction team is trying to meet. As such, sustainability can not be separated from improvements of the construction industry as a whole, i.e. through a more integrated and better managed process.

The figure also shows the typical system specific approach to the control of desired aspects, e.g. on component level (somewhere in between material and building system level) certain aspects will be dominant whereas on other system scale (e.g. regional level) the urban development indicators will be the dominant design objectives.

On a superficial level the figure obscures the real problem, i.e. on the transition or boundaries between two system levels, between actors and across life cycle stages.

Another issue that is not immediately apparent is the present lack of support for an integral comparison of different design alternatives. For the time being the value system to compare different envelopes on the radar chart is lacking. Ultimately, the objective is to provide the value system that would allow the mapping of all performance aspects onto the 'Value Triangle' of Figure 1.

Sustainable construction can now be defined in operational terms based on the set of performance aspects with suitable indicators. Along the Process axis, the need for operational instruments to optimize performance, can be identified. The framework allows us to measure how different process phases deal with resources at various scales of the built environment. The ultimate goal of the operational framework is to develop the instruments to ascertain in what way the built environment can be self sustainable within system boundaries at meso or even macro levels (i.e., no inputs or outputs crossing the system boundary means fully self-sustaining). The performance indicators enable us to measure how well the 'product' performs. It is paramount that these performance metrics reflect the multiplicity of performance indicators, enabling integral performance assessments.

Along the process axis we need to measure the effectiveness of the process, i.e., how well stakeholders undertaking each process work together in meeting the sustainability objectives at different system boundaries. Transparency of objectives and tasks across system boundaries at different system levels is a key performance requirement, since many mistakes of the past can be traced back to a lack of task and objectives coordination.

Each system boundary poses its own set of sustainability issues apart from the issues resulting from the aggregation of its subsystems. An acute challenge is finding the system boundaries, process phases and actors that in current practice have the greatest impact on the resulting performance of the built environment.

2.2 Sustainable construction metrics

The construction industry uses a major part of the 6 billion tons of industrial raw material that we deplete from the earth's resources each year. Environmental impacts are tremendous but hard to measure objectively for each single construction project. The trend in sustainability evaluation in the USA is toward life cycle assessments for each material used in a particular building, i.e., a micro-level analysis. Few if any attempts have been made to evaluate environmental or sustainability impacts at larger scales[15]. But LCA based methodologies are far from operational at this point, mainly because of the following reasons:

- *An LCA has to address a wide range of environmental aspects*, usually split up into three domains: *pollution* (emissions of hazardous material into the environment), *depletion* (use of biotic and a-biotic raw materials), and *impairment* (all negative structural effects in the environment). Many of these aspects are very hard to quantify in an objective way. In fact, for the latter category, hardly any physical, measurable inputs and outputs have been defined.
- *Combining different aspects of the LCA domains into one integral eco-rating is very difficult*, since there are no reliable indicators to distinguish the relative importance of the various indicators. Moreover, emergent properties on the system scale are an important parameter in the determination of relative importance[15]. Not surprisingly, so-called eco-labeling of products in other industrial sectors is usually done on the basis of a very narrowly defined LCA method (e.g., pollution through acidification (NH3) and eutrophication (phosphates), as in the case of detergents). Needless to say, such disparate indicator labeling does not make much sense for building products
- *The underlying data for an LCA is usually very hard to obtain*, especially objective, quantitative data about emissions, wastes and energy inputs in the production process due to proprietary information concerns by profit-driven corporations

A future objective of sustainability research is the definition of environmental or ecological impairment indicators such that they can enter an LCA method to produce an integral sustainability assessment.

Impairment has very different system scale effects. Inside a building, for example, human comfort and health (sick buildings, VOC's, stress factors) are important aspects. On larger system scales we find effects on mobility, traffic, groundwater, and indeed the whole ecosystem to be the key factors. But we are far removed from deployment of full LCA in all of these areas.

What we witness is a shortcut to so-called performance profiles (sometimes presented as radar charts as in figure 2). These methods typically define a distinct number of system boundaries, and a select set of indicators for each system. The key to the success of these sets of indicators is that they find acceptance in the design and

[15] Pearce, Annie R, Dissertation Georgia Tech, 1998

engineering community and that (re)design methods can be developed that reflect them. Additional material on measurement procedures and facility assessment tools can be found in the quoted dissertation.

Towards a new set of performance indicators

Environmental performance indicators need to be defined along with metrics and agreed evaluation procedures. There have been early attempts to define quantifiable indicators at various system scales and boundaries but standardized ways to measure the environmental performance of alternatives do not yet exist. Moreover, many innovative building products and designs will not pass present prescriptive regulations and therefore never enter the market, irrespective of the potentially improved performance.

Table 1 shows an example of the type of performance indicators that need to be assessed for building materials.

Table 1: Sample Information Requirements for Sustainable Building Materials

Environmental Performance	Technological Performance	Resource Use Performance	Socio-Economic Performance
Impacts on Air Quality	Durability	Energy	Occupant Health/ Indoor Env'l Quality
• Carbon Dioxide	Service Life	• Embodied	• VOC Outgassing
• Hydrocarbons	Maintainability	• Operational	• Toxicity
Impacts on Water Quality	Serviceability	• Efficiency	• Susceptibility to biocontamination
Impacts on Soil Quality	Code Compliance	• Distributional	Appropriateness for:
Ozone Depletion Potential	R-value	Degree of Processing	• Scale
Site Disturbance	Strength	Source Reduction	• Climate
Assimilability	Constructability	Materials	• Culture
Scarceness		• Renewable	• Site
Impacts during Harvest		• Recycled/ Recyclability	Economics:
Processing Impacts		• Reused/ Reusability	• Contribution to Economic Dev't.
		• Renewability	• Cost
		• Local/Transport Distance	• Labor Skill Requirements
		• Packaging Requirements	• Labor Amount Requirements

3. DRIVERS FOR CHANGE IN THE CONSTRUCTION INDUSTRY

This chapter lists the potential drivers for change in those areas that have been identified as the main problem areas in sustainable construction (Chapter 1). Policies, technologies, etc. are described briefly in order to prepare the predictions in Chapter 4, on how these drivers will have contributed to a change in sustainable construction in 2010.

Many divers in this chapter will be elucidated by describing current trials, emerging technologies, and early policies. This list is by no means intended to be exhaustive but intended as guidelines in the assessment of effectiveness of the individual drivers and their prioritization by experts in the field.

3.1 Energy conservation measures

Measures to improve the energy efficiency of buildings hold tremendous potential. The Congressional Office of Technology Assessment estimates that commercially available, cost-effective energy technologies could reduce overall energy consumption in the USA by as much as one-third--worth some $343 billion. Strategies such as proper siting and airtight construction, as well as installing energy-efficient equipment and appliances and renewable energy systems will reduce the amount of energy a building needs to operate and to keep its occupants comfortable.

Buildings for the 21st Century is a national approach to create a new generation of buildings which are energy efficient, high quality, affordable and environmentally sustainable. With this approach, our country uses energy efficient and solar technologies and designs now available to save 20% of the energy currently used in buildings, and to reduce the energy use of new buildings by 50% relative to present building practices.

Buildings for the 21st Century has the goal of achieving that vision by the year 2010. To meet that goal, it will draw together the diverse knowledge and technologies of many buildings- and energy-related programs at the USA Department of Energy. It will also bring together such partnership programs as ReBuild America, Building America, and the President's Million Solar Roofs Initiative. Using this combined expertise, Buildings for the 21st Century will work to spread the word to those who really need to hear it: a diverse list that includes architects, builders, contractors, local governments, homeowners, mortgage companies, and many others.

Other renewable resources such as wind and geothermal energy systems can also supply energy to buildings. It is important to do complete site and resource assessments to ensure that the system or resource being considered can supply the necessary energy. This is a guideline, not an indicator.

Current policies are aimed at a market based approach, recognition of clean energy alternatives, collection of empirical evidence that a policy is effective, and long-term orientation.

Some 'winners' indicate that there is reason for optimism: R&D of renewable energy has brought down the cost of renewables to the point that wind energy competes favorably with conventional electric power in some areas of the country. The government's natural gas policy, which promotes competition, has produced a market that is supported by ample supplies at reasonable prices. Technology innovation, aided by government energy efficiency policies, has resulted in improvements in the efficient use of energy, even in the face of declining energy prices.

3.2 Land use regulations and urban planning policies

There is no lack of measurable indicators. From 1970 to 1990, the density of urban population in the USA decreased by 23 percent. From 1970 to 1990, more than 30,000 square miles (19 million acres) of once-rural lands in the USA became urban, as classified by the USA Census Bureau. From 1969 to 1989, the population of the USA. increased by 22.5 percent -- and the number of miles driven by that population ("vehicles miles traveled" or "VMT") increased by 98.4 percent.

There is no discussion that placing green building projects within easy access of public transportation, medical facilities, shopping areas, and recreational facilities decreases the need for automobiles and encourages bicycling and walking. In addition, successful green buildings blend into the community, preserving natural and historical characteristics, and will utilize existing infrastructure in order to reduce sprawl.

3.3 Waste reduction opportunities

Recycled-Content Materials

There are already many building products available today that are manufactured from recycled materials. For example, organic asphalt shingles contain recycled paper, and some shingles are made from re-manufactured wood fiber. Cellulose insulation is manufactured from recycled newspaper.

Alternative building materials can conserve resources, as well. Technologies that allow more efficient use of lumber include stress-skin panels; engineered framing products, such as I-beams, glue-laminated products, and finger-jointed lumber. These products allow for the use of "scrap" lumber that might otherwise be landfilled, as well as the use of small-dimension lumber.

Materials Reuse

Lumber and other products, such as windows, doors, cabinets, and appliances, can be salvaged when buildings are demolished or rehabilitated. It makes sense to employ materials that are still useful, rather than destroying or disposing of them. This approach not only uses resources more efficiently, but also conserves valuable landfill space.

Other building techniques use "waste" materials such as straw bales and used tires to as building elements. These materials reduce costs of construction while maximizing resource efficiency. Native, or "indigenous," materials, such as clay or stone have low embodied energy and can serve as resource-efficient building materials.

Construction-related waste accounts for about one-fourth of total landfilled waste in the USA (source?). Yet many construction materials can be recycled, including glass, aluminum, carpet, steel, brick, and gypsum.

Construction and renovation waste can also be reduced by salvaging, rather than land-filling, including items that have some remaining life, such as appliances, household goods, office equipment and furniture, building materials.

Construction waste can also be reduced/minimized by designing buildings to use standard-dimension lumber and through adaptive reuse (renovating existing buildings, rather than destroying them and erecting new ones).

3.4 Resource Conservation strategies

Use of waste and recycled building materials

Opportunities in this area will depend mostly on the introduction of new materials on the market and emerging brokerage services to re-use building materials.

Water Conservation

Installing energy-efficient appliances and fixtures, and changing irrigation practices and behavior can reduce water consumption by 30 percent. Low-flow shower heads, faucet aerators, and water-conserving toilets can conserve a considerable amount of water, energy, and other costs, such as water treatment costs. Many water utility companies offer rebates or incentives to install water-conserving fixtures and appliances

Graywater--water used for bathing, clothes washing, and similar tasks--or collected rainwater can be used to water landscape or for irrigation purposes.

3.5 Indoor Air Quality Control

Energy-efficient buildings are more airtight and therefore hold greater potential for indoor air quality problems. Because many building products can contribute to poor air quality, one can reduce these potential problems by selecting materials lower in chemicals and toxins, and installing mechanical ventilation systems to ensure an adequate fresh air supply.

3.6 Proliferation of environmental energy technologies

Urban scale «Cool Communities»

Important improvements will result by matching available technologies with the appropriate applications. A good example is reported in DOE study[16] on a «Cool Communities» strategy applied in hot climates, e.g., in southern California. Research on the use of lighter colored reroofs, resurfaced pavements, and shade trees has found that these measures can directly lower annual air conditioning bills in Los Angeles by $200M, cool the Basin by 3 degrees C , indirectly save $160M more in air conditioning, and reduce smog by 10%, worth another $360M.

Photovoltaics

In the wake of the oil crisis in the 70's, the USA began an extensive research and development program on Photovoltaics (PVs). During the 80s, a series of full-scale tests in commercial buildings were performed. In the 90s, a few far-sighted utilities have begun to install distributed PV systems integrated in their grid, slowly shifting away from fossil energy sources.

In June of 1993, DOE and the National Renewable Energy Laboratory put a $25M program in place to foster integrated PV systems in commercial buildings.

The potential market for PV application in the USA is big; it is only a matter of time until market forces aided by proper government incentives will approach that market with competitive building-integrated PV systems.

Similar expectations exist in other markets such as heat pumps, high performance glazing, co-generation and wind energy.

3.7 Re-engeering of the Design Process

Looking at the building from a "whole building" or systems engineering perspective, buildings will be viewed as integrated systems rather than a series of independent components. Incorporating this perspective into the designing, planning, and building stages can have significant effects on the outcome. For instance, efficiency improvements that might be hard to justify on their own accord are seen in a different light when they result in a smaller heating and cooling system for the building. Synergies such as these are common in building designs, but are often overlooked. Increased consideration of potential synergies will foster the use of advanced building

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[16] Arthur H. Rosenfeld et.al. Direct and Indirect Savings: Magnitudes and Implementation policies, Designing for the global environment, Nov. 1995, Atlanta.

technologies that incorporate solar and other forms of renewable energy; and an integrated approach both to new-building construction and old-building renovations.

Co-engineering strategies: 'Design for Performance'

Green buildings are achieved through an orchestrated activity of the team of actors involved in the process of programming, designing, construction, use and recycling of the facility. Many improvements are necessary in the orchestration of the complicated process, in order to take benefit of available technologies and products.

Integrated design systems are becoming more common place in the building engineering domain[17]. Technical building systems are the prime application fields of integrated design approaches. The aim is to support collaboration between owner, designers, part manufacturers and engineers, usually referred to as 'co-engineering' where architectural designers and engineers work jointly towards better technical solutions. Optimal co-engineering will be enabled by better coordination of the search and specification of technical solutions through the different process stages, i.e., design, manufacturing, construction and site assembly and maintenance.

3.8 Proactive role of building manufacturers: made to order

Product manufacturers are entering a new era when all or most product information is exclusively available electronically. Companies are aware that the Internet will change the way that product data is accessed, selected, ordered, and specified during the design stages. There are enormous challenges involved in «going electronic» with present paper-based catalogues, in order to consolidate a competitive edge once companies are on the net.

The designing 'demand side' will start adapting its traditional role of 'buyer' of the product to a one-to-one co-engineering relationship with the manufacturer. Such relationships enable products made to meet a sustainability performance requirements profile.

3.9 The move towards new 'Cost' metrics: LCC+LCA

Future buildings will actively involve the adoption of life-cycle, whole cost accounting based on economic and ecological value systems, accelerating the use of sustainable technologies and establishing the concepts of system engineering in all phases of building design, construction, financing , and operation. The move to new ways of measuring costs will also serve to educate the public about the true costs of a building's ownership, occupancy and operation, along with the energy and non-energy contributions that a properly designed building can make to productivity, personal health, comfort and sustainability.

[17] Godfried Augenbroe, A CO-ENGINEERING APPROACH TO BUILDINGS, VIII Rinker Conference, Gainesville, Florida, Febr. 1998.

New metrics will be based on a combination of life cycle cost (LCC) and environmental life cycle assessment (LCA), with the potential of beginning a new era of cooperation in community planning, construction, financing, and the establishment of affordable housing.

3.10 New partnerships and stakeholders

New partnerships among local governments, utilities, energy service firms, and private industries, will be formed with the goal of increasing investment in research and large-scale implementation of new practices.

Specifically, sustainability is about working with community partners to increase their awareness and use of the many technologies and concepts now available, while working to advance those technologies and concepts. Some communities will need help to modify their building codes and standards; others may need help implementing a net metering program with a local utility; others may need workshops on building design or best environmental practices for home building. Moving the construction industry toward sustainability will involve collaboration on the part of all stakeholders to find common solutions to problems like these.

3.11 Adoption of performance-based standards

The development of performance-based specifications is being undertaken in many countries of the world already. These specifications will likely be preceded by the development of performance-based building codes. Different stakeholders will benefit from performance based specifications. These specifications will improve the reliability of buildings and build in guarantees to reduce their environmental impact. Owners and manufacturers will benefit from the increasing opportunities to apply new materials and new technologies

LEED Rating system

The wide spread adoption and implementation of the LEED rating system is closely linked to performance based standards. It should be noted that LEED is unique in that it was not created by an organization representing a national government. LEED rates the environmental aspects of a building and the behavior of its occupants to arrive at a final score that results in a platinum (highest level), gold, silver, or bronze plaque being awarded. A wide range of issues are evaluated to include energy and water use, indoor health, recycling for occupants, access to mass transit, materials impacts, landscaping, construction waste management, building siting, and maintenance. If successful, the LEED Building Rating System could profoundly alter the types of buildings being created in the USA.

3.12 Product innovation and certification

Directories and councils fostering the development and use of new products are important catalysts for change.

Certification of materials as being produced in a sustainable fashion is a very important component of sustainable construction. Wood is the dominant material in residential construction in the USA and vast quantities are consumed each year in the form of dimensional lumber, plywood, oriented strand board, and other products. The Smartwood Program of the Forestry Stewardship Council (FSC) is making inroads into traditional American forestry practices by motivating wood product companies to have their forests certified as being managed to produce a sustainable harvest and respect the plant and animal biodiversity of the forest. If Smartwood is successful in applying a strategy of simultaneously influencing consumers and producers of wood products, the forestry industry in the USA could be transformed to an activity that is truly sustainable.

The National Fenestration Rating Council (NFRC) was formed to develop a voluntary, national rating system for windows, doors, and other fenestration products. NFRC's uniform energy performance rating and labeling system allows builders and consumers to compare the efficiency of fenestration products. *NFRC Certified Products Directory* contains information on the U-value of more than 20,000 certified products.

Green Building Products and Materials Resource Directory, produced by the North Carolina Department of Commerce, Energy Division, and the North Carolina Recycling Association, is an online database providing information on environmentally-friendly and energy- and resource-efficient building materials. The entries include information on each product's composition, waste products, recyclability in design, recycled content, embodied energy, and energy efficiency, among others.

Green Building Resource Guide provides information on The Green Building Resource Guide, a database of more than 600 green building materials and products. The Guide is available as either a reference manual or a CD-ROM database.

Rainforest Action Network lists suppliers of innovative building alternatives, recycled/salvaged lumber suppliers, certifiers of sustainably produced lumber, and builders of alternative housing (such as straw-bale and rammed earth).

Lighthook's Strawbale House and many similar lists provides information on strawbale building technology, as well as links and resource lists.

Used Building Materials Association (UBMA) is a non-profit, membership-based organization representing companies and organizations involved with acquiring or redistributing used building materials. The "Exchange" portion of its Web site includes online directories of building materials available and building materials wanted.

3.13 Adoption of incentive programs

The US Environmental Protection Agency (EPA) offers several programs that aim to reduce energy consumption in buildings. The Energy Star Buildings Program is a voluntary energy-efficiency program for commercial buildings in the USA. The program focuses on profitable investment opportunities available in most buildings using proven technologies. Program participants can expect to reduce their building's energy consumption by about 30 percent.

3.14 Education and training

The success of sustainability in general and sustainability in the built environment in particular is very much dependent on how institutions of higher learning respond to the ideas generated as a result of widespread interest in sustainable development. An organization known as Second Nature has as its core mission changing what is taught at American universities by embedding environmental literacy in the curriculum, and has been conducting training sessions on how to accomplish this change. A number of other organizations have similar, parallel efforts underway, including Campus Ecology, a branch of the National Wildlife Federation, and the World Resources Institute. Campus Ecology works with student leaders on campuses, training them on issues and activities that will help make their institutions more environmentally responsible. Similarly, the World Resources Institute is working with Colleges of Business in the USA to help them begin including environmental issues as a factor in business decision making. A wide range of other efforts where organizations work with Medical Schools and Law Schools at universities will probably have an aggregate impact on the progress of sustainability in the USA.

3.15 Recognition of commercial buildings as productivity assets

The World Health Organization estimates that 30% of all new and remodeled buildings suffer from poor indoor environments caused by noxious emissions, off-gassing, and pathogens spawned from inadequate moisture protection and ventilation, resulting in $60 billion annually in lost white-collar productivity from Sick Building Syndrome (SBS) in the U.S. alone.

Several recent studies have shown that making a building environmentally responsive can increase worker productivity by 6% to 15% or more. Since a typical commercial employer spends about 70 times as much money on salaries as on energy, any increase in productivity can dramatically shorten a green building's payback period.

Achieving improved productivity requires better control of indoor performance, utility, and serviceability of the built asset, better maintained through adequate investments in facility management, regular building diagnostics and proper maintenance.

4. RECOMMENDATIONS

The following is a list of recommendations based on discussions with experts, results from the survey and research experiences from the authors.

Metrics

- The application of finance and accounting theory to the valuation of new energy and efficiency options[18]. The experience in manufacturing over the last two decades indicates that traditional accounting-based procedures for valuing new technologies significantly understate their benefits.
- Present eco-rating procedures are inadequate, incomplete, and poorly embedded in a framework for integrated sustainability assessment. Diversifying these tools for different actors, stakeholders and system boundaries, and a migration path along intermediate products, is important.
- Develop a complete set of environmental performance indicators with suitable metrics
- Define procedures to obtain reliable LCA data for materials and components on all aggregation levels encountered in the facility
- Build a data base with reliable and up-to-date LCA data for construction materials
- Develop nation-wide accepted performance based specifications for materials and systems

Process

- An analysis of present constraints posed by regulations is important to remove the barriers impeding new practices and products in the building industry. A re-engineering of the way we regulate the building process though codes and regulations is probably unavoidable.
- Collaborative engineering models, protocols and systems must focus on integral assessments of design through the different design phases. They must incorporate sustainability indicators in performance based strategies that match client requirements with assessed design performance (ASTM). Tools must be embedded in collaborative CAD environments and should be accessible by all actors in the process.
- Develop useful tools that appeal to different actors and stakeholders and that can easily be embedded in existing practice. Rather than adapting the practice to the tool, the new generation of design tools should reflect the diversity in skills and objectives of its user base
- Develop new generation of multi disciplinary integrated design environments
- Develop an integrated life cycle environmental and financial cost measure that can work within various system boundaries

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[18] Shimon Awerbuch, Designing for the global environment, Nov. 1995, Atlanta.

- Build co-engineering partnerships for customized product development and remove barriers to shorten time to market

Policy

- Ecologists and economists arrive at different unreconcilable conclusions as to what is absolutely necessary and economically feasible in the next 20 years. This calls for new concepts rather than incremental improvements.
- Improvements in energy efficiency in general and gradual removal of dependency on fossil fuels are targets that will become realistic in the next 50 years. Between now and 2010 a major breakthrough in energy reduction in new buildings should be accomplishable.
- Remove regulatory barriers and streamline innovation
- Develop performance standards, building guidelines and practices
- Conduct benchmarking on new systems for performance evaluation
- Target technologies that produce buildings that use 50% less energy than the present norm (AHRAE 90.1)
- Identify best practices
- Build showcases and monitor and diagnose systems in practice
- Build a timely national data base to cultivate and promote proven technologies; extend to a life-cycle information system for constructed facilities
- Establish a process to manage liability concerns

Technology

- Design for recyclability. Design should distinguish between re-use of components and recycling of the materials of a component. The latter requires extensive research into optimal combinations of materials and new components made from their recycled waste.
- Expand rationalized industrialized building practices
- Develop components and integrated solutions through co-makership alliances
- Develop plug and play building components that are re-configurable
- Explore and advocate an international dimension to system modularity in building components and systems

Education

- Expand education and training on implementing new technologies and building practices
- Share knowledge with developing countries and adopt local sustainability metrics in exported technologies

5. CASE STUDIES

This chapter lists a random selection of industrial case studies and best practices. The latter have been supplied by the CIB Task Group 16.

5.1 Industrial Best Practices

Interface Inc.

Interface, Inc is a $1 billion a year international manufacturer and marketer of commercial interior products: carpet tile, broadloom carpet, fabrics, raised flooring and specialty chemicals. Energy efficiency projects first received serious attention at Interface in 1995. The interest in reducing energy consumption has been driven by two different but compatible forces: Interface's CEO, Ray Anderson and COO, Charlie Eitel.
The company has launched an enterprise wide initiative called QUEST (Quality Utilizing Employee Suggestions and Teamwork) aimed to eliminate all waste. Waste is broadly defined as anything that goes into end products that does not come out as value to the customer.

In 1994 CEO Ray Anderson created a movement called EcoSense to push Interface toward sustainability.

The two programs together have resulted in thousands of projects ranging from lighting retrofits to photovoltaic arrays, saving the company a cumulative $40 million. To respond to the challenge, Interface is currently developing a strategy to pull together its resources into one toolkit that will be presented to the facility managers at our 28 sites around the globe.

Interface has declared seven fronts for sustainability: Eliminate Waste, Benign Emissions, Renewable Energy, Closing the Loop, Resource Efficient Transportation, Sensitivity Hookup, Redesign Commerce, Eliminate Waste

Hellmuth, Obata & Kassabaum (HOK)

Being one of the world's largest design firms, HOK has demonstrated a special commitment to sustainable construction through implementing a variety of procedures, guidelines, databases, and protocols to stimulate and support the generation of sustainable designs.

A significant element is the 'Sustainable Design Guide', which is a tool to assist project teams in defining and prioritizing sustainable design goals. The checklist is organized by three design phases: Pre-Design, design and Documentation, Construction Administration, and by sustainable design topic: Planning and Site work, Energy, Building Materials, Indoor Air Quality, Water Conservation, and Recycling and waste Management.

A new and very complete version of the Design Guide has recently become available[19].

5.2 Current practice

5.2.1 Planned Developments

Suburban development in the US has contributed to many environmental problems, most significantly the dependency on the automobile and loss of productive land. The size of most planned unit developments (PUDs) is probably their greatest value in sustainable construction. Individual buildings can be built in a green manner, and sustainability issues beyond the walls of an individual home or commercial building that impact the whole community can also be addressed in a logical long-term large-scale manner.

Village Homes

The development of Village Homes in Davis, California was begun in 1975 and was based on principles of self-sufficiency, community, energy conservation and market appeal. It occupies 70 acres and was designed for 200 homes. The main components of the development are narrow streets, cul-de-sacs, on-street parking, interconnected pedestrian ways, communal green space, including agricultural land, smaller lots, and the orientation of every house lot for southern exposure. Commercial and recreational uses were provided in the community center to decrease automobile usage. The streets in Village Homes are 25 ft. wide, as opposed to 35 ft. for typical subdivisions at the time. The narrower streets cost less money to build, and they also slow traffic, mitigate automobile noise, help reduce stormwater run-off, and leave more land for green space. Parking is either in on-street parking bays or in detached garages

Dewees Island

Dewees Island is a 1,206 acre barrier island off the coast of South Carolina. The premise of the development is a high-end retreat in tune with the 350 acres of existing wildlife preserves on the island. Environmental regulations for wetlands and coastal development as well as environmental groups placed severe restrictions on development. The first phase was 10 home sites ranging from $200,000 on 1 1/2 acres inland to $315,000 on 2 1/2 acres on the waterfront. The total maximum allowable build-out is 150 single family homes on 420 acres of developable land. The other 786 acres is protected by covenant from any development. For any given property lot, averaging more than one acre apiece, no more than 7,500 sq. ft. may be disturbed by construction. As part of a community outreach environmental education program, the developers built an education center on the island for visitors and residents to have an information source to learn about the native flora, fauna, and ecosystems.

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[19] HOK, Sustainable Design Guide, January 1998. Senior Editor: Sandra Mendler , HOK, Washington DC.

Civano-Tucson Solar Village

Civano in Tucson, AZ is the first attempt to create a new land development with social amenities, affordable housing, and a job-to-housing balance required to make it economically feasible while also designing in energy and water efficiencies in the buildings, landscape and infrastructure.

5.2.2 Traditional Neighborhood Development (TND)

Traditional neighborhood development (TND) grew out of Andres Duany and Elizabeth Plater-Zybek's belief in the connection between community form and function: if the structural elements that embody a traditional American small town are recreated in new and infill developments, then the values and functions of community will follow. Duany and Plater-Zybek began developing the TND concept in their work for Robert Davis at Seaside, Florida. The beachfront property on the «Redneck Riviera» was to be a return to the classic small American town. The architects traveled through the Southern USA, especially Charleston, South Carolina and Savannah, Georgia, observing the physical structures which give these towns their qualities of pedestrian life, defined neighborhoods, public space, identifiable organization, and architectural character. They were also able to identify and codify land-use hierarchies and densities from commercial centers, to mixed-use and multi-family neighborhoods, to single-family neighborhoods. The overriding principle of these neighborhoods is that they have a radius no greater than one-quarter mile from the center to the furthest dwelling. The basis for implementing TND is a set of codes which mirror the structure of typical land-use ordinances by defining land uses, lot sizes, setbacks, and height. However, TND ordinances go beyond the measurable character of land uses by also defining aesthetic and materials codes for buildings.

Seaside in Florida

Seaside was the first built expression of the TND principles begun in the mid 1980's. The 80 acre town is expected to grow to about 650 dwellings and 2,000 residents. The plan consists of a mixed-use town center located off the main through-road with a pattern of limited access streets radiating outward to the small, detached single-family home lots. A grid overlay ties the radial streets together and connects to the main through road, distributing traffic throughout the community. Parking is limited to areas outside the development and on-street within the development. A strict architectural code determines the materials and appearance of the development as well as ensuring certain features such as front porches and picket fences which are meant to engender community interaction. The code prescribes features that are indigenous to the vernacular architecture, recreating not only the appearance but also the natural ventilation and shade that pre-air-conditioned dwellings utilized for passive cooling. Sand and shell walkways behind structures form the pedestrian network. All the home lots are small with a shallow front setback that moves the porches closer to the street and creates a tight urbanistic facade.

Haymount, Virginia

Haymount is a 4,000 dwelling unit, 1,605 acre development on farmland in eastern Virginia on the Rappahannock River. The land planning process used an extensive environmental assessment overlay mapping process that outlined all environmentally sensitive areas and individual trees of 18 inches in diameter or greater. Approximately 37% of the site will be developed and the existing agricultural land will be converted to organic farms. The land plan consists of 5 neighborhoods with 750,000 sq. ft. of integrated office and retail space. There are 22 types of housing ranging from more expensive single -family dwellings to smaller single-family homes and a variety of multi-family dwellings. The sewage treatment will be provided by constructed wetlands at a scale of 6 for the first phase of 300 homes. The multi-disciplinary planning team, common to the best of sustainable construction, included planners, landscape architects, architects, engineers, and hydrologists.

Harbor Town in Memphis, Tennessee

Harbor Town is built on an island in the Mississippi River in Memphis, Tennessee. The development is meant to embody the traditional values of Southern town through its physical character. The plan is a combination of a grid and axial street system, with three major focal points. The homes are built on smaller lots, 3,000 to 5,000 sq. ft., with front porches, many small neighborhood parks, and back alleys with parking on the streets. Smaller single family homes are designed in the «shotgun» style, a traditional form so-called because it utilizes an circulation spine through the building from front to back, with the front and back doors in line. This style makes cross-ventilation feasible with front and back porches to cool the air as it passes. Lots for these homes are 31 ft. by 91 ft. long and the homes themselves are 1,500 sq. ft. without garages. By setting the 18 ft. wide homes 10 ft. back from one side and 3 ft. from the other side, cars can be parked beside the dwelling, saving the necessity to build garages while eliminating the ubiquitous American garage door facade. The rectangular shell, the circulation path which passes from one room to the next without use of a hallway, and the use of one room for living, dining, and kitchen, reduces materials use to the absolute minimum.

Celebration in Florida

Celebration is a 4,900 acre new town developed by The Celebration Company, a subsidiary of The Walt Disney Company, and opened in 1996. Celebration was planned by architects Cooper, Robertson & Partners and Robert A. M. Stern to create a model of neo-traditional planning. The major design elements are; a central commercial «downtown» core, mixed housing types, a public school, health facilities, a 109 acre office park, and a golf course. An advanced infrastructure system of telecommunications and fiber optics, pedestrian paths and trails are all intended to reduce transportation needs and create a pedestrian friendly environment. The development uses a series of guidelines and controls, including approved builders and stylistic controls, for the architecture of housing types. These types range from townhouse to single family, with designs based on traditional American architecture. The land development pattern creates a secondary street network of alleys and hidden or rear-located garages to remove vehicles from the principal street frontage.

5.2.3 Transit Oriented Development (TOD)

The architect and planner Peter Calthorpe developed the design strategy for cities called Transit Oriented Development (TOD) in the 1980's. The foundation for this development type centered around mass-transit is the high rate of automobile use in the USA. Vehicle Miles Traveled (VMT) per household has been determined to have increased by 82% from 1969 to 1990 while the US population has only increased by 21% during the same period. The average transportation mode split in the US is calculated as 86% by auto, 8% walking, 3% bicycle, and 3% by transit. TOD is an attempt to alter these patterns. The guiding force is transportation efficiency and the fundamental connections between home and work and one community to the next. 'Pedestrian pockets' link the nodes of commerce and transit stops with the residential and recreational areas in close proximity. TOD is explicitly energy conserving by supporting mass-transit, pedestrian access, density and mixed-use, infill around existing transportation infrastructure and consequently, the preservation of surrounding natural areas.

Laguna West in Sacramento, California

Laguna West in Sacramento County, 12 miles south of Sacramento, California is the first expression of the TOD concept. The 1,045 acre development will have 3,300 dwellings in 1,800 detached homes and 1,500 townhouses and apartments. The town core will have 300,000 sq. ft of parking and 1.4 million sq. ft of commercial space. As a bedroom community serving Sacramento, this development could have been another example of suburban sprawl, except that it is linked by mass-transit and carries through Calthorpe's "pedestrian pockets" concept which is the core of TOD.

Habitat for Humanity

Habitat for Humanity is a non-profit non-denominational religious international organization devoted to the construction of 10,000 low-income housing units annually. The group sells completed homes to qualified participants with interest-free loans. Participants are obligated to contribute personal sweat-equity in the construction of both their own home as well as others, along with community volunteers and vendors who contribute labor and materials. Homes are constructed over the course of several weekends when a full crew of dozens of volunteers assemble for intensive housing-raising sessions.

The Jordan Commons project is a 200 home, 40 acre project meant to provide affordable sustainable housing in the lower-income community of Homestead, Florida which was severely damaged by Hurricane Andrew in 1992. The principles of community, community services, energy-efficiency, and affordability make this project a comprehensive approach to sustainable development. Specifically, the ideas of environmental responsibility, economic viability, and social equity are combined in one project using housing as the foundation. The premises of pedestrianism and energy-efficiency are particularly important economic considerations for lower-income groups.

5.2.4 Individual Buildings

Individual efforts and buildings have been the mainstay of the sustainability movement in the US beginning with solar energy based dwellings in the 1970's. More recent sustainable buildings are employing holistic approaches to deal with the impacts of buildings on the environment and their human occupants.

Rocky Mountain Institute - Office and Residence

The Rocky Mountain Institute (RMI) is a non-profit organization that promotes energy-efficiency and sustainable construction world-wide, based in Snowmass, Colorado. The founder of the Institute, Amory Lovins has become an renowned expert in the design of energy-efficient building systems with a focus on lighting and the calculation and documentation of the benefits of efficient commercial building systems for both utility savings and productivity gains resulting from good indoor environmental quality. RMI focuses on the reduction of electrical power consumption due to the enormous environmental costs of its production. Electrical consumption uses one-third of all the fuel in the US and produces one-third of carbon dioxide pollution

Sustainable Development and Construction Initiative, Inc. - Abacoa Residences

Sustainable Development and Construction Initiative, Inc. (SDCI), is a non-profit group centered around the University of Florida, Center for Construction and Environment, in Gainesville, Florida. The group consists of academics, architects, developers, engineers, building contractors, and energy and waste specialists devoted to sustainable construction education and implementation.

The Abacoa development in Jupiter, Florida is a 2,000 acre mixed-use development that is expected to build-out in 20 years at 6,000 dwellings, plus approximately 3,000,000 sq. ft. of commercial space, a university branch and a baseball training camp. The development is located adjacent to a mass-transit rail system which links it to cities along the Florida southeast coast. The existing land is pine flatwoods and agricultural land that is expected to be restored to its native ecosystems within the community as a whole and through a wildlife corridor «greenway» which extends completely through the development.

Southern California Gas Company - Energy Resource Center

Southern California Gas Company is one of the largest utilities in the U.S. They have just this year, 1995, completed the Energy Resource Center for large commercial customers that utilizes the cutting-edge of material and energy resource efficiency in a model sustainable construction showcase and educational facility.

This 43,000 sq. ft. office building in Downey, California uses an existing office building that was partially dismantled and renovated. Approximately 400 tons or 70% of the original building materials were either reused directly or put into recycled waste stream. The building cost between $5.9 million and $6.5 million to build, excluding an estimated $3.2 million saved by using the existing site and materials. The specific green features of the building add about $225,000 to $275,000 to the cost, but operating savings are expected to be $25,000 dollars a year giving a simple payback of 10 years.

Croxton Collaborative - Audubon House

The Croxton Collaborative architectural firm is one of the leading U.S. architectural practitioners of green design and construction. They have been involved in several high profile design projects including the Natural Resources Defense Council office renovation and the National Audubon Society office renovation, both in New York City.

The Audubon House was created from the renovation of an 1891 office building, reusing the resources and restoring the architectural character of an existing structure instead of building a new building. This decision was calculated to have reused 300 tons of steel, 9,000 tons of masonry, and 560 tons of concrete. The existing building was 8 stories and a 9th floor penthouse was added to create 100,000 sq. ft. of office space. A major component of the effort was the multi-disciplinary approach that also brings the client and non-traditional consultants such as environmental scientists and indoor air quality experts into the design team to a greater extent than is typical. This holistic approach was utilized to realize sustainability design goals of a healthy and pleasant working environment, environmental soundness, and quantifiable dollar, energy and material-use reduction. The economics of energy-efficiency were a major consideration with a maximum cumulative payback period of 5 years for all of the energy-related systems.

Environmental Showcase Home

The largest single user-group of the Good Cents Environmental Home Program are various electrical utilities around the country. The Arizona Public Service utility in Phoenix, Arizona, used the guidelines of the Goods Cents program and consultation with Steve Loken of CRBT to design and build a demonstration home using all of the sustainable construction goals of energy, water and material conservation. Water-use and extreme variations in temperature are paramount concerns in the desert Southwest, whereas a high availability of solar energy presents a unique opportunity for the utilization of solar energy systems.

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