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EC 5th Framework

PERFORMANCE BASED BUILDING THEMATIC NETWORK 2001-2005

PeBBu COMPENIUM: STATEMENTS OF REQUIREMENTS

PeBBu Compendium 2 Final Report

Performance Based Building Thematic Network
Funded by EU 5th Framework Research Programme
Managed by CIBdf

Statements of Requirements

PeBBu Compendium 2

FINAL REPORT

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Performance Based Building Network (PeBBu) is a thematic network funded under the European Commission's (EU) 5th framework – Competitive and Sustainable Growth and has been operational from October 2001 till September 2005. This project has been managed by CIBdf, The Netherlands. The PeBBu Network has been facilitating in enhancing the existing performance based building research and activities by networking with the main European stakeholders and other international stakeholders. The network has also been producing synergistic results for dissemination and adaptation of performance based building and construction. More than 70 organisations worldwide have been participating in the PeBBu Network.

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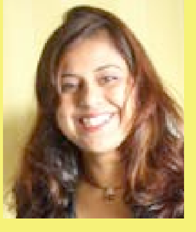

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FOREWORD

This report has been made possible thanks to joint funding from the Dutch Government Building Agency (GBA) / Rijksgebouwendienst (RGD), the US General Services Administration (GSA) and the CIB, and thanks to in-kind and financial support from the Building Research Establishment (BRE) and the International Centre for Facilities (ICF). The authors want to acknowledge here the permission given by the UK Defence Estates to analyse and record one of their recent key programs of construction.

A major contribution to the Compendium comes from Daan Oostinga. During his internship at the Dutch GBA/RGD, he studied and reported on three selected projects that where part of substantial construction programs of the GBA/RGD. His hard work, insights and keen ability to listen allowed him to write three Case Studies that will be an excellent source of lessons learned with respect to the use of the Performance Based contracting. This work, in our view, is a milestone for PBB because it provides the kind of field research that is still too rare. We would also like to take this opportunity to thank the other members of the PeBBuCo team at BRE and at ICF: Gerald Davis, Michael Clift, Lynne Blair, and Joan Wilson participated in different ways. Without their contribution and participation, this work would not have been possible.

When starting a project such as this one, which is intended to break new ground, it is always difficult to predict what will happen, what the actual level of effort necessary will be, and what the actual result will be. We are grateful to the CIB and to its Secretary General, Wim Bakens, for having had the foresight to embark in this adventure, for their trust in our ability to pull it together and for their patience and support.

<u>Compendium 2 (PeBBuCo) Project Team</u>

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EXECUTIVE SUMMARY

The Compendium 2 project (PeBBuCo) was set up as an aligned PeBBu Task by the CIB to confirm what is understood by a Performance Based Building approach (PBB). The PeBBuCo team was mandated to prepare a "consensus based conceptual framework" for the PeBBu project overall. This consensus was accomplished by presentations, papers, articles, bulletins, special publications, and other communications with members of PeBBu throughout the project.

The two primary objectives for this project were to (1) help the PeBBu Domains and Tasks to prepare their own conceptual frameworks within an overall understanding, so that these frameworks would be congruent, and (2) present case studies of PBB projects to trace how the Statements of Requirements were created and used throughout the projects show cased.

In order to accomplish these objectives, the PeBBuCo team prepared the following deliverables:

- PBB Conceptual Framework (presentations, supporting papers, bulletins and articles).
  This separate document synthesizes the overall concept of the PBB approach. (See Part 1)
- Case Studies.
  The Compendium 2 reports on case studies of PBB projects, the Statements of Requirements that were prepared for those projects and the lessons learned from the projects. It includes an Overview (See Part 2), a section on "How to capture the information for a case study", including a template and an interview guide to be used by others to prepare similar project studies (See Part 3) and Examples (See Part 4)
- Sample Functional Statements (See Part 5):
  -- Functional statements in prior PFI UK Case Studies
  -- Three UK Examples of Functional Statements
  -- Functional Statements from ASTM Standards on Whole Building Functionality and Serviceability
- Impact of UK Building Regulations on Performance Based Building (See Part 6)
- Supporting documents (See Appendices):
  Terminology, List of Key Words for Research Mapping, Glossary of Abbreviations, Acronyms and Initialisms, and Bibliography

The case studies are expected to serve as examples so that others can use the template to prepare similar case studies and upload them to the Compendium 2 Web Page at the CIB Website. In time, this interactive Web Page should become a repository of information and lessons learned so that stakeholders starting a PBB project will be able to set up such projects with more confidence and avoid some of the difficulties that have been encountered on projects in the case studies.

It is recommended that the Research Agenda being prepared for the Building and Construction Industry should include funding for such case studies as one of the research proposals. Also, major portfolio owner and managers, both in the public and private sectors, are urged to include Evaluation Case Study tasks as a routine and on-going activity on all their projects. If done in a structured way, with an SoR as the starting point, these evaluations can be done easily, with a minimum of effort and added cost. The cumulative results of such studies would provide invaluable feed-forward to the next projects. These could also serve for benchmarking purposes.

CONTENTS

Introduction

PART 1

1 Introduction

PeBBu is an EU funded "Thematic Network" dedicated to the exploration of the Performance Based concept, as it applies to the Building and Construction Sector (PBB). PeBBu has made great strides in bringing people together to share their work, in pulling together information and knowledge, and in focusing more attention on this important "Theme". By creating a critical mass of people who are interested and working with this concept, PeBBu has already fulfilled the expectations that are at the core of such a "Thematic Network". It has also given substance to the pro-active program of the CIB and to the work of some of its working commissions.

Starting in the fall of 2001, and completed in the fall of 2005, this PeBBu Thematic Network project has brought together, at a number of meetings, members of CIB from over 30 organizations in Europe and others from organizations around the world. (Bakens et al. 2005, CIB 2003, Lee and Barrett 2003, PeBBu 2002,).

The Compendium 2 project (PeBBuCo) was set up to confirm what is understood by PBB. The PeBBuCo team was mandated to prepare a "consensus based PBB conceptual framework" for the overall PeBBu project and to develop documents that would provide examples of how the PBB approach is used during actual building projects. To fullfil its mandate, the PeBBuCo team (Francoise Szigeti, Kathryn Bourke and Josephine Prior) developed a number of documents in support of the main PeBBu project. (CIB 2003, PeBBu 2002, Prior and Szigeti 2003a, Prior and Szigeti 2003b, Prior, Szigeti and Oostinga 2003, Szigeti 2005, Szigeti and Davis 2005).

These documents were used in discussions with the rest of the PeBBu members and others within CIB. The PeBBuCo team participated in the break-out sessions of all Domains during PeBBu meetings and presented at all PeBBu general meetings, and many PeBBu Domain meetings, in order to help provide congruence between the work of the Domains and the overall PBB conceptual framework. As a result a consensus about the use of terms and concepts has been significantly accomplished, although debates will likely continue for a long time with respect to the application of PBB in practice.

This project was coordinated more specifically with Domains #2 – Indoor Environment, Domain #3 – PBB Design of Buildings, Domain #5 – Organization and Management (closed), Domain #7 – Regulations, Domain #8 – Innovation, and Domain #9 – Information (closed). Team members of PeBBuCo collaborated and worked with members of:

- Domain #2 -- on the conceptual framework and on the terminology specific to this domain. The Domain #2 conceptual framework is congruent with the overall PBB conceptual framework.
- Domain #3 -- on the application to the overall PBB conceptual framework of The Hamburger Model created by Giehling (Ang et al 2005, Spekking 2005, and Szigeti and Davis 2005).
- Domain #5 -- on the reports, by providing written contributions to the in particular about the state of PBB in Canada.
- Domain #7 -- on reports, by providing written comments.
- Domain #8 -- on a Delphi Study of PBB Definitions.
- Domain #9 -- on the structure of PBB information, and a set of related key words for use in the research mapping task aligned with the PeBBu project.

The two primary objectives for the PeBBuCo project were to (1) support the PeBBu Domains and Tasks, so that their own conceptual frameworks would be congruent with the overall PBB Conceptual Framework, and (2) present case studies of PBB projects to trace how the Statements of Requirements were created and used throughout the projects show cased.

To accomplish the objectives stated above, the PeBBuCo team prepared the following deliverables:

- PBB Conceptual Framework:
  The PBB Conceptual Framework synthesizes the Performance Based Building approach overall. It is summarized and documented separately. One Document is a CIB Bulletin titled "What is Performance Based Building (PBB): In a Nutshell (June 2005). The other is a separate CIB publication titled "What is Performance Based Building (PBB): Taking Stock".

- Case Studies:
  The Compendium 2 reports on case studies of PBB projects, the Statements of Requirements that were prepared for those projects and the lessons learned from those projects. It includes an Overview (See Part 2), a section on "How to capture the information for a case study", a template and an interview guide to be used by others to prepare similar project studies (See Part 3), and Examples (See Part 4).

- Sample Functional Statements (See Part 5):
  -- Functional statements in prior PFI UK Case Studies
  -- Three UK Examples of Functional Statements
  -- Examples of Functional Statements from ASTM Standards on Whole Building Functionality and Serviceability

- Impact of UK Building Regulations on Performance Based Building (See Part 6)

- Supporting documents (See Appendices):
  -- Terminology
  -- List of Key Words for Research Mapping
  -- Glossary of Abbreviations, Acronyms and Initialisms, and
  -- Bibliography. (References cited are listed in the bibliography appended to this report.)

The case studies are expected to serve as examples so that others can use the template to prepare similar case studies and upload them to the Compendium 2 Web Page at the CIB Website. In time, this interactive Web Page is expected to become a repository of information and lessons learned so that stakeholders starting a PBB project will be able to set up such projects with more confidence and avoid some of the difficulties that have been encountered on projects in the case studies.

For the PeBBuCo project, the team prepared a template to gather the information from Case Studies. This template was pilot tested and adjusted so that it could serve to record information about projects of different size and complexity, while providing a standard structure for the information thus collected. In this manner, it will be easier to analyse future Case Studies in relation to those already reported on, and to build on those reports as they are completed. As part of the Case Study work, an interview guide was also created and tested. It is intended to make it easier for others to ask questions from the people involved in such projects without having to start from scratch.

This PeBBuCo project is not a research project. It was given the mandate to produce a tool for stakeholders starting PBB projects, and as a way to help others organize information about PBB projects. Using this tool, and lessons learned, can make it easier to procure such projects, set up project teams and create an understanding of the benefits of a PBB approach, as well as the potential difficulties to be avoided.

From our experience and knowledge of the field, this Compendium project is the first of its kind in that it presents studies of completed building projects that were procured using a PBB approach. It is therefore in and of itself a "State-of-the-Art" report. This Compendium, and the other documents prepared for this task, provide access to terminology, definitions and references. These will give clients, stakeholders and researchers an up to date view of the consensus about PBB reached in the course of the PeBBu project.

These Case Studies have already been used in the following ways:

- The main investigator of the three GBA/RGD (Dutch Government Building Agency) Studies used them as part of his thesis for Masters degree;
- The Dutch Government's GBA/RGD used the case studies as part of its in-house evaluation. The lessons learned from these case studies have already been used to inform other GBA/RGD projects.

Although the Compendium contains only a few case studies, some comments can be made, based on the findings of the case studies:

- Statements of Requirements have to be very carefully stated so that it is easy to verify that a proposed solution can explicitly meet those requirements.
- High level Statements of Requirements need to be paired with indicators of capability so that design solutions can be evaluated before they are built in order to avoid misfits. In particular, the need for change has to be taken into account, since constructed assets have a long life, while uses and activities can change very rapidly.
- When checking a design solution against the "explicit and implicit" requirements for a project, it is essential to test different ways that the assets might be used in order to anticipate changes. Otherwise a building or constructed asset, in whole or in part, can very quickly become unfit for its users.
- Statements of Requirements are a key element in the ISO 9000 series of standards. To be able to measure quality, provide quality assurance and quality management systems, it is essential to explicitly state the requirements of the customer, and to include a process that ensure that the quality of the end product, expressed by a level of performance for a given cost, be measurable and verifiable. Thus this PeBBuCo project makes explicit how PBB links to ISO 9000.

In practice, this means that clients, when procuring constructed assets, should ensure that their Statement of Requirements include "Functional Statements" that can be paired and compared with "Indicators of Capability".

Conceptually, such dialog between client and supplier, requirements and capabilities, can also be expressed as two halves of a "hamburger bun", with the statement of the requirement in functional or performance language (Functional Concept - FC) matched to a solution (Solution Concept - SC) in more technical language, and the matching, verification / validation that needs to occur in between. (Figure 1) (Ang et al, 2005 and Spekkink 2005). In a recent paper (Ang et al, 2005), the Hamburger Model is described as follows:

"The functional concept (FC) represents the set of unquantified objectives and goals to be satisfied, related to performance requirements to fulfil these needs. The solution concept (SC) represents the technical materialization that satisfies at least the required performance. The development or selection of a solution concept is a design decision. The assumed or actual realization allows for the determination of expected or real performance. This performance differs in general from the required performance and shall be at least equal to the required performance.

"A validation method, by measurement, calculation or testing, is necessary to evaluate the performance and to compare alternative solutions. Systematic decomposition creates a coherent set of performance requirements and technical solutions with appropriate validation methods. The structure of an object is being described by decomposition and the pertaining set of performance requirements and verification methods is developed and organized."

To effectively compare demand and supply (Gap Analysis), calibrated scales can be used that measure both the levels of requirements and the capability of the asset. These can be either already in use, or being designed, or on offer to be bought or leased. That methodology is an ASTM / ANSI standard and is currently being considered as an ISO standard (Figure 2). (Szigeti, Davis, and Hammond, 2005, p.108).

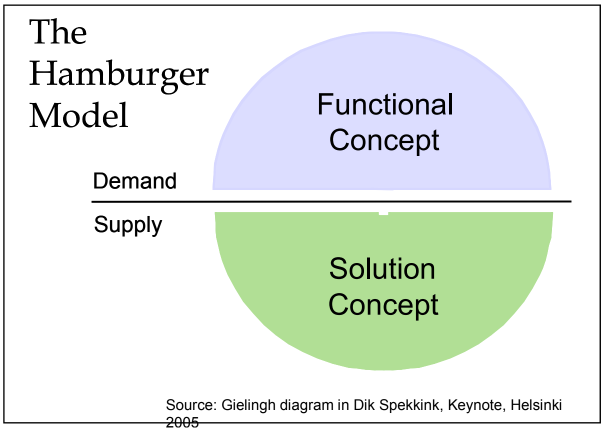

Figure 1. The Hamburger Model

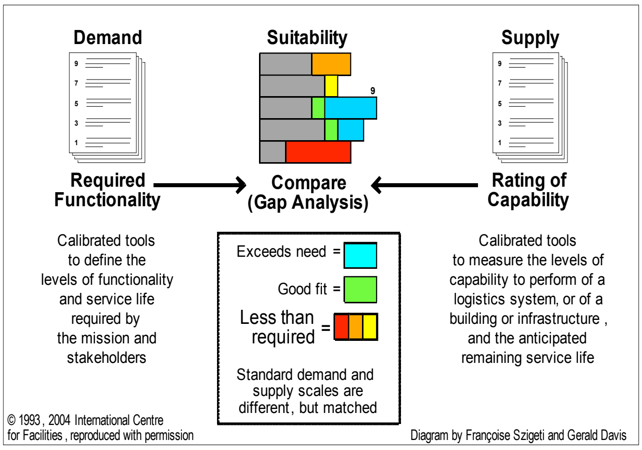

Figure 2. Suitability: Compare demand requirements to capability of supply

This dialog between the two sides of the demand (FC) / supply (SC) matching process, applies all through the "supply chain", whether it is done explicitly and transparently or implicitly and intuitively (Figures 3 and 4). (Spekkink 2005)

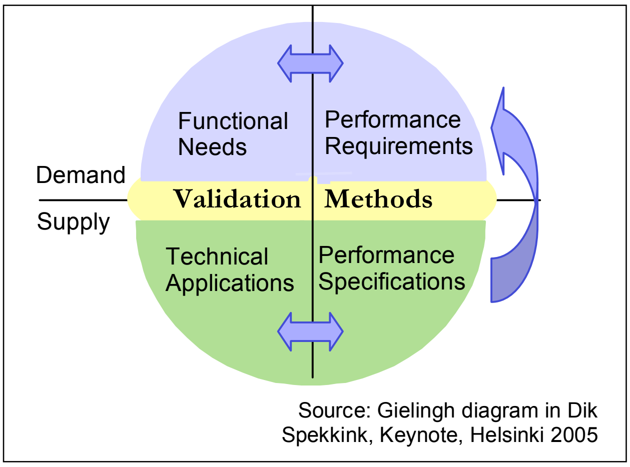

Figure 3. Translation and Validation

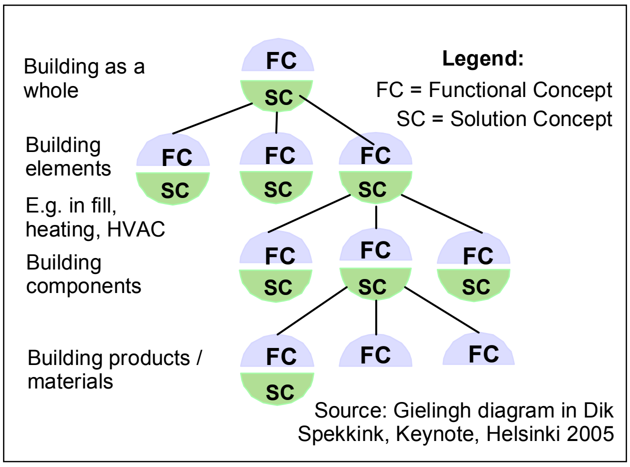

Figure 4. Application through the supply chain

Each time there is a request for proposals, or a contract to procure, the need for explicitly stating the requirements of the client has to be considered. This applies from the mission of the organization all the way to the choice of materials, or the provision of any other asset and resource.

Buildings and other constructed assets are a useful support to business ends. Over the last decades, there has been a growing recognition of the need to consider buildings and constructed assets in the context of business, from the perspective of end users, and as "means of production", instead of only as an overhead and cost centre. Concepts such as Demand, Supply, Production, Management, Maintenance and Operation, and Use, help us understand the relationships between clients, other stakeholders, occupants and users (demand) and those who provide, manage, maintain and operate, the constructed assets (supply).

Figure 5 shows in summary the flow of information over the life cycle of a facility or constructed asset, from a management point of view. This includes the feedback loop that links a facility in use to the requirements and capabilities that are compared and matched anytime decisions need to be made. Decisions are made as part of portfolio management, during the feasibility phase before a project is launched, at the start of the project, during design, construction and commissioning, when resources need to be allocated for operation, maintenance and repair, when major alterations, repairs or renovations have to be procured, etc.

Figure 6 focuses on the details required to prepare Asset Management Plans. This diagram is congruent with the information labels needed for compliance with the relevant IAI (International Alliance for Interoperability) Industry Foundation Classes (IFC).

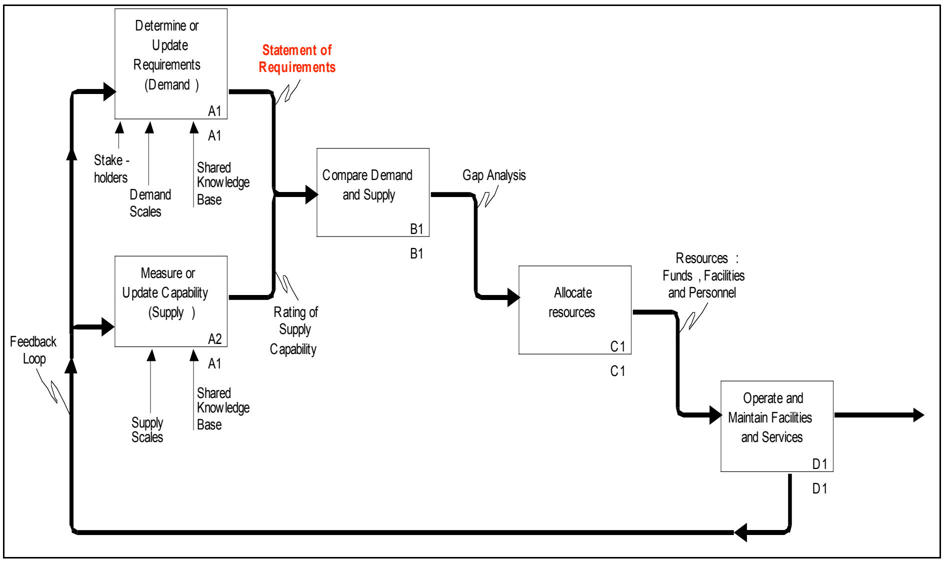

Figure 5. Overall Statement of Requirement in the Life Cycle Loop

(Fig.. 5 and Fig. 6 Source: Diagram by Francoise Szigeti and Gerald Davis, 2005 © International Centre for Facilities

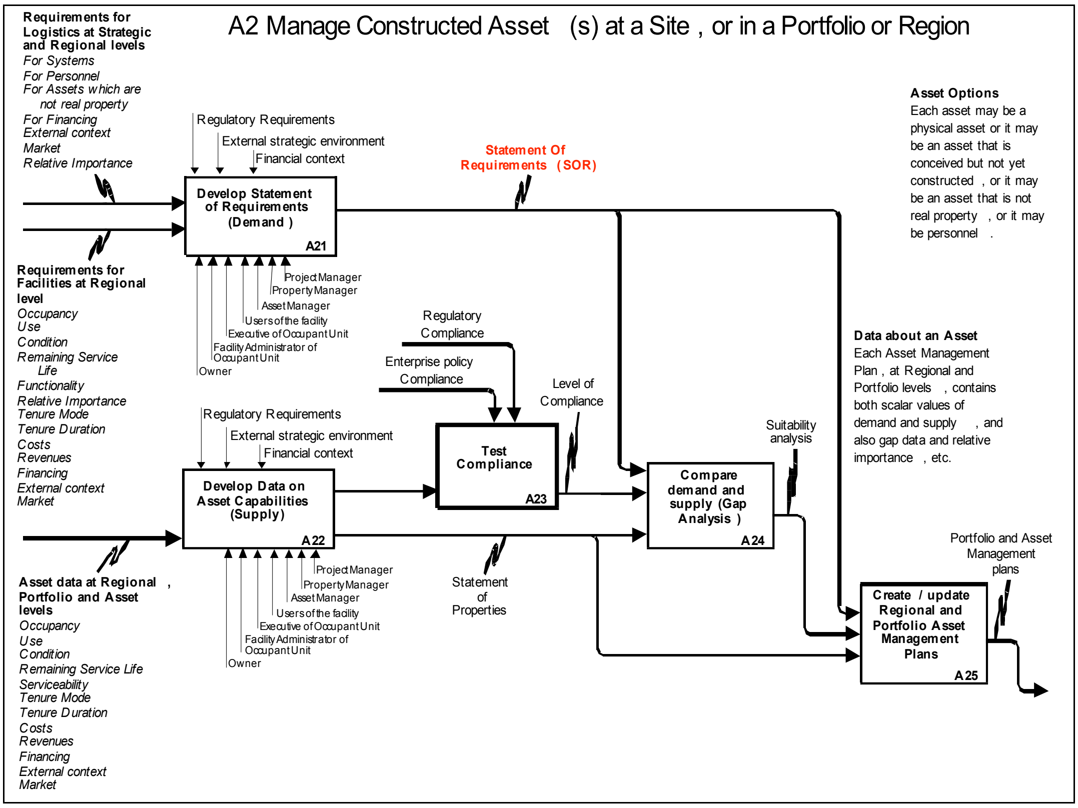

Figure 6. Overall Statement of Requirement in the Life Cycle Loop

Table I provides a context summary of the key elements and dimensions in the whole process. The Statements of Requirements for a constructed asset, whole building or facility are positioned in relation to these other dimension. In effect, one could say that this table presents the insides of the Hamburger.

- The top part illustrates the Functional Concept (FC).
- The bottom part illustrated the Solution Concept (SC), and
- The middles gives further details about the verification / validation that links the two halves.

Only when clients really know and understand why they require what they are about to procure and can state their requirements clearly, explicitly and comprehensively, can they make informed decisions, and expect the provider team to do the same. Clients also need to take the time to spell it out, or be vulnerable to misunderstandings and disappointments. Keeping track of budgets, costs and schedules is not sufficient.

The more complex the project, the longer the horizon, and the more numerous the stakeholders, the more complex the process for stating the requirements for the project will be. Knowing and making explicit the objectives and purposes for each transaction is important at every step of the Life Cycle Management of a constructed asset. The challenge is how to hand-over the information and make decisions from one level of hierarchy to the next, and from one phase of the project delivery to the next, in the context of the overall SoR that defined the whole project to start with.

On the other hand, as the project moves forward, is commissioned and used, there will be changes to its use. If there exist well documented, explicit, sets of statements of requirements to support each stage of decisions then it will be possible to adjust those statements easily to the changes in use, and to fine-tune the asset in a manner that is responsive to the changed objectives of the users.

Table 1: WHY AND WHAT <compare> HOW: Context for Statements of Requirements

HIERARCHY	**WHY + WHAT**	**COMPLIANCE**	**APPLICATIONS** **Characteristics: Aspects** **Topics - Attributes**
Society levels •global •international •national •regional •municipal •local	**Requirements levels** •Objectives / Goals / Targets •Functional Statements and other Requirements in user language •Performance Requirements in technical language •Operational Requirements	**CODES & STANDARDS (external)** •**Mandatory** •have legal authority •Minimum required (e.g. for fire, health, safety, etc.) **NORMS** •**Not mandatory** •have legal authority **ONLY** if included in regulations	**Regulations, at different levels of application, such as:** (e.g. environmental/green topics, clean air, accessibility, hazardous waste, water, etc.) Building regulations Planning regulations Environmental Regulations Occupational Health and Safety
•Customers & stakeholders, •Groups of 'users' (inclusive of visitors and surrounding community)	Same as above	**STANDARDS (internal)** •**Voluntary** •internal to the organization or group•Either higher level of performance than Codes or additional attributes not covered by Codes and Regulations + Indicators of capability **CLIENT CONTRACTS** And subcontracts – serial or integrated – Including verification / validation methods and Tools – Including Key Performance Indicators (KPIs)	**Statements of Requirements (SoR) (Project brief / Program)** •**Description of "user group/individual" / Mission(s) / Operations / Logistics support / resources, etc.** •**Environmental context** •**Time / Project milestones** •**Cost / Financial /Economics** •**Procurement route** •**Quantity** •**Functionality / Serviceability (Equivalent indicators of capability)** •**FM / O&M** •**Service Life / Required condition** •**Security / Protection** •**Accessibility, Sustainability** •**Other attributes, etc.**
Individual/specific users (e.g. home owners, shopkeepers, hotel managers, etc.)	Same as above		
Evaluation, validation, verification / auditing	**Compare / Match Gap Analysis**	**Performance Test Methods (PTM), calculations, measurements, etc.**	**Key Performance Indicators Customer Satisfaction surveys, assessments, metrics, etc.**
•Infrastructure of Countries, Municipalities, and Whole sites •Whole Buildings and Constructed Assets •Buildings, Building Systems, and Sub-systems •Components and	**HOW** •→ From project and design analysis To constituent parts •To whole constructed asset from constituent parts ←	•Prescriptive & PB Technical Specifications used on projects •Occupants' manual, O&M manuals, Building Systems Commissioning documentation, testing and controls software applications, etc.	•Acceptable solutions / Deemed to satisfy solutions •Specific solutions in given situations

Elements •Products, Services and Materials			
Szigeti, F. & Davis, G., International Centre for Facilities (ICF) © 2001rev 2005. Based on a sketch by Foliente, G., CSIRO			

Case Studies: Overview

PART 2

2 CASE STUDIES: OVERVIEW

2.1 Summaries

The case studies assembled to-date and included in the Compendium cover major projects in the UK (the Building Research Establishment - BRE case study) and in the Netherlands (the Rijksgebouwendienst / Dutch Government Buildings Agency - RGD case studies). They were prepared separately, by individuals who are familiar with the evolving conceptual framework for SoR.

The BRE case study concerns two projects undertaken by the Ministry of Defence (UK), as part of their ongoing Prime Contracting Initiative. The first project dealt with is the "Building down Barriers" test project of the concept. The second is the pilot (Scotland) phase of the Regional Prime Contracting project. Prime Contracting is an example of an integrated project, where the design and construction phases of procurement are not rigidly separated, either chronologically or in terms of which party is responsible for each phase – in practice there is an integrated team comprising clients, designers, constructors and facilities managers within an integrated supply chain. Prime Contracting aims to deliver both capital improvements (new and refurbishment projects termed Core Works) and facilities management services (termed Core Services) across the full range of Defence property, including offices, barracks, training grounds, aircraft runways etc. The ultimate aim of the project is to provide an estate suitable to support the delivery of Defence services.

The RGD case studies concern 4 projects where RGD were involved on the client side. They range from a museum to a tax department. They are also examples of integrated projects, where both public sector and private sector performance requirements are involved. Three of the four projects are part of two major programs, one to build new Law Courts and the other to build new Tax Department Offices.

Project I. Summary: The Rotterdam "Wilhelminahof
The Rotterdam "Wilhelminahof" consists of a complex including: a Palace of Justice, the Regional Headquarters Tax Office, and a commercial office building. The overall goal for the project was to give the urban development within the area a boost for further investment. The urban revitalization was to be initiated by the "Wilhelminahof" building.
Procurement and tendering were based on functional requirements on the desired serviceability of the buildings. A DBFM-O (Design - Build - Finance - Manage – Operate) contract was signed in the transition from definition to design stage in public private contract with the RGD. The bridge nearby over the river Maas and a subway station were part of a Public Private Partnership initiative. Within the building process, Performance Based Building focused on contracting at an early phase of the project and on performance specifications. The project documentation consists of a spatial statement of requirements, performance requirements, technical descriptions, prescriptive solutions, and functional requirements including organizational descriptions, general requirements and guidelines. The project was a mixture of innovative Performance Based Building and traditional aspects.

Project 2. Summary: Naturalis, National Museum of Natural History, Leiden
Naturalis is the newly build housing for the National Museum of Natural History in Leiden. By refitting the railway station site and by renewing and refurbishing the monumental "Pesthuis" (seventeenth century building, Plague house) a historical part of the city has been revitalized. The development of Naturalis is the result from a Public Private Partnership between the Municipality of Leiden, the RGD and developer HBG Real Estate (formally known as Mabon). The project was owned by a private party at first and rented by the RGD. Today the building is owned by the RGD

Projects 3 and 4. Summary: Central Building for Tax Department, Roosendaal and Heerlen
These two projects are based on New build – Integrated contracts (development contract). Performance Based Building focused on contracting at an early phase of the project and integrating design and build capabilities through a development contract. Procurement and tendering were based on demand performance specifications which were the tender documents. Based on performance offer specifications, the projects were awarded to the developer. The basic contract between the RGD and HEVO consisted entirely of performance specifications as they were formulated by the RGD and the Tax Department.

2.2 Similarities between the UK and Netherlands examples

In each of the examples, there are a combination of performance based requirements and input / prescriptive requirements within the Statement of Requirements part of the contract documentation.

- Each includes an expectation that involving a wider representative group in developing the requirements for the project and the design concepts will improve the output / building.
- Each project has included some documentation which was standard / existing before the project, and which tends to be based on prescriptive requirements.
- Each project includes some element on maintaining / running / financing the project through a relatively long part of the life cycle post occupancy.
- Each has focussed primarily on the earlier phases of the procurement process, and most emphasis and innovation appears to have been placed on how to communicate an SoR, rather than on checking responses.
- Each is expected to lead to efficiency and/or cost savings.
- Each is anticipated to support greater innovation.
- Each requires the parties to work with a high level of cooperation.
- Each challenged the skills on the client side in articulating their requirements in a performance based SoR.
- Each involved considerable cultural and process changes from typical procurement routes.
- Each involved a high level of collaborative checking of developing requirements and continual monitoring in the early stages of the project (the Cluster technique in the UK, the “pressure cooker” meetings in the Netherlands).
- Each involved some element of flexibility on the ultimate price to be paid for delivery of the project.

2.3 Differences between the UK an Netherlands case studies

The key difference appears to be the role of the Architect – in the UK case study the term does not even appear, whereas it would appear that in the Netherlands the Architect expects to lead delivery of projects and determine key aspects of “good” design. An example would be in the case study on the Tax Department, where the Architect determined that glazing should cover the exterior of the elevator shafts despite the technical objections and consequent ongoing problem with cleaning (Section – Tax Department, item 4 - Lessons Learned).

The objective of capturing the expertise of facilities managers and gaining the cost and user satisfaction benefits associated may be difficult to achieve without a significant re-education process for Architects in the Netherlands.

On the other hand, in the UK it is fairly apparent that very similar problems will occur. Future demand is often difficult to foresee. Unforeseen performance requirements for particular uses will be faced as within the Netherlands projects. In the UK Case Study, there seems to be a relatively weak Architectural contribution, which would appear to be the most appropriate skill set to resolve such issues.

From the Case Study reports, there appears to be more formal and developed techniques of risk management, value management and function analysis used with the wide project group in the UK, whereas these appear mainly to fall within the specialist knowledge of the Architect in the Netherlands.

2.4 Key lessons

1. There is no such thing as a completely fresh start – existing documents that are cast in prescriptive / input requirements will continue to be used and cited in PBB projects, and used alongside output / performance requirements.
2. Typically, the higher level requirements are easier to describe in output terms – the separation of the detailed design response does not seem well developed from the case studies.
3. Some stakeholders involved in PBB projects will gain influence and authority, others will lose. There will therefore be resistance to the change.
4. Incomplete ability to foresee future demand may cause problems which are difficult to manage in a PBB context. For example, flexibility does not seem to have been well developed, judging from the case studies. On the other hand, this is a problem for all building projects, since buildings are "hard", fairly static, difficult to change unless planned that way, and long-lasting, whereas what people "do" is in constant change.
5. Spatial and environmental requirements tend to be set prescriptively, even though it would appear that, in principle, issues of foreseeability and acceptability of variable performance based on user requirements are equally applicable to these aspects of performance requirements as to any others.
6. The more successful projects include FM expertise from the outset.
7. The projects studied show that PBB principles can be used in a variety of situations, such as: Technically challenging and innovative projects, Refurbishment and heritage projects, Long term projects, and Commercial projects.

Case Studies: How to Capture the Information

PART 3

3 CASE STUDIES: HOW TO CAPTURE THE INFORMATION

3.1 Sample Interview Guide

Summary explanation to the person being interviewed

Context for this Study
In a Performance Based approach, end users and other stakeholders express their requirements in "user" language, and the client documents those in a Statement of Requirements (SoR). The documentation prepared by the client, with the participation of the end users and other stakeholders, as appropriate, can be augmented by input from the provider team. Whether those overall requirements are met when the project is completed, or the space rented, should be verifiable.

To evaluate Performance Based Building in practice, it is useful to prepare Case Studies of projects that have used a "performance based" approach for any part of the whole life cycle of facilities, or the project a whole, so as to learn from past projects. Such Case Studies feed forward into future projects and provide a source of base line experience.

A Case Study's purpose is to reach some generally applicable conclusions that can be shared. Case studies are usually conducted after the project is completed, possibly as part of a Quality Assurance program, a Building Performance Assessment, or a POE (Post Occupancy Evaluation).
These studies should include as much context information as practicable, so that in the future, those wanting to learn from cases studies and implement a similar approach in another situation, can adapt the lessons and practices from a case study to their own circumstances. As Barrett says "... technology transfer is a process and [ ] best practice cannot simply be taken from one organization context and used in another with no adaptation or assimilation on the part of the recipient organization." (Barrett, working paper 2001)

This Study focuses on how the requirements of the "end-user and other stakeholders" are captured. It is specifically targeting the following:

- User + Project Requirements
- Evaluation (Process)
- Lessons Learned by those involved

Figure 1 illustrates the Life Cycle Management of Facilities, and other constructed assets. It shows the Life Cycle from the perspective of those who manage, operate, maintain and use them, whether as owner-occupier or landlord. It puts the SoR in context. It also shows the key role of SoRs as the documents of reference throughout. User and stakeholder requirements define the objectives for the logistic support and assets to be provided for a specific purpose, but independent of what solution might be chosen. They can be expressed in qualitative or quantitative terms. Performance requirements translate user requirements in more precise quantitative and technical terms.

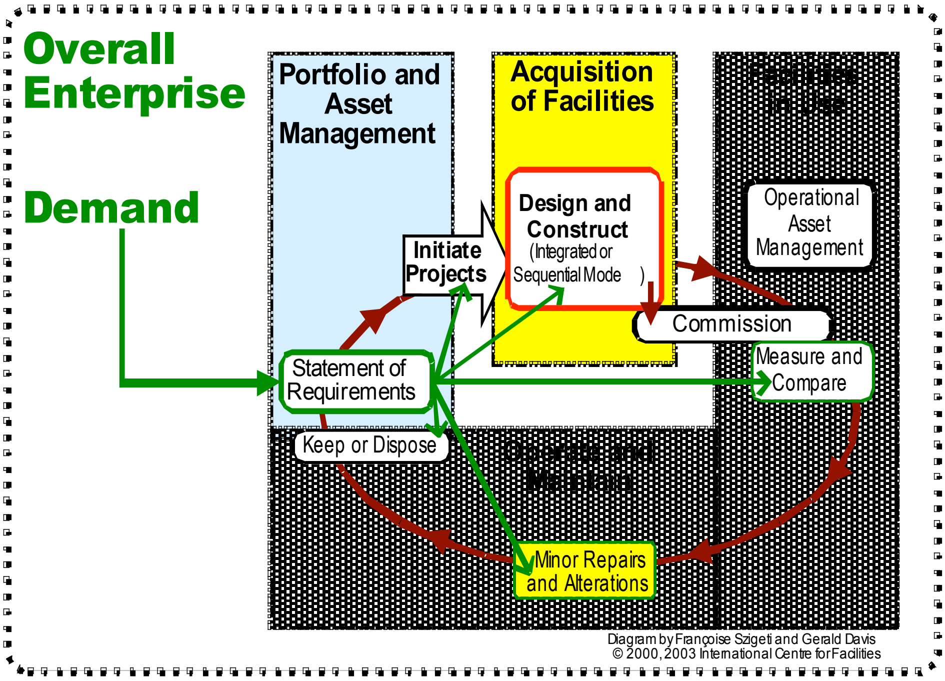

Figure 1. Statement of Requirements and the Whole Life Management Cycle of Facilities

Figure 2 illustrates how the SoR relates to the Delivery Process, and its key milestones. In this study, the delivery process is the primary cycle of activities reviewed. Information about how the project is performing in-use is also captured, but is not the primary focus of this study. Figure 2 source Oostinga, D., Compendium of PB Statements of Requirements, CIB 2005

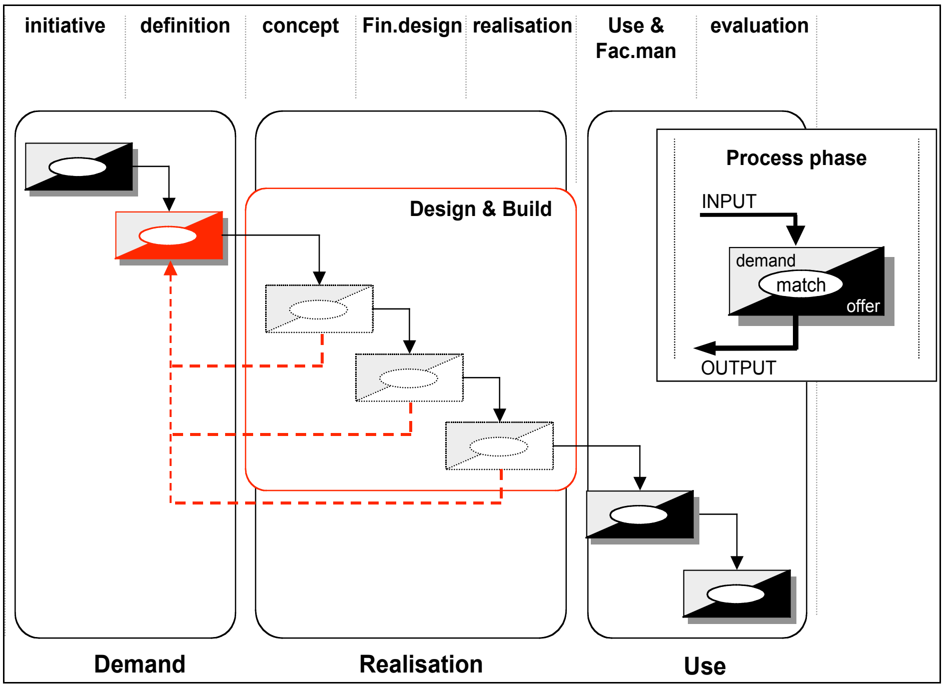

Figure 2. Statement of Requirement and the Milestones in the Delivery Process

Figure 3 illustrates where the "integrated" contract normally fits in the delivery chain, in relationship to the project delivery milestones. This "one main contract" procurement route is not the only route, and not necessarily the best for all projects. All procurement routes and contracts benefit from added "performance related" information and from a comprehensive SoR. Figure 3 source Oostinga, D., Compendium of PB Statements of Requirements, CIB 2005.

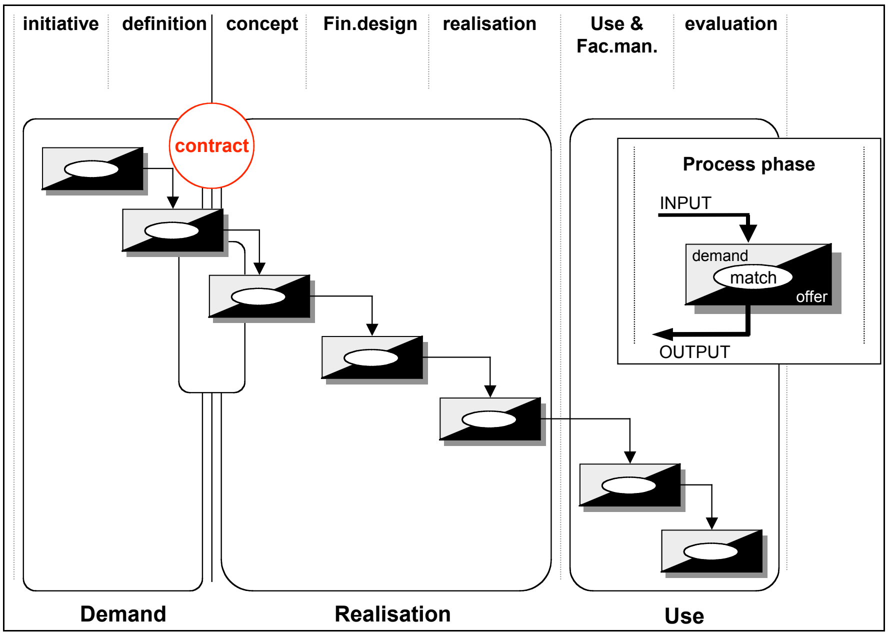

Figure 3. Integrated Contract in relation to the Process Phases

Sample questions for interview guide
For each project and situation, a similar interview guide will need to be prepared and adapted to the circumstances of the study. This Guide is not an exhaustive questionnaire, and the questions included here are examples, although they have been used. It is provided to give those who want to prepare a Case Study the opportunity to build on the experience of others.

It is usually best to use "open-ended' questions, and let the persons interviewed talk freely. It is important to gain their confidence and to listen carefully. Respondents will usually give far richer information when dealing with open-ended questions. If the interview is "directed", then the person being interviewed is likely to answer in a narrow manner instead of tapping their memory and giving broad feed-back. Of course, if specific information or numbers are needed, then such precise questions should be included.

Suggestion to study team
Print the questions with enough space added in between lines to write some notes during the interview or immediately thereafter.

Project: General Questions about the Project

- What were the key objectives for the project?
- What were the key constraints on the project?
- What kind of procurement route / process was used?
- Who were the participants involved in the procurement process and what did the process look like to them? To other stakeholders?

(Asking the respondent to sketch the process may be useful to identify the parties involved and the relationships)

Project Requirements: Performance Based Building (PBB) & Project

- What was the Performance Based focus for this project?
- What did the participants understand as being different about this project from a traditional approach?
- On what basis was the decision made to use a Performance Based approach?
- Are there unique Performance Based features specific to the project?

User + Project Requirements: SoR Documents

- Who was involved in preparing elements of the SoR?
- What process was used to prepare a SoR for this project?
- What is included in your SoR? Do you have a guide for assembling SoRs? Do you have a standard format and table of contents?
- What approach, methods and tools did you use to capture Performance-Based Requirements?
- How were the providers of products and services selected?
- Are the providers of products and services involved in the preparation of SoRs? Are they involved in the translation of "user requirements" (demand-input) in a more technical language, or in setting the indicators of capability and the levels of service (supply-outcomes)?

  If not, was another type of collaborative process used early on?

  or was a traditional sequential process used?

- What kind of data does the SoR for this project contain?
  a. Does the SoR describe how to verify that the requirements have been met at the end of the project delivery?
  b. If yes, how does the SoR describe this verification of requirements process? Does it includes methods and tools to be used? Etc.
  c. Who is responsible for the verification that the requirements are met?What is your experience with the assessment and verification of the design compared to requirements?

Evaluate - Tools

- Has there already been an assessment of the project in use and a verification that the end product meets the requirements as stated in the SoR? If so,
  a. What aspects of the requirements were checked?
  b. How was compliance between requirements and technical solution measured?
     1 What methods or tools were used to check for compliance?
     2 Were these methods and tools explained to the providers at the start of the project?
     3 Who were the people involved in the assessment and verification of the project?

Evaluate - Overall

- Was the SoR available at the start of the project

- Is the SoR for this project a static or a dynamic document?
- Were all the Performance Based requirements clear to all parties involved at the start of the project?
- Were all parties involved, including the providers, involved in the preparation of the SoR at the start of the project?
- Were all means of assessment / verification clear to all parties involved at the start of the project?
- Were there any difficulties in the building *process* related to the performance based requirements?
    - Were there interpretations, during the building process, of the performance statements included in the contract?

      If so, in what phase did the interpretation occur and who provided the interpretation?
- Are there any difficulties with the object (facility, constructed asset) itself that relate to the Performance Based approach used in this project?
    - Are there user dissatisfactions related to Performance Based Building?
    - Are there user satisfactions related to Performance Based Building?
- If you were starting another PBB project, what you would you want to change from what you did on this project? What is the worst part of that experience
- If you were starting another PBB project, what you wanted to be sure to keep from what you did on this project? What is the best part of that experience

3.2 Annotated Template

This version of the Template includes annotations (in italics) aimed at those people who will prepare Case Studies of completed projects. The purpose of such studies is to find out whether a project has been following a Performance Based approach.

If yes, then to what extent was the Performance Based approach used, e.g. at the beginning of the project? As part of the contract? All the way down the supply chain? What were the lessons learned? What might be done differently? What worked and what did not. The "commentaries" are intended here in a broad way to record the substance of the comments from the interviews.

Page I: General Information

Case Study No:	Compiled by:	Date: : /version
ORGANISATION DETAILS	PROJECT DETAILS	CASE STUDY DETAILS
Organisation Type: 1. Client / owner 2. Contractor / constructor 3. Consultant 4. Specialist (specify) 5. Other (specify)	Procurement routes: 1. New build – main contract 2. New build – sub-contract 3. Refurbishment/Renovation – main contract 4. Refurbishment – sub-contract 5. Mixed – main contract 6. Mixed – sub-contract 7. Sequential contracts 8. Integrated contracts 9. Other (specify)	Case Study Contents Summary (Key points):

	Enter here only the kind of procurement route used for this project, but do not describe. The procurement route is addressed in more detail in the "project development" section.	
Organisation Name:	Project Title:	Case Study Key words:
Organisation contact name:	Organisation contact Information:	e-mail:
Organisation Sector: 1. Public sector 2. Private sector 3. Voluntary / charity 4. Academic 6. Other (specify)	Project Date and Value (approx):	Case Study Document Refs: *Include all the documents that are referred to in the Case Study*
Organisation Location:	Project Location:	Case Study Website Refs:

Page 2: Project Description

Project Phase	SoR documents - List	Summary of the documents listed
PBB focus: Aspect(s) of the project addressed in performance terms *Can be all, or only parts of the project*	Selection Criteria: List Unique PBB aspects of this project	Summary *This is the place to include a short summary of the unique aspects of the project*

Project Summary	
Background and Context	
Key Objectives of Project	
Key Constraints of Project	*These constraints can be of many kinds. They are part of the context for the project. They can include: financial and economic considerations, location, special risks, timing and scheduling, etc.*
Project Process	*This part should describe the procurement route that was used in some detail, so that it is clear what the characteristics of the procurement approach were. Ideally include a sketch of the process and roles*
Project Documents – Introduction	*Summarize the project documentation which was used, including the planning studies, the Request for Proposals (RFP), the legal documents. Describe the type and content. Give some insight about the variety of information available. This includes all the formal documentation for the project and even information, if available*
Project Documents – Commentary	*This part should record any comments from the participants about the usefulness of the documents, their appropriateness, their weaknesses, what worked and what did not work. Project documents used in the PB approach have to be well structured, comprehensive, and explicit about why the project exists and what the client expect as result.*
Project Process – Introduction	*The Introduction part should be used to describe planning, programming and other building processes in an objective way.*
Project Process – Commentary	*This part should record any comments from the participants about the usefulness of the process(es) involved, their appropriateness, their weaknesses, what worked and what did not work. Project process(es) used in the PB approach differ from traditional processes. They are*

	normally more collaborative, integrated and inclusive.
SoR – Introduction	*The SoR introduction should be used to make clear what type of documents the Statement of Requirements (SoR) consists of. In addition, any useful insight about how to assemble such a document, and using it, should be recorded here.*
SoR – Commentary	*This part should focus on the SoR documentation and include comments from the people interviewed. It should record any comments from the participants about the usefulness of the documentation prepared and used, its timeliness, appropriateness, weaknesses, usefulness, etc. This is where to record what worked and what did not work.*
Validation/ Verification/ Evaluation / Assessment/ Measurement/ Test/ Audit process	*Within the verification part, show the building successes and problems as stated by the users - local facility management, individuals and groups who actually occupy the facility, etc. Examples from the interviews would help show and document which aspects of the facility are satisfactory and which unsatisfactory are not. Use of indicators of performance, performance tests, assessment methods and tools make clear what the gap might be between the SoR documents (especially the performance specifications) and the outcome.*
User/customer satisfaction studies	*This part should record and review any studies that may have been conducted to capture the perceptions of the occupants and other stakeholders with regard to the facility, how it supports their work, and whether they are satisfied or not.*
Tools used: Indicators of capability / compliance	*This part should show and explain which "tools" (instruments) were used to focus on quality (the match between demand and supply).*
Differences: Comparison to traditional approach/ method	*This should be straight forward and highlight the differences between this project and more "traditional" projects.*
Lessons Learned	*Lessons learned are intended to record specifically those items that were described in the interviews and noted from the assessment as in need of improvement or particularly successful. They provide feed-forward about what worked and what did not. What worked is as important if not more.*
Best Practices Commentary	From the interviews, present elements that will allow the reader to decide whether the case is a best practice, or which elements are a best practice.
Conclusions And recommendations	Lessons learned are part of the basis for the conclusions. The conclusions are meant to be a summary of all lessons learned, best practices, as well as questions raised, recommendations from the interviews and from the team conducting the Case Study.

3.3 Template - blank

Page 1: General Information

Case Study No:	Compiled by:	Date: /version
ORGANISATION DETAILS	PROJECT DETAILS	CASE STUDY DETAILS
Organisation Type: 1. Client / owner 2. Contractor / constructor 3. Consultant 4. Specialist (specify) 5. Other (specify)	**Procurement routes:** 1. New build – main contract 2. New build – sub-contract 3. Refurbishment –	**Case Study Contents Summary (Key points):**

	main contract 4. Refurbishment – sub-contract 5. Mixed – main contract 6. Mixed – sub-contract 7. Sequential contracts 8. Integrated contract 9. Other (specify)	
Organisation Name:	**Project Title:**	**Case Study Key words:**
Organisation contact name:	**Organisation contact Information:**	**e-mail:**
Organisation Sector: Public sector Private sector Voluntary / charity Academic 6. Other (specify)	**Project Date and Value (approx):**	**Case Study Document Refs:**
Organisation Location:	**Project Location:**	**Case Study Website Refs:**

Page 2: Project Description

Project Phase	**SoR documents**	**Summary of the documents listed**
PBB focus: Aspect(s) of the project addressed in performance terms – Can be all, or only parts of the project.	**Selection Criteria: Unique PBB aspects of this project**	**Summary of the unique aspects of the project**

Project summary	
Background and Context	
Key Objectives of Project	
Key Constraints of Project	
Project Process	
Project Documents – Introduction	
Project Documents – Commentary	
Project Process(es) – Introduction	
Project Process(es) – Commentary	

SoR – Introduction	
SoR – Commentary	
Verification: Evaluation / Assessment / Measurement / Audit process	
Tools used: Indicators of capability / compliance	
User/customer Satisfaction studies	
Differences: Comparison to traditional approach/ method	
Lessons learned	
Best Practices Commentary	
Conclusions and recommendations	

Case Studies: Examples

PART 4

4 CASE STUDIES: EXAMPLES

4.1 Case studies in the Netherlands

Compendium of Performance Based
Statements of Requirements (SoR)
Performance Based Building in Dutch Practice

Case Studies from

1. Tax Department,Department of Justice, Court of Law, and Customs Department, and Netherlands Ministry of Spatial Planning, Housing and the Environment - Rijksgebouwendienst (Dutch Government Building Agency)
2. Rijksgebouwendienst (Dutch Government Building Agency)

3a. Rijksgebouwendienst (Dutch Government Building Agency), Directorate South, on behalf of Tax Department Belastingdienst Roosendaal

3b. Rijksgebouwendienst (Dutch Government Building Agency), Directorate South, on behalf of Tax Department Belastingdienst Heerlen

March 2005
Prepared by: Daan Oostinga
Rijksgebouwendienst
The Hague, The Netherlands

4.1.1 Case 1: Wilhelminahof

General Information

Case Study No: 1
Wilhelminahof

Organization detail

Organization type:
Court of law
Architect: R.Ligtvoet, architectural firm Kraaijvanger Urbis, Rotterdam.
User: The Rotterdam Court of Law (Gerechtelijke diensten Arrondissement Rotterdam)
Tax office
Architect: Cees Dam, Cees Dam & Partners Architecten BV, Amsterdam.
User: Rotterdam Tax Department (Centrale Belastingdienst Rotterdam)
Metro
Architect: Zwarts en Jansma, Abcoude

General:
Landscape-architect: Adriaan Geuze, West 8, Landscape-architects, Rotterdam
Project developer: Bouwfonds Vastgoedontwikkeling bv, Burginvest bv

Investor: Maatschappij voor bedrijfsobjecten NV (MBO) (ING-bank) in cooperation with Bouwfonds Vastgoedontwikkeling bv

Project management: Rijksgebouwendienst (Dutch Government Building Agency), F. Hofman

Advisor building structure: Ingenieursbureau Zonneveld bv, Rotterdam.

Advisor Building services: Technical Management, Rijswijk

Contractor: Building combination (bouwcombinatie) DURA/Van Eesteren VOF

Organization name:

Tax Department, Justice Department, Court of Law, Customs Department

Organization contact name:

Tax Department
Mr. Cor Kik
Tel: 010-2904444
Email: Cor.kik@belastingdienst.nl

Court of Law
Mrs. Yvonne Somers
Tel: 010-2971279
Email: y.somers@rotarr.drp.minjus.nl

Organization sector:

Public sector

Organization location:

Tax Department:
Laan op Zuid 45, 3072 BD Rotterdam
Postbus 50960
3007 BB Rotterdam
3072 DB Rotterdam
Tel:+31(010) 290 44 44
Fax: +31(010) 290 43 06

Court of law:
Wilhelminaplein 100 – 125
3007 BL Rotterdam
Postbus 50950
3007 BL Rotterdam
Tel: (010) 297 12 34

Project phase:

Use

PBB focus regarding the building process:

Performance Based Building Focus on contracting in an early project phase.

PPB focus regarding requirements:

SoR focus on automation, security and flexibility.

Compiled by:
Daan Oostinga
Netherlands Ministry of Spatial Planning, Housing and the Environment
Rijksgebouwendienst (Dutch Government Building Agency)
Intern TU Delft Faculty of Architecture, Department of Real Estate & Housing
Mail address:
Rijksgebouwendienst
PO Box 20952
2500 EZ The Hague, The Netherlands

Project details

Procurement routes:
Public Private Partnership:
City of Rotterdam
Rijksgebouwendienst
Burginvest Properties BV
Bouwfonds vastgoedontwikkeling BV
RET (Rotterdam Electric Tram company)
Contract type: Integrated contract (development contract)

Project title:
Wilhelminahof Rotterdam

Project date and value (approx):
Costs: 181.000.000 Euro (including 79.000.000 Euro for the court of law)
Project start: 23 February 1994
Date of project delivery: May 1996
Use Tax office: June 1996
Use court of law: September 1996

Project location:
Tax Department:
Laan op Zuid 45
3072 BD Rotterdam
The Netherlands
Court of law:
Posthumalaan 74
3072 BD Rotterdam
The Netherlands

SoR documents
General SoR documents

- Spatial Statement of Requirements Tax Department, including: surface area requirements;
- Spatial Statement of Requirements Justice Department, including: surface area requirements;
- Performance Requirements General, including: requirements, cost group description;

- Performance Requirements Tax Department, including: requirements, cost group description;
- Performance Requirements Justice Department, including: requirements, cost group description, process criteria.

Additional SoR documents

- Performance Requirements RGD, including: performance requirements, cost group description;
- Performance Requirements JR120 general office functions, including: requirements;
- Additional technical descriptions, including: prescriptions of technical solutions;
- Additional prescriptions marketable office buildings, including: prescriptions, spatial;
- T.H.O.R.P. Technische Handleiding Ontwerpen R.P. bureaus;
- Technical Manual Design groups-, station-, district departments of the federal
- Police & Customs Department Requirements, including: requirements, codes and design solutions;
- Acoustic guidelines for jail cells in Courthouses, police stations and penitentiaries, including: prescriptions, design solutions;
- Functional Requirements Courts of Law, including: organizational descriptions, general requirements and guidelines.

Selection criteria: (unique PBB aspects of this project)

Procurement and tendering based on preliminary design concept and functional requirements on the desired serviceability of the buildings, DBFM-O (Design-Build-Finance-Manage and Operate) contract in the transition from definition to design stage in public private partnership with RGD.

Date/version:

16-09-2003, Final

Case study details

Case study contents summary (Key points):

Process evaluation

- SoR development;
- Building Process (interviews);
- Use phase evaluation (interviews).

Product evaluation

- Use phase evaluation (interviews);
- Post occupancy evaluation (observation).

Case study key words:

Wilhelminahof, Statement of Requirements, Performance Contracting, Performance Specification.

Case study document refs:

- SoR documents Wilhelminahof
- VROM, *Wilhelminahof*. Rotterdam: Uitgeverij 010, 1996.
- De Algemene Rekenkamer, *Tweede Kamer der Staten-Generaal, Huisvesting Justitiële Diensten*. Sdu, The Hague: 1999.
- Eigenbrood, R., *Wilhelminahof, Architect Dam&Partners*. 14-08-2003.
- Hofman, F., Interview: *Wilhelminahof, projectmanager*. 04-06-2003.
- Hensing, J., Interview: *Wilhelminahof, Facility Management RGD*. 05-08-2003.
- Kik, C., Interview: *Wilhelminahof, client/user*. 07-08-2003.
- Somers, Y., *Wilhelminahof, client/user*. 19-08-2003.

- Zanten, van, H., *PeBBu, advisor/expert*. 27-06-2003.
- Wilmer, J., Wilhelminahof, *Central Bureau Housing Tax Dep*. 22-08-2003.

Case study website refs:

- http://www.rijksgebouwendienst.nl/catalogus/
- http://www.skyscrapers.com/re/en/wm/bu/111122/
- http://www.jpvaneesteren.nl/single.asp?item=104
- http://www.kopvanzuid.rotterdam.nl/2170.htm
- http://zwarts.jansma.nl/Projects/051/
- http://www.damenpartners.nl/projecten/project.php3?code=HVZ

Project description

Project summary:

The Rotterdam "Wilhelminahof" consists of a complex including: a Palace of Justice, the Regional Headquarters Tax Office, and a commercial office building. The overall goal for the project was to give the urban development within the area a boost for further investment. The urban revitalization was to be initiated by the "Wilhelminahof" building. Procurement and tendering were based on functional requirements on the desired serviceability of the buildings. A DBFM-O (Design – Build – Finance – Manage – Operate) contract was signed in the transition from definition to design stage in public private contract with the RGD. The bridge nearby over the river Maas and a subway station were part of a Public Private Partnership initiative. Within the building process, Performance Based Building focused on contracting in an early phase of the project and on performance specifications. The project documentation consists of a spatial statement of requirements, performance requirements, technical descriptions, prescriptive solutions, and functional requirements including organizational descriptions, general requirements and guidelines. The project was a mixture of innovative Performance Based Building and traditional aspects.

Background and context:

The Wilhelminahof is an ensemble consisting of three office buildings, a courthouse, shops and a metro station. The building is located on the so called "Kop van Zuid", a new development area which has the ambition to become the second city centre of Rotterdam. Two out of three office buildings make a whole. This part is in use by the Tax Department and houses the offices of the Justice Department. At the side of the river are two separate buildings. These are a lens shaped office tower and a courtroom. In between the offices and the courthouse are shops and a metro exit. Cees Dam & Partners were responsible for the design of the large building mass and the lens shaped office tower. The courthouse is a design made by Kraaijvanger & Urbis (architect Rob Ligtvoet). The metro station, a design by Moshé Zwarts en Rein Jansma, is a technical highlight because it is built around the old metro tube which was only broken through at the time of completion. With this approach the metro traffic did not have any disruptions.

Figure 1: Wilhelminahof

The cooperation between participants was based upon previous experience with the Justice Department, Tax Department, RGD and ING. The cooperation with the financier came from a package deal regarding a project called JR120 (Hofman, 2003). The JR120 program had started in the early nineties in cooperation between Ministry of Justice and the RGD. As a result of the program, qualitative and quantitative shortages would be resolved, with 18 Courts of Law and 26 penitentiaries built. These projects were part of a package of eight development and investment contracts. The total value of the JR120 projects is approximately 1.16 billion Euros (De Algemene Rekenkamer, 1999, p.1).

Parts of this project are leased from owner ING and part of the building is owned by the RGD. This is a result of government policy. At that time there was a policy of leasing instead of buying. The first lease offer was made by the developer based on a general program. Performance specifications were the basis for further design (Hofman, 2003).

The Ministry of Justice is responsible for all stages of justice, from law making to prevention, enforcement and aid to victims. The department focuses particularly on juvenile delinquency and aliens' registration. Several of those activities are housed in the Wilhelminahof building. As a result the spatial requirements vary from detention cells to courtrooms and office space.

The Tax Department is part of the Treasury Department. The Tax Department organization consists of taxation and customs, facility centres and investigation service. The executive organization consists mostly of taxation and customs supported by a management team.

The Court of Law building has a building surface area site of 10.000 m^2 and a building surface area of 4.200 m^2. The gross floor space is approximately 38.500 m^2 (including parking space) and the building houses somewhere around 800 occupants. The Tax Department has a building area of 5.600 m^2 and approximately 1600 occupants.

Key objectives of the project:

*Overall project goal***:** urban development of “Kop van Zuid”

Court of Law

The main goal was to centralize the widely dispersed services of the Rotterdam Court of Law. JR120 was the main reason: The Ministry of Spatial Planning, Housing and the Environment together with the Ministry of Justice created a program for the housing of district justice departments called the JR 120. JR 120 consisted of an alternative rental program and related aspects. Wilhelminahof was a part of the program.

Tax Department

The main goal was to centralize the widely dispersed services of the Rotterdam Tax Department. The Tax Department real estate portfolio was outdated and did not provide enough space for current needs. Project focus was on efficiency of the work process.

Key objectives PeBBu:

The key objectives in working with the Performance Based Building approach was to gather experience working with performance requirements and to be able to involve the contracting parties in an early phase of the building process in order to save costs and add value within the product.

Key project constraints:

SoR Focus

Focus within Statement of Requirements for the Court of Law was on automation and security. Because of the special characteristics of a court and its occupants, the requirements were far from standard. Pedestrian traffic streams of public and law enforcement are thoroughly separated. Focus within the Statement of Requirements for the Tax Department was on automation and security as well. Another major requirement in both buildings was flexibility. The new building space should be flexible enough for further rent.

Project development:

Several parties were involved in the idea of starting an urban development project on the “Kop van Zuid” in Rotterdam. The City of Rotterdam, the RGD, Burginvest Properties BV, Bouwfonds vastgoedontwikkeling BV and the RET, Rotterdam Electric Tram company, were responsible for initiating a feasible project. A partnership between public and private parties was formed. By realizing several large-scale office buildings, the government hoped to stimulate investors to develop the entire urban area.

A boost in the development of the project was a series of workshops, so called pressure cooker meetings. Under the presidency of Chief Government Architect Kees Rijnboutt, workshops were set up once every two weeks and a masterplan was created within three months. These meetings resulted in unexpected coalitions between parties with opposite interests and stimulated a strict planning (VROM, 1996. p.8). A Quality-team was set up to assess the architectural quality of the conceptual designs, consisting of, among others, the architects Kolhoff, Huet and Busquets.

Due to a lack of means and a shortage in government finance, the RGD was neither the client nor the developer any more. The RGD enforced a market lease approach by the highest government level (The RGD had no formal responsibilities regarding construction). A lease contract for fourteen Court buildings called operation JR120 fitted the profile. The RGD represented the Tax Department and the Justice department. In 1994 a realization/development contract was signed. Bouwfonds has been the project developer and Bouwfonds and ING Vastgoed together were the investor and owner. The Wilhelmina tower was developed by Bouwfonds, ING Vastgoed and Burginvest Properties. A lease contract was set up for 20 years with an option to extend the contract. Part of the starting-up costs were included in the lease contract. Costs of specific parts not meeting market standards, like courtrooms (security), were partly included within the lease contract and partly financed by the RGD (VROM, 1996, p. 11).

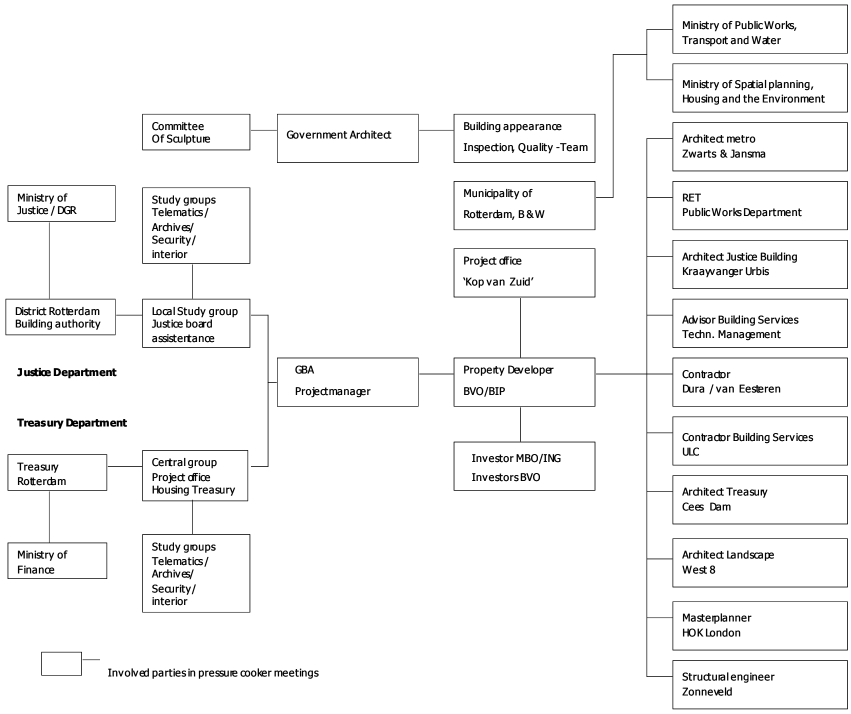

Figure 2: organizational chart

Regarding Performance Based Building, the project was new in scale. It is important to know there was a certain necessity for working with performance specifications in general. There was a lack of capacity within the RGD to work on Statement of Requirements and design solutions. Also, it was the minister's official policy at the time to apply the performance approach when outsourcing tasks to the market. So there was a policy and financial basis for working with performance specifications. The emphasis shifted from making projects to contract management. The same reasons for working with a Performance Based approach applied to the "Wilhelminahof" project. Contracting offering parties in an early project phase to outsource those tasks has traditionally been the responsibility of the RGD (Van Zanten, 2003). The Director General of The Ministry of Spatial Planning, Housing and the Environment played a role in convincing the developer to agree to work with the performance based method (Hofman, 2003).

There is no doubt regarding the success of the project concerning urban development. Nowadays numerous large office buildings have been developed and the "Kop van Zuid" is a part of Rotterdam that people are proud of. Development of the project was a success because of the focus on result, continuity of key players, sufficient authority (otherwise the pressure cooker meeting would not work) and balanced interests (VROM, 1996, p. 11). The project was completed in 1996.

Project documents introduction:

Project documents are as numerous as they are different. A wide variety of documents exists from general government notes to technical drawings of a prisoner's cell. Specific project related performance requirements, as well as numerous standard performance specifications, are defined by the RGD. Spatial and functional requirements are also defined by the user organization.

Project document types:

- Spatial Statement of Requirements, including surface area requirements;
- Performance Requirements, including performance specifications, cost group descriptions and

process criteria;
- Technical descriptions, including prescriptions and technical solutions;
- Prescriptions from marketable office buildings, including spatial prescriptions;
- Technical Manuals for design, including requirements, codes and design solutions;
- Guidelines, including prescriptions and design solutions;
- Functional Requirements, including organizational descriptions, general requirements and guidelines.

Focus in this case study is on performance specifications.

Project documents commentary:

A strict difference should be made between a prescriptive statement of requirements (the Dutch PvE) and a performance based statement of requirements. Together they form the overall Statement of Requirements (SoR). In this case, most requirements were already made (standard) by different organizations (Tax Department, Justice Department and Customs) and had little to do with the RGD's view on performance specifications. The result is a mix of working with vague specifications, measurable performances and detailed prescriptive solutions.

Project process introduction:

Procurement and Tendering.

A development contract was signed based on performance based requirements on the desired serviceability of the buildings. The user organization was represented by the RGD and was involved in every phase of the process. The Chief Government Architect was responsible for the architectural quality from a government point of view as stated in government notes. The user organization, the RGD and the Chief Government Architect were the three demanding parties concerned with the user organization. The fact that they had a similar interest does not mean their roles were integrated. These three parties defined different demands in a different way and they had different communication networks.

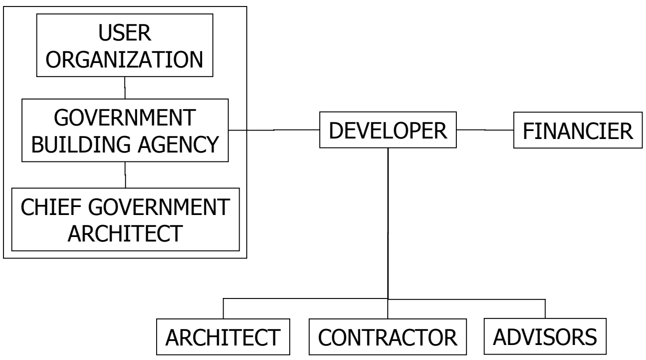

Figure 3: simplification of the organization chart

The figure shows the different responsibilities and is not complete regarding contractual relations and communication lines but should be interpreted as a simplification of the organization chart. The developer is the contractual client. The RGD leases the space for twenty years in the interest of the Government Departments. The project management (RGD) was in close contact with the local workgroup under of the director Justice staff, Justice Housing and the Tax Department bureau for housing in Rotterdam. Naturally there has been close cooperation with the Municipality of Rotterdam, the project developer and financier/investors. The architects were selected (nominated) by the Chief Government Architect and contracted by the developer. Although the developer had a say in the concept and design, the control over architectural quality was the responsibility of the Bureau Chief Government Architect.

Definition.

The JR120 project concerning housing for the Justice Department has been the start of working with performance specifications in this way. Specific aspects to the Justice Department were replaced by Tax Department requirements. Based on experience the standard performance specifications were adjusted (Van Zanten, 2003). Before creating performance requirements specific to the building, the user (Tax Department and Court of Law) was trained in performance based briefing by RGD employees responsible for Performance Based Building and an external consultant. Several government departments have their own documentation on requirements, the Tax Department and the Justice Department have their own as well. Departments have their own separate organizations responsible for housing. These organizations do not consist of experts like the RGD does and are not meant to fill in the part of the RGD. Within this project, these organizations were expected to state the users wishes and needs, and adjust their own standard specifications. Requirements were developed by the user organizations in consultation with the employees in brainstorm sessions. The standard statements of requirements of the Tax Department and Justice Department have been adjusted to the specific building circumstances. These justifications have been discussed with the RGD and debated until the requirements matched the users' demands.

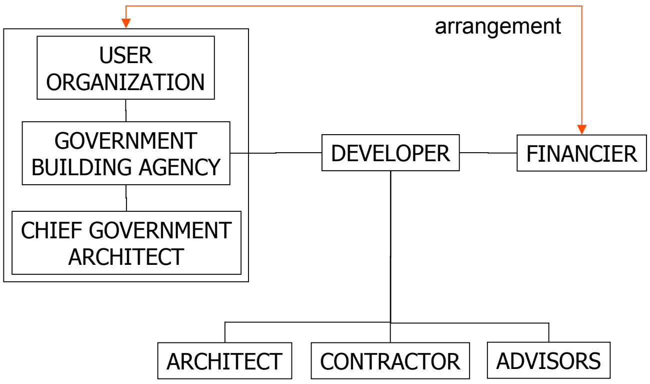

Figure 4: simplification of the organization chart

Concept and final design.

Selection of the architect is a task of the Chief Government Architect who is responsible for the architectural quality of the building and its surroundings. Pressure cooker meetings (workshops) under the presidency of Chief Government Architect Kees Rijnboutt were set up once every two weeks and a master plan was created within three months. A Quality-team was created to assess the architectural quality of the conceptual designs from an objective point of view. During the conceptual phase the user organizations were able to assess the design and learn from advancing experience. Based on the performance based requirements contracting took place.

Realization.

Now that the client had created conceptual performance specifications and the contractor/developer could specify the offer specifications, the basis for a contract existed. During realization there has been continued control as a result of interim verification moments. These checks should prevent future misunderstanding regarding the interpretation of performance specifications for both client and developer. Control on realization by the contractor has been a task for the developer. The owner, ING was given the task of controlling the quality on behalf of the user groups and the RGD checked functional quality and user-requirements.

Project process commentary:

Procurement & Tendering.

The project's brief was based on performance based requirements describing the desired serviceability of the buildings. A DBFM-O (Design-Build-Finance-Manage-Operate) contract was signed in the transition from definition stage to design stage in a public private contract with the RGD. To enable tendering and contracting at an early phase of the project, the required needs had to be formulated in a performance based way. Another reason for describing performances instead of prescriptive requirements was the need to facilitate innovative solutions.

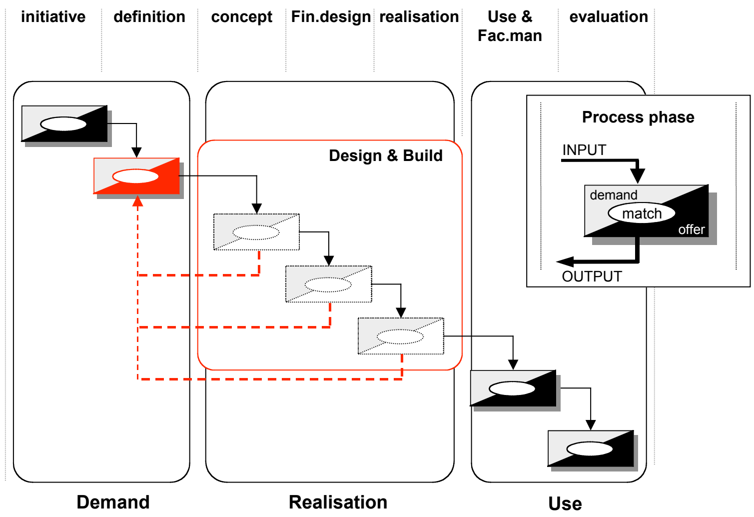

Figure 5: design & build

Early contracts outsource RGD work to a developer, architect, contractor, etc., Such contracts can save costs and possibly add value. The dilemma was to define the performances needed in such a way that the demanding party would still be guaranteed a building of sufficient quality. In this case the contracting took place before the final design, giving the offering parties a chance to come up with their own design solutions and integrate their experiences.

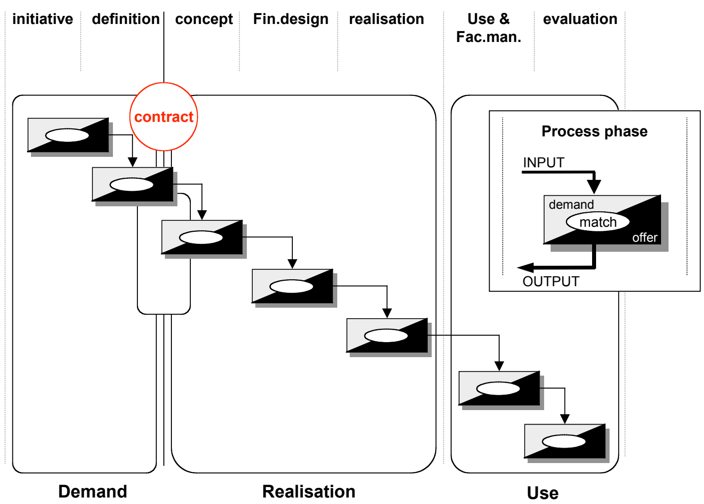

Figure 6: contracting moment

Definition.

Requirements are developed by the user organization in consultation with the employees, in brainstorm sessions and employee association. *"Decisions are always made in a hierarchical system"*, according to participants. The employee on the work floor, with a standard work process and task description, will barely have a say in practice. The requirements stated by the Tax Department are not as performance based as the ideal principle of PeBBu describes. The Tax Department did try to integrate their own experiences with products and design solutions (Wilmer, 2003). When defining the specifications, influence from different parties can be expected. The experience of an organization like the Central Bureau Housing of the Tax Department, with different suppliers, will result in a preference towards certain materials or building services. As a result, the person responsible for defining the needs and wishes will influence the specifications made by the RGD experts during the process. In addition the assessment of the offer specification can be used as a tool to obstruct certain solutions. This can be counter productive towards the PeBBu goals of product innovation.

Mostly procurement and tendering will take place within the pre-design phase. The extend to which performances are described instead of physical solutions might be complicated for a contractor (Van Zanten, 2003).

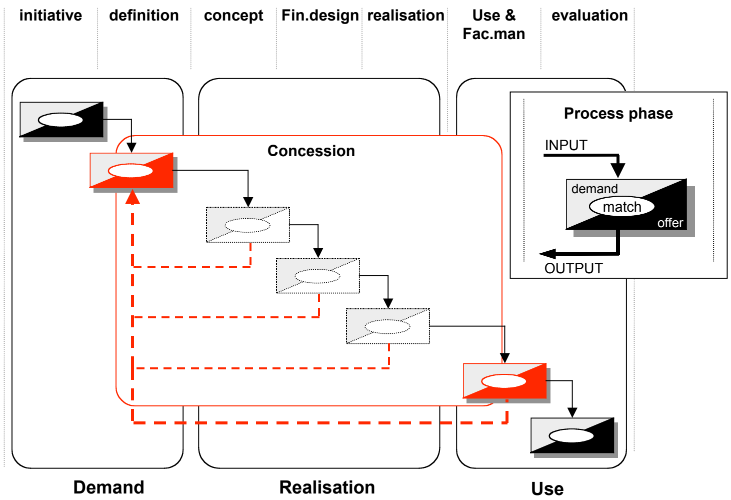

Figure 7: ideal concession

Because of the responsibility of the developer towards the client, the ideal situation in a "concession" contract is the focus on serviceability. In this project, the responsibility for functionality and serviceability was divided between client, developer, owner and the RGD. On a construction level the developer remained the one responsible. On a level of internal refurbishment the RGD was the organization the client turned to. On a workplace level the client turns to his own internal organization responsible for housing. Instead of the developer and owner, the internal organization responsible for housing is the organization which has to deal with client dissatisfaction. The process in practice was a mixture of performance based aspects and a traditional approach towards construction.

Concept.

The Chief Government Architect and the developer shared the chairman's position in the workshop meetings. Both demanding parties and offering parties had a say in the conceptual design. The architect had a hard role in this process because he had to serve more than one party: the client, the developer, the Chief Government Architect and the RGD. The Chief Government Architect will get preferential treatment because he is responsible for selection on behalf of the nation, and the developer and client are just responsible for selection in the specific project (Van Zanten, 2003).

The only physical tool to manage architectural quality is an essay written by former Chief Government Architect Dijkstra. In the performance specification on visual quality there is a reference to this note, without handing an explicit instrument. The note only provides a framework for the architect and is open to interpretation by the Bureau Chief Government Architect.

Final design.

According to Eigenbrood (2003) of Dam & Partners (architect) the standard Statement of Requirements, of the different departments, can be too rigid. Rigid SoR documents are no longer a starting point for the design phase. An architect likes to start blank, according to Eigenbrood. This way the architect is not influenced by unnecessary constraints (from the architect's point of view). Requirements with clear performance based demands can be experienced as a feeble story by the architect. The positive aspect in the eyes of the architect is that the same performance can be achieved with different solutions (Eigenbrood, 2003). But the performance based statement of requirements is still bound to a budget, which limits the possibilities. The architect will analyze the work-processes himself without copying the standard statements (Eigenbrood, 2003).

Regarding the influence of the contractor 'one on one' cooperation is far from desired in the eyes of the architect. Construction drawings can be kept "in house" in order to have control over detailed design information. The architect wants to keep control in order to defend the quality of his design (Eigenbrood, 2003). From the contractors point of view the architect can make a project complicated because of his view on time, costs and quality. Because the architect will usually be supported by the client and Chief Government Architect, there is a barrier between designing- and constructing parties.

The process design and the assessment of solutions are not living up to the theory of PeBBu completely. Offers on performance requirements are regularly interpreted with the phrase "will be fulfilled". This way of defining offer specifications stimulates the urge for control by the demanding parties, because the match between demand and supply cannot be verified in an early stage. The threat in this feature of the process is the fact that offer specifications will be accorded on a "by word of mouth" basis, without having any insight in the future solution. It might be that a Statement of Requirements is interpreted before contracting as a result of its dynamic character. If demand and supply, input and output, do not match, the process will still continue. A feedback-loop needs control tools for analyzing the demand and supply match. It also needs a mandate for interference (freezing the process) and taking a step back in case of a mismatch.

Final design and realization.

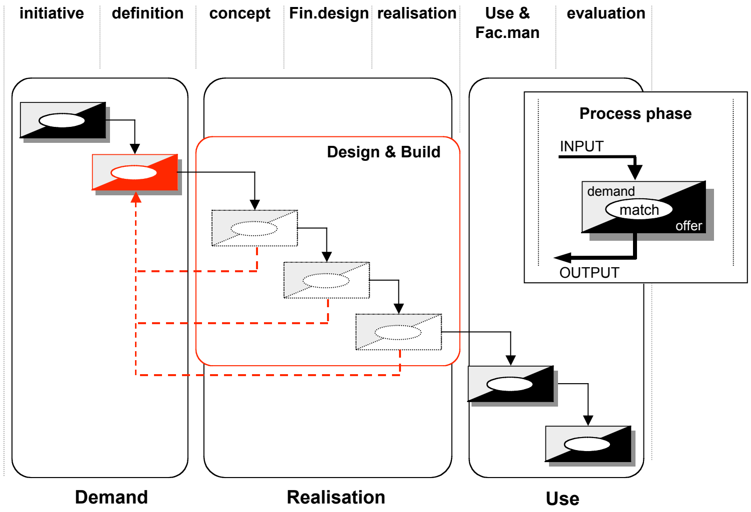

Figure 8: integral contract process

Integral contracting is dependent on the willingness of an architect and contractor to cooperate. Combining design and construction knowledge is needed, but will only be successful if both sides are focused on a common goal. Despite the fact that design and construction are contracted by a developer, the cooperation is not bound to be a guarantee for innovative solutions. The most important barrier, as a result of conflicting interests, is the control over the design. Traditionally the architect had control, but the contractor will try to integrate his own experiences and relational advantages (suppliers) in the design.

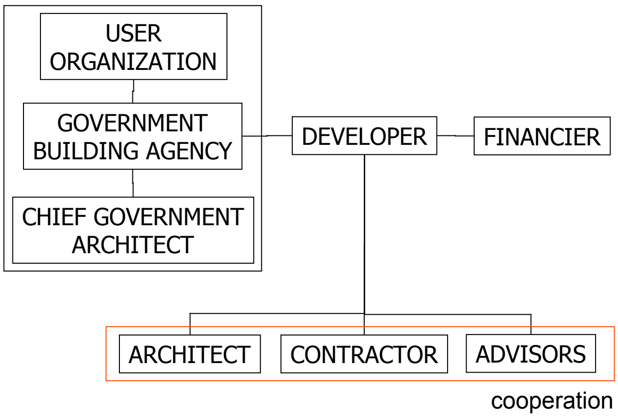

Figure 9: organizational diagram; cooperation in supply

An extra link in the organization by using a development contract can become a barrier regarding control of quality. The contractor will cut back on the product costs. The developer in his turn will cut back on the total building costs and maximizes the yield over the first year (BAR). Next, the RGD needs to control quality in cooperation with the ING (owner) (Hofman, 2003). The situation aims at continued control.

Use & Facility Management.

In the first period after delivery there was a meeting group which included the Tax Department, the contractor, the developer and the RGD. This group had frequent meetings to resolve problems which were partly caused by the early transfer of the building. This meant the user inhabited the building prematurely, before the contractor finished his job. In general the building shows no more or less complaints than other buildings, says Jan Hensing, Facility Manager RGD. The RGD does get complaints about the climate in most buildings, right after delivery, and the "Wilhelminahof" is no exception. In the large hall, this problem might be prevented by using less glass or other climate installations, but the main problem in the building is the change in use because of adjusted occupation. The future changes or expansions of workforce are hard to predict and, as a consequence, hard to deal with. A major advantage in the project is that the building is highly flexible regarding office space (Hensing, 2003).

Evaluation.

Evaluation took place right after project delivery, but functionality and serviceability can only become clear after a certain period of use. The RGD does not work with standard tools to assess the user satisfaction but there is a strong desire to do so by RGD Facility Management. This organization could use the feedback to improve their customer-orientation. An evaluation of user satisfaction is also desired by advisors and architects to adjust their views on general standardized physical demands.

Project evaluation/assessment/measurement/audit process:

Tax Department

The assessment of the building's performance (2003) is based on interviews with participants (especially Facility Managers of the RGD and the user organization). Undesired aspects, stated by the respondents, are a mixture of construction/technical aspects and consequences of insufficient specifications, evaluation/assessment and checking/testing. Right from the moment of project delivery, imperfections were mostly due to construction related items. There have been some problems with the elevators and the climate control. The climate within the building has been a continuous factor of discomfort. Bottlenecks, after project delivery, have resulted in a two and a half year dispute with the project developer. Only after threats to freeze the rent payments was the developer forced to make a move because of the endangered interests of the owner (ING) (Hofman, 2003).

1) Spaces do not always match the needs regarding work processes. Some processes have different functional needs.

Requirement:
Functional
Building: Spatial aspects
Code: F.19.00
Regarding expansion in the future, the following aspects have to be taken into account:
The interdependent functional relations between different divisions need to be guaranteed.
There may not appear serious disruptions in operational management causing divisions to necessarily move out,
………..

Functionality and serviceability:
A "Tax form Campaign" demands a certain amount of space (one room). This spatial need could not be fulfilled. A conference room had to make place for this specific work process and the space for conferences was rented in a hotel nearby. These adaptations are costly (Kik, 2003).

Requirement:
Space
Spatial aspects
Code: F.42.00
Internal flexibility is necessary

Internal flexibility is defined as the possibility to:

- Change the housing of functions within a space module,
- Change the surfaces of an area or room according to the change in spatial needs,
- This requirement concerns the whole building except for specific functions (detention-circuit).

A consequence of internal flexibility:

- The structural lay-out needs to be designed as an open load bearing structure without any bearing internal walls,
- The structural facilities and building services need to be realized with the possibility of rearrangements, especially in the non-specific office space,
- Spaces which hold more specific functions need to be situated and designed in a way that causes as little limitations to the flexibility as possible,
- Such a system of measurements needs to be realized so that deviations regarding the Statement of Requirements as a result of arrangement losses (losses in useful floor space) are as little as possible,
- Every standard workplace needs to have usable and controllable technical facilities,
- Built-in components and finish need to be easily adjustable regarding the measurements, materialisation and mobility.

Functionality and serviceability:
A 'misfit' in the arrangement of spaces resulted in windows which could not be opened by the user. The windows were originally designed for a large "open" space in which these windows had no provision for manual operation by the user. In the present situation these windows have to be opened separately by individual users. Flexibility and change need to be the consequence and differently controlled.

To fulfil the need for flexibility, a thorough study could to be made in advance, before an arrangement of spaces is fixed. This type of flexibility cannot be achieved with just a few flexible interior walls. Flexibility also shows in the amount of square meters and not just flexible arrangement of spaces in a minimal amount of square meters.

2) Serviceable needs have to match the flexibility of space.
Requirement:
Technical
Electro technical installations:
Code: T.75.00
Constructing a cable and wiring network for the benefit of the energy and information needs, and for all electrical supplies in the building, including organizational installations and user appliances. The cable system and electrical wiring have to be delivered in such a condition that the system can be expanded economically, and re-arranged conveniently and efficiently. … (further technical requirements)
See also F.19.00 & F.42.00 regarding flexibility.

Functionality and serviceability:
In the Tax Department building, the wiring and data connections have been left out in spaces which were initially used for processes that did not need these services. Because of internal movement and adjusted circumstances, the space which were planned to house a different process no longer meets the needs of he current uses.

Services like computer connections, climate services, finishes, etc., should be adapted to the spatial flexibility otherwise you still have an inflexible building (Kik, 2003).

3) Realized requirements are physically static.

General flexibility requirement
Functional
Space
Spatial aspects

Code: F 42.00
Internal flexibility is necessary

- The structural facilities and building services need to be realized with the possibility of rearrangements, especially in the non-specific office space, …

Specific requirement
Functional
Space
Spatial aspects
Code: F 62.00
…
Decentralized printer-rooms:
- housing the rooms in separate (± 6 m^2) spaces with soundproof interior walls and a exit-door with glass strip;
- …
- lockable if these rooms border other rooms.

(Additional specifications are no part of the performance requirements)

Static requirements:
The Tax Department reorganizes constantly. Requirements are easily out-of-date and are not taken into account the moment the physical process moves within the building. The realized requirements tend to stay put, without moving with the matching process.

For example, a printer in a contract room needs to be sheltered from the public. As the process is moved so is the printer, but the required building aspects regarding visual contact with the printer stay at the same place (Kik, 2003). In another room the printer is visually accessible to everyone. The demand no longer matches the physical environment. Another example is the doctor's room with more specific acoustic demands (higher wall insulation). When the room moved as a result of organizational moving the physical solution stayed where it was. It takes time to make adjustments to another standard room so the requirement is not fulfilled during the time it takes to rearrange the spaces. There is a lack of space in the total building to cope with storage.

Specific processes which need special requirements tend to be moved just as easily as standard office space. A certain flexibility regarding those processes needs to be considered in the design phase. The process has to stay within the same space or the special facilities should easily be (not costly) moved jointly. This aspect could be taken into account during the definition phase.

4) Rules and regulations are to be taken into account in the design phase.
Functional
Working conditions
Code: F.28.00
The building needs to fulfil the requirements regarding the ARBO-law.

ARBO: Working conditions legislations, additional legislation related to absence through illness, standardization, guidelines and European legislation.

Technical
Maintenance
Code: T.114.00
The facade and the glass of atria, glasshouses, etc., are reachable for maintenance work, in conformity with safety regulations according to the ARBO-law. At a building height of 9000 mm or more, or if the shape of the building shuts out other methods, an installation needs to be placed for façade cleaning and maintenance.

Conformity
These requirements are required as a base for further plan-development. Façade lifts need to meet prevailing laws (labour inspection publication P120 "moveable scaffolding).

Functionality and serviceability:
The elevator shafts had to be glazed at the exterior because of an architectural demand for a representative (aesthetic) look. But because of general regulations (ARBO), a glass cleaner is not allowed to go into the shaft. The facility management is forced to hire expensive cleaners with special experience with this kind of jobs. The cleaners secure themselves to the roof of the elevator to reach the inside of the glass shaft. An employee of the lift distributor has to be present to guarantee the safe use of the lift. There are no clear requirements specific to lifts and the process of cleaning. These imperfections could easily be prevented by involving the "eye" of the experienced facility manager (Kik, 2003).

Lessons learned:
The experience of those responsible for the facility can easily save the user or the owner money by their involvement as an advisor within the definition and design phase. The eye of the experienced facility manager can easily pinpoint misfits in the phase of use by taking a look at the Statement of Requirements or drawings. As a result the owner or users do not need to pay for costly adjustments in the phase of use (Kik, 2003).

5) Design solutions which do not match the process can become costly as a result of physical damage to the building. For instance as a result of internal transport (Kik, 2003).

Functional
Space
Spatial aspects
Code: F.45.00
For the benefit of internal transport, the doorways of "transport routes" (hallways, archives, canteen, computer room, etc.) should provide a free passage. They need to be at minimum 1200 mm width and 2100 mm high.

Internal transport: The following spaces need to be easily and quickly reachable from the unloading bay and the doorways (frame) need to be adjusted to transport of goods (width 1200 mm, height 2100 mm). This adjusted doorway will also be placed in:

- First aid room;
- Archive;

- Canteen;
- General workshop;
- Printing room;
- Mail room;
- Central computer room.

The spatial design of the hallways needs to meet the previous requirement. If a staircase is part of a "transport route" the previous requirement is also applicable. Structural transport of goods needs to be prevented in the public areas and employee workrooms.

Functionality and serviceability:
The requirements concern design solutions by claiming that these measurements will deal with transport processes. The actual process is not described specifically and as a result the building's interior is often damaged. The instruments for transport are not adjusted to the building design, which fails to serve the process of internal transport. A change in organization will affect the layout and thus the "transport route". In this building there are several aspects of unsatisfactory transport.

In practice, the requirement is not able to prevent physical damage to corners, doors and building parts which stick out. Instead of prescribing measurements within the requirement, the description could concern a forward view on use and change.

6) Architecture and maintenance. Design aspects can become costly.

Spatial Visual
Elements
Code: RV 10.00
Artificial light is supporting the spatial structure and contributes to an satisfactory view from the site at night.

Functionality and serviceability:
The architect designed a light strip made of electric bulbs. These bulbs do not last long so they have to be replaced often. The strip is only reachable with a ladder. Those responsible for maintenance are not willing to climb a ladder every few days to replace a bulb. As a result the "satisfactory view" from the lightening is not met. A few bulbs missing in the strip mutilates the architectural image.

The architectural requirements are vague and subjective. Naturally, a continuous control on the design process will provide the interpretation. The requirement is not directly related to maintenance or other aspects in the phase of use. This might be a problem because of the costs involved.

There have been numerous leaks as a result of missing lead foil. These faults can only be traced back to the contractor. Another reason for leakages was the budget cutback on isolation materials regarding the pipe work. Because of a lack of isolation condensation occurred and resulted in leaks. These imperfections might cause a huge problem for the user regarding the ceilings and floors, not in the least because of the time and costs the user organization needs to spend on repair (Kik, 2003).

Court of law
1) General requirements regarding water and moisture are not met.
Technical
Building
Building technology/services + building physics
Code: T.4.00
The building envelope, including crawl space etc, need to be watertight to conform with NEN 2778

Assessment of this specification from realization up to and including use.

Basic requirements: water tightness
Basements tend to flood as a result of groundwater level in Rotterdam. The lowest floor level is one and a half meters below water level of the nearby Rijnhaven, part of the Rotterdam harbour. Because of missing lead, water came through the basement walls at first. After excavation and drainage the problem was solved partly. But still the building has to cope with moisture problems by upcoming water through the floors. Because of upcoming ground water, the basements still have water problems. The scope of this problem is magnified by the fact the transformer space is situated in the basement. When flooded, the basement cannot be entered because of the danger of electrocution. Electrical installations have to be placed upon an elevation or even mounted on the walls. Another problem of moisture and water is the structural damage and filthiness.

Basic structural demands are to be checked very carefully. If a solution is brought up by the developing party, it should be checked before realization. The party responsible can easily be found but the user will be the victim of rebuilding activities or even damaged building services. In the case of damaged building services (electrical supply), the work processes can be hampered, not to mention the consequences of a failing security system in a court of law and detention circuit.

2) One-of-a-kind situations
No specification found

Basic requirements: safety
Windows were not safe just after completion. When a window was not closed very properly, the window was blown into the room behind as a result of wind bursts,. Experience with this type of window system in combination with high wind pressure might have prevented this problem. There was no specification found.

In this case, the combination between the chosen window system and the high wind pressure was an unfortunate one. The question is: Can these kinds of problems can be foreseen in advance.

3) Accessibility and Safety

No specification found

Basic requirements: safety
The accessibility for stretchers is far from sufficient. A stretcher cannot enter or leave the building horizontally.
Functional
Building
Spatial aspects
Code: F.25.00
The building needs to be fully accessible to handicapped people, excluding the detention circuit. The design needs to be of a standard which will receive a vignette of the Dutch Handicapped Council (Stichting Nederlandse Gehandicapten Raad) in Utrecht.

Basic requirements: accessibility for handicapped people
Modifications had to be made for handicapped accessibility at user costs. According to the RGD the

requirement was fulfilled. In practise it did not meet user needs.

In this project, the document "integral accessibility government housing" was used. In addition the assessment tool "integral accessibility" was used to check on design solutions. The document deals with all aspects of spaces in which traffic occurs. Performance based specifications dealing with measurements and finishing of materials are designed to meet user demands and guarantee a safe and convenient use. It is not clear if the specifications and assessment were not used the way they should have or if the design simply did not meet the specifications. The fact is that the user is not satisfied. The tool/document is complete but has to be used strictly and consistently.

4) Spaces are designed to house other functions than the processes that will take place within that space in the phase of use.

Space
Technical services aspects
General
Building services
Code: F.74.00
Specifications
Design temperatures during the heating season and during working hours need to meet the following values:

- in hallways with a outside door: 18°C;
- in other hallways, staircases, toilets and Xerox rooms etc., with short stay purpose: minimum of 15°C;

Functionality and serviceability:
A void in the building is now used as a waiting room but was initially designed to be a hallway. The hallway requirements regarding climate are not designed for long term occupation by users. The facility management had to improvise. Because of high temperatures as a result of the occupants, extra ventilation was needed. By opening the doors to the fire staircases and making use of the overpressure installation, the space is ventilated. This is not in conformity with fire regulations and is not sufficient to fulfil climate requirements.

Spaces which were designed to house other functions than the processes that will take place within that space in the phase of use cannot meet the specifications and need to be adjusted. In the phase of use, adjustments can be very costly and are usually made by the user by improvising as the example shows.

5) Processes will change their spatial requirements over time.

Only specifications related to expansion and change are flexibility specifications.

Functionality and serviceability:
Regarding the Statement of Requirements, there was too little attention paid to future changes in processes and spatial needs. The need for archive space will decrease as a result of digital storage of information. Consequences are not only the change in surface needs but also change in structural needs. The bearing structure does not need to be capable of coping with intense pressures created by heavy archive storage.

Surface need calculations are made based on the "Handbook of performance level for buildings regarding Tax Departments" (Handboek prestatieniveau van gebouwen t.b.v. de Belastingdienst) and "Performance specifications JR 120, general office functions" (Prestatie Specificaties JR 120, algemene kantoorfuncties) in which all surface measurements are described in relation to the functional use. The total amount of floor space can be seen as a sum of all separate needs. It is very hard to foresee changes in spatial needs and to adjusted requirements.

6) Fulfilling the Statement of Requirements does not necessarily mean fulfilling the users' needs.

Technical
Building
Building technology/services + building physics
Code: T.5.00
The cells need to meet the T.H.O.R.P. (technical handbook designing police departments) …

Functionality and serviceability:
Present requirements/demands of the police department housed within the building do not match the Statement of Requirements (T.H.O.R.P.) and as a result the building is not matching the processes. Within the detention circuit there is not thought given to claustrophobic detainees. The building is not fulfilling visual requirements necessary for control of detainees. Another problem is the possibility of fleeing in case of fire. Initially there where no facilities to cope with evacuated detainees. The only possibility for the police could have been to let all detainees out on the streets. The user organization had to make adaptations in order to deal with fire emergencies.

The actual user is barely involved in the briefing process. The standard design solutions (T.H.O.R.P.) do not match the users' needs.

7) Product innovation possibilities
Regarding innovative products, the contractor came up with an integral solution for blinds. The contractor wanted to use tinted glass instead of external blinds. This design solution had to be checked in advance (before realization) by the RGD. The RGD hired an independent consultant to assess the glass (ARBO, material, etc.).

Functional
Working conditions
Well-being
Code: F.65.10

When sun reflective glazing is used, adequate measures need to be made to avoid light or blinding discomfort or discomfort as a result of heating by the sun.

Code: F.65.20
In the façade, options must be made regarding light diffusion. The light diffusion may not influence the installations and windows negatively. The light diffusing needs to be individual controllable, per pattern of 1800 mm and centrally controllable.

Technical
Products and material characteristics
Code: T.136.00
The glass ... needs to fulfil the following specifications and realization:
Dutch Practical Guidelines:
NPR 3577 and NEN 35676
…
materials
Code: T.168.10
All glass included in the façade of the building needs to meet a light translucent factor (lichttoetredingsfactor L.T.A.) not higher than 0.35, and the light reflection on the outside no lower than 0.15.

Lessons learned:
It is necessary to evaluate design solutions from contracting parties before realization because of the consequences later on. Once the solution is realized there is no way back because of the discomfort experienced by the occupants. The costs for some changes would be prohibitive to the occupants. Checking an innovative solution is a task of the RGD. If the client would ask the contracting party to prove that the innovation will fulfil the requirements, the contracting party will bill the client eventually. Counterproof would remain a task to be performed on the client side. *"'The only way to guarantee customer satisfaction is by checking it yourself"* (Wilmer, 2003)
General Lessons learned: SoR aspects for improvement in the project

- The estimate for storage space was too low. Every temporary empty space is now used as storage room;
- The functional plan does not fit the demands optimally. More processes should be situated on the ground floor:
    - conference rooms;
    - client meeting points;
    - security should be part of a flexible plan.
- Design solutions and work processes should be more integrated.
- The present building is short of service elevators.

SoR commentary:
Process Bottlenecks
User involvement.
The RGD and the Bureau for Housing of the Tax Department have formulated performance specifications in cooperation with the user organization. The same process was used with the Court of Law requirements and specifications. Staff members were normally the ones responsible for formulating the employees' wishes. The user (responsible for housing) knows what he wants, up to the brand of the carpet supplier. According to Wilmer (Tax Department) a statement can easily be made in opposite order. First the user thinks of the solution and then formulates his demand into a performance based requirement (Wilmer, 2003). The user tends to steer the architect and contractor during the design phase. Because the user is still involved in the assessment process he is able to oblige the designing party to make certain design decisions. The architectural firm has an own view on user requirements and is in the position to steer the users demands. The fact there's always some sort of user involvement and power of the architect regarding design solutions is hidden in the process (Eigenbrood, 2003). The architect's opinion can be intimidating because his will is normally fulfilled by the client (user/owner). In addition the architect is normally supported by project managers and the RGD which is an obstacle for facility management input. Another obstacle for input from facility management is the interest of the user. The user is not interested in facility management and all aspects involved but is the one party who should emphasize the importance of specific knowledge to focus on functionality and serviceability. A general obstacle for performance specifications is the documentation of departments. The Tax Department has its own standardized requirements and specifications which are regarded as the "bible" for the internal organization (Hensing, 2003).

Development of performance specifications and offer-specifications.
There have been several conceptual versions of the performance specifications Wilhelminahof. Those concepts have been used to develop the requirements using advancing insight as a result of dialogue between demanding party and tendering party. The first concepts have been combinations of user organization SoR documents and RGD performance specifications. The overall view of the Chief Government Architect was incorporated in these performance specifications. A concept was created and discussed with the user organizations. Development continued until a final concept was formulated. The final concept was handed out to the tendering party which made an offer concept. From the project documents, it becomes clear what problems were faced. First of all, the user made some corrections initially and the expert group made several adjustments. Also the project manager made several comments foreseeing interpretation problems in consultation with tendering parties. One problem was the use of terms and definitions. Different parties do not use the same terminology.

Example A:
Source: Fax-message to Hans de Jonge and Frank Hofman From Tolsma
In a meeting with the project developer:
DG: "The building needs to be integrally accessible"
Developer: "Sure, if you can supply us with a document which defines the term integrally accessible"

Example B:
Interview Eigenbrood, 2003:
Some requirements contain the term "duurzaam" meaning sustainable, but what is sustainable? Nowadays there are other views on the contents of the word than a couple of years ago.

Definitions within performance specifications should be clear to all parties involved, before realization and the control over supply solutions is done instinctively without a proper set of tools and without the emphasis on functionality and serviceability.
Contract specifications.
Contract specifications need to be clear to all participants and controllable for the demanding party. The way specifications can be checked is a standard problem, but the requirement itself can be a burden in the phase of use as well. The Court of Law building is a technically complex project, according to Somers, who is responsible for facility management. Technical serviceable facilities experience a mushroom growth which results in a building process which is always behind. When a project will take several years, it might be better to postpone certain decisions to a later phase of the project. This will not result in major differences, according to Somers. Defining technical solutions for supportive facilities is not to be made within a definition phase of the project if the user wants to have up-to-date services. In addition, before completion there will likely be cutbacks on the design, especially on serviceable facilities (communication in this case). The result might be an outdated building (Somers, 2003).

The necessity of some performance requirements can be questionable in the eyes of the architect. For example demands concerning lighting. Dam & partners have a strong view on how to deal with lighting, but are constrained by a strict requirement. Climate requirements have to cope with the same problem, Eigenbrood says. Advisors are normally too rigid in their judgement regarding the assessment of design and requirements, because of the fact that they will be blamed (by the RGD) if the performance does not match. This experience is restricting to the architect and does have an effect on the interior atmosphere (Eigenbrood, 2003). A problem for the architect is the demand for a building that conforms to market standards. These types of requirements usually focus on highly flexible, economically optimized and standard office buildings, which are not much of a challenge for the architect because of the multiple constraints.

Differences, comparison to traditional approach/method:
The following aspects of PeBBu are the main differences in comparison to a traditional building process:

- Contracting in an early phase;
- A tender consisting of full development;
- The contract includes financing and rental aspects;
- Part of the requirements are formulated in performance specifications;
- Strategy/scheme development and realization.

Lessons learned:
Measurement and comparison of functional capabilities of different facilities are unsatisfactory in the project's processes from start to finish. To get good value from facilities it is desirable to involve knowledge from all different phases of a building's lifecycle. The diversity in knowledge within these project's processes is limited and is experienced as missing by facility management. If the goals of PeBBu regarding support for office work want to be achieved, the right people need to be integrated within the definition and design process.

Innovative ways of dealing with the building's life-cycle are not broadly-based, not by the tendering parties nor by demanding parties. In this case study, the facilities were only seen as a cost instead of a means to get work done as efficiently and effectively as possible. An occupant expects the tendering party to come up with a fulfilling building without really analyzing the needs and demands which concern supportive facilities. Those needs come up during use and will be dealt with later, causing improvisation.

Because of a missing contract for facility management, the innovation and increase of functionality and serviceability of a building and its services is lagging. In the "Wilhelminahof" project facility management is a small (separate) organization within the user organization, without financial interest in functionality and serviceability and without budget to introduce improvements. They have to improvise with the means they have, and those are small.

It is essential to define appropriately the scale of functionality and serviceability. In this case, the building capabilities of performing as required are focussed on an architectural, structural level. From a user's point of view problems appear on that structural (architectural) level and facility equipment like computers, printers, coffee machines, etc. are of minor importance. Users are not aware of the possibilities of what they can ask for. They define functional requirements extended with process descriptions and leave the interpretation up to the architect. A standard office space is expected and by combining the architect's role with the contractors focus on cost reduction and profit as a goal, a standard office is what the user will get. Innovation on the level of serviceability is not a specific target in the process. In addition, the level of "outsourcing" the buildings lifecycle is limited. The possible advantage of integrating design and construction could be seen as a goal, without integrating facility management. As a consequence price-making is limited to building costs without integrating and foreseeing maintenance or even rebuilding. If the need for performance-based building on the level of user-needs is based upon trends in facility management, it seems more logical to test new innovative ways of working in the real estate industry on market orientated parties. The trend in the private market may be the fact that the workplace is starting to become identified as a key to business competitiveness but in the public sector this view did not get through at the time of the project. The public sector needs a hand from the RGD to realize the possibilities of facilities to add value to core business processes.

Conclusions:

Benefits:

Lesser costs for the RGD in early phase of the building process.
Because of defining the demand in the shape of performance specifications, the client (RGD on behalf of the client) is not forced to spend time on defining design solutions. A contracting party can make an offer in an early phase based on previous experiences. A result is a uniform starting point (document) of the definition phase.

Making the client more professional.
The client will be forced to think of his future housing in combination with its organizational processes because of the way requirements are stated. Using performance based specifications, the client becomes more professional. (Wilmer, 2003).

Making the dialogue easier.
Because performance based specifications have clear goals (functional purpose of an aspect) it is easier for the client and user to consult with an architect. The architect is able to understand the essence of the requirement which improves the mutual communication (Wilmer, 2003).

Facilitating innovative solutions.
Performance specifications do not invite tendering parties to think of innovative product solutions in particular but the key factor is they are no longer a constraint by prescribing the solution. Performance

specifications are able to facilitate product innovative solutions.

Setting a basis for quality?
The performance document states a basic quality level and has the benefit of steering and controlling the autonomous operating manager on the project.

Bottlenecks:

Control over the supply specifications remains a problem. Lesser costs in an early phase of the building process are disputable.
Because performance specifications in this case do not cover the whole building, specifications are supported by a "traditional" Statement of Requirements, the contractual characteristics remain disputable. The fact the participants at the demand side still want to steer the supply, means those participants spend a lot of time on checking up on the offer. The process architecture for Performance Based Building will only be successful, as a result of achieving the theoretical goals, if the client lets go of the urge to control. This means the success is also about trust between demanding parties and the supply side. Quoting Wilmer; "The demanding party needs to break with the habit of wanting to control continuously".

Innovative solutions from the developer/contractor will always need to be checked by the demanding party.
The offering party will logically claim the solution he has come up with will fulfil the performance requirement. Because the demanding party does not want to be surprised after realization, they need to validate or reject the solutions themselves. This can be costly because of the fact it needs to be done by a third, impartial party, in order to avoid disputes with the developer/contractor. If the offering party needs to prove their solution by testing it, then the costs will have to be settled with the client. Innovative solutions will always have additional costs for the client. The question is whether the costs for assessment by a third party outweigh the cost or quality benefits of the innovative solutions.

Participants need to back up the PeBBu goals.
Performance Based Building sets out goals which cannot easily be achieved without the proper basis. The focus on performance instead of the solution must be integrated throughout the process. These goals require willing participants. The people 'in the field' need to step down from their traditional role as 'guardian' or even 'opponent'. The demanding party needs to trust the supplying parties to come up with a solution that is in the interest of the user. The idea of contractors and developers "sabotaging" the quality needs to be overcome. Not only does the natural barrier between client and developer needs to change but also the relationship between architect and contractor. Performance Based Building asks for the participants to believe in the goals of Performance Based Building and focus on user demands.

Setting a basis for quality?
The performance document states a basic quality level but has to deal with the hurdle of an autonomous operating manager on the project who can still change certain aspects within the performance specifications based on his own experience.

A formal approach.
Working with performance specifications asks for a more formal approach in the process. Traditionally participants could easily make arrangements during a meeting but the performance document is not suitable for that approach because requirements need to be spelled out in an agreement. (Van Zanten, 2003).

4.1.2 Case 2: Naturalis

General Information

Case Study No: 2

Naturalis

Organization Details

Organization type:

Tenant: Rijksgebouwendienst
User: Naturalis
Architect: Fons Verheijen of Architectural firm Verheijen/Verkoren/de Haan
Refurbishment Architect: Flip Robers
Landscape Architect: Bosch en Slabbers
Investor: Hulotte
Advisors HBM Utiliteits 'development and construction', Technical management (building services), Galjema B.V.
Contractor: Main contractor and contractors building services: HBM, Wolter en Dros Amersfoort (services), Wolter en Dros Elvi (elevator), Ergon Electronics bv Leiden (electrical services)
Property developer: Mabon
Project manager RGD: F. Hofman and J. Karreman

Organization name:

National Museum of Natural History Leiden

Organization contact name:

Ms. Nora van Van Klingeren
Tel: 06-54617914
Email: van Klingeren@naturalis.nnm.nl

Organization sector:

Public sector

Organization location:

National Museum of Natural History Leiden

Darwinweg, Leiden
P.O. Box 9517
NL-2300 RA Leiden
The Netherlands
Tel: 071 - 5687600
fax: 071 - 5687666

Project phase

Use

PBB focus regarding the building process:

Performance Based Building Focus on contracting in an early project phase and integration of design knowledge and realization knowledge by working with a design & build contract.

PPB focus regarding requirements:

SoR focus on prescriptive museum aspects.

Performance specification focus on technical specifications.

Compiled by:

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Mail address:

Rijksgebouwendienst

PO Box 20952
2500 EZ The Hague, The Netherlands

Project Details

Procurement routes:

Public Private Partnership:

- Rijksgebouwendienst (Dutch Government Building Agency);
- local government of Leiden;
- Dutch Ministry of Education;
- Naturalis;
- property developer Mabon.

New Build

Contract type: Integrated contract (design & build)

Project title:

Naturalis

Organization contact information:

Ms. Nora van Van Klingeren

Tel: 06-54617914

Email: van Klingeren@naturalis.nnm.nl

naturalis@naturalis.nnm.nl

Project date and value (approx):

Total Building Costs: 39.540.000 Euro (New build part and refurbishment), 17.270.000 Euro (interior)

Project start: 12 October 1995

Date of project delivery: 23 May 1997

Open for public: April 7, 1998

Project Location:

Darwinweg, Leiden
P.O. Box 9517
2300 RA Leiden
The Netherlands

SoR documents

General Statement of Requirements NNM

- Spatial Statement of Requirements, including: surface area requirements ;
- Climate requirements;
- Electrical requirements, including: elevator specifications;

- Structural and Architectural, including: materialization, various calculations, finish level;
- Performance Requirements General RGD, including: requirements, cost group description.

Additional documents

- Various calculations, including: buildings physics, acoustics, exploitation costs and installations;
- Assessment of final design by Galjema B.V. technical advisors (assigned by RGD);
- Spatial requirements for storage space by DISTRICON logistics management (assigned by NNM), including: evaluation Spatial SoR.

Selection criteria (unique PBB aspects of this project):

Procurement and tendering based on preliminary design concept and functional requirements on the desired serviceability of the buildings, DBFM-O (Design-Build-Finance-Manage and Operate) contract in the transition from definition to design stage in public private partnership with RGD.

Date /version:

16-10-2003, Final

Case Study Details

Case study contents summary (key points):

Process evaluation

- SoR development;
- Building Process (interviews);
- Use phase evaluation (interviews).

Product evaluation

- Use phase evaluation (interviews);
- Post occupancy evaluation (observation).

Case study key words:

Naturalis, Statement of Requirements, Performance contracting, Performance Specification, Public Private Partnership.

Case study document refs:

- SoR documents Naturalis
- VROM, *Naturalis*. Rotterdam: Uitgeverij 010, 1998.
- Rijksgebouwendienst, *Nieuwbouw Naturalis, gebouw en functie goed op elkaar afgestemd*, VROM, 1998.
- Rijksgebouwendienst, *Nationaal Natuurhistorisch Museum in Leiden*, projectdocumentatie 12/95, VROM, 1995.
- Project documentation
- Dijkstra, E., Interview: *Naturalis, Architect VVKH Architects*. 12-08-2003.
- Karreman, J., Interview: *Naturalis, projectmanager*. 16-06-2003.
- Pol, J. van de, Jhingoer, R., Interview: *Naturalis, Facility Management RGD & user*. 12-08-2003.
- Van Klingeren, N. van, Interview: *Naturalis, client/user*. 21-08-2003.
- Le Comte, P., Interview. *Naturalis, advisor*. 09-09-2003.

Case study website refs:

- http://www.rijksgebouwendienst.nl/catalogus/
- http://www.bam.nl/baminternet/baminternet/index.jsp
- http:// www.naturalis.nl
- http://www.vvkh-architecten.nl

Project Description

Project summary:

Naturalis is the newly built housing for the National Museum of Natural History in Leiden. By refitting the railway station site and by renewing and refurbishing the monumental "Pesthuis" (seventeenth century building, Plague house) a historical part of the city has been revitalized. One of the main recognizable features of the building is the fact the newly built part and old "Pesthuis" are separated by a road (Darwinweg). The two buildings are connected by a glass and steel pedestrian bridge. The development of Naturalis is resulted from a Public Private Partnership between the Municipality of Leiden, the RGD and developer HBG Real Estate (formally known as Mabon). The building does not just contain exhibition space but also climate conditioned storage space (over 10.000.000 objects), laboratories, office space for 120 employees, a library, a restaurant, a movie theatre and an auditorium. A total of 25.000 m^2. The project was owned by a private party at first and rented by the RGD. Today the building is owned by the RGD.

Background and context::

With the opening of Naturalis in April 1998 it was the first time zoological and geological collections were housed in the same building in the Netherlands. Ten years before delivery, a small taskforce started with designing exposition plans. The team consisted of three scientists, a biologist, geologist and botanic and several other museum employees who were concerned with exhibit design and education tasks. Within a traditional-like process development a sketch design, concept and final design of the exhibition features were created. In the last phases, the exhibition team was supported by a taskforce of museum employees and external advisors. Around 1997 seven exhibition plans and the design were ready for realization. The exhibits take place in a building complex, which is specifically designed for natural historic collections. Architect Verheijen has specifically emphasized the routing through the exhibit by stairs and different floor levels in order to achieve the conceptual goal of a "dynamic museum".

The building not only contains exhibit space but also conditioned storage space (over 10.000.000 objects), a laboratory, office space, a library, a restaurant, a movie theatre and an auditorium. Architect Huybert Cornelisz Van Duyvenvlucht has built the brick "Pesthuis" between 1658 en 1662. Nowadays the "Pesthuis" is the museum entrance leading to the newly build part of Fons Verheijen. Lower parts of the new building, with a floor plan of roughly four squares, is coloured terracotta just like the roof of the "Pesthuis". The high-rise part is eye-catching because of the zinc plating in different measurements.

Figure 1: Naturalis

The Museum organization

The museum organization consists of a general staff and coordinating secretariat overlooking the directorate operational management, production and public, collections and research. Apart from the 175 permanent employees, there are working volunteers in all museum divisions. They provide assistance to the public during main events and help execute national surveys. Others are involved in the museum garden or the bookstore.

Goal of the organization is to use the unique historical collection to participate in educating the public and promoting the respect towards nature within the Dutch society. The museum work field consist of research, archiving, showing the collection to the public and supportive aspects. Most disciplines have computer work processes without specific spatial or technical demands. For research laboratories specific demands are required. Also archiving demands for special requirements regarding climate and regulations.

Figure 2: the old "Pesthuis"

Naturalis has a gross floor space area of approximately 25.764 m^2. The total costs of investment are 39.54 million Euros for the New Build and renovation and interior costs of 17.27 million Euros. The building was designed for 110 permanent and 30 temporary employees.

Key objectives of project:

Overall project goal:

Re-house the National Museum of Natural History as a part of the urban development of the Leiden train station area.

Key objectives regarding design:

Main goals of the museum organization are:

- To practice science, creating a collection and exhibit;
- Underlining the importance of a museum by restyling the urban setting;
- A " free" route through the exhibit;
- Preventing "museum tiredness";
- High standard climate requirements (storage space of 22.000 m^3 may only difference 1 degree in temperature over a one year period);
- Austerity in materialisation and use of space.

Key objectives PeBBu:

Using Performance Based Building to integrate design and construction knowledge within the process and to be able to involve the contracting parties in an early phase of the building process in order to save costs and add value within the product.

Key constraints of project:

SoR Focus:

Focus within the Statement of Requirements from the new build museum complex regarding user requirements are fitness for purpose, functionality and serviceability. Specific requirements regarding laboratory aspects and storage space among other specific museum aspects were prescriptive instead of performance based.

Major constraints in the project are the performance based technical requirements, which will determine the building costs. In the concept stage, it is necessary to determine what it is the separate spaces need to fulfil and what it takes to do so (in a matrix format) in order to generate insight in building costs.

Project development:

The Museum of Natural History "Naturalis" was part of a Public Private Partnership between Rijksgebouwendienst, the local government of Leiden, the Dutch Ministry of Education, the Naturalis organization and real etstate developer Mabon. Mabon won a multiple study assignment written out by the government of Leiden. The assignment consisted of a plan including offices, dwellings, retail and catering industry situated around the central station area.

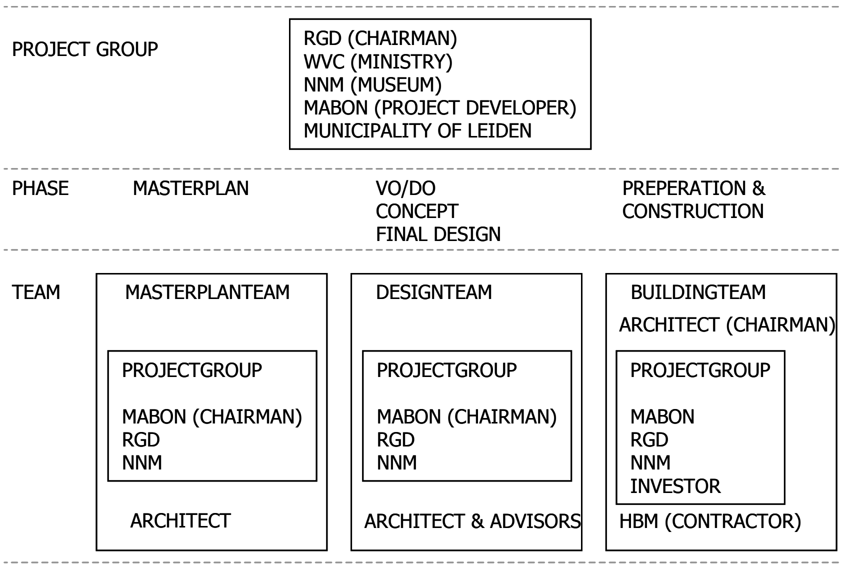

Figure 3: *Team model*

The city of Leiden contributed to the project by handing over the structurally refurbished "Pesthuis", building land and part of the garden construction. Before the project started, a feasibility study was carried out by Dutch Ministry of Education, Culture and Science, Ministry of Spatial planning, Housing and the environment, Government of Leiden, Mabon B.V. and Arconado Management Services B.V. (Swedish investor). The surplus value of Public Private Partnership was focussed on: shorter realization time, limited rental burden for RGD (lower rate of return), optimisation of plans and neighbourhood. Surplus value should also be achieved regarding the guarantee of quality (VROM, 1998). The project developer took the risks of cost-quality and planning. The Statement of Requirements and the building costs were separated and limited the risks from a cost and quality point of view (Project documentation, *Publiek-Private Samenwerking NNM*, Leiden, januari 1992).

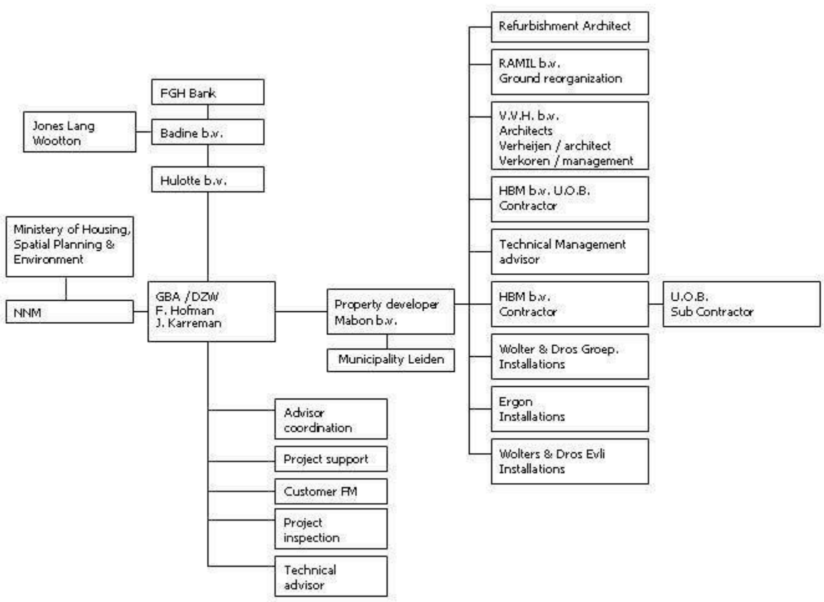

Figure 4: organization chart "realisation"

Private finance was (and still is) a goal of the government in city renewal plans (Fourth note Spatial Planning. *4e NOTA Ruimtelijke ordening*). Because of financial deficit, the Ministry of Spatial Planning, Housing and the Environment tries to generate private funds in order to give urban development an investment boost. In return the private risks are lowered by long-term lease contracts with public organizations. Another reason for a public private partnership is the possibility of shared know-how. Because of this Government policy, the RGD is committed to high priority projects from a business economics and housing point of view (Rijksgebouwendienst, 1998). Intensive dialogue took place between the RGD and the developer Mabon regarding the building costs. In consultation with Mabon, the RGD made costs assumptions regarding quality, finish level and permanent installations. RGD and Mabon both commissioned separate cost calculations by an independent bureau. These costs were then compared and agreed upon.

The Chief Government Architect Rijnboutt appointed architect Fons Verheijen from Leiden as project designer. From the project start, the architect had intensive contact with a project team from the user organization. The cooperation layout was to be a variation on a design and build contract, in the Netherlands called a “bouwteam” focussed on cooperation between contractor, architect and advisors. (Dijkstra, 2003). Although public parties initiated the project, the project was eventually transferred to a project developer. The project developer is Mabon, a daughter company of HBG.

Project documents introduction:

Different project documents have been used. A wide variety, from government notes up to technical drawings. Specific project related Performance Requirements are made by the RGD and an external advisor. Standard performance specifications were created by the RGD. Most requirements concerning the use of the building are created within the user organization by a team of specialists.

Project document types:

- Spatial Statement of Requirements, including surface area requirements;
- Spatial Statement of Requirements, including relational diagrams;
- Technical descriptions of desired supportive installations;
- Descriptions of spatial measurements based on collection measurements (in detail: average length of a giraffe, prehistoric skeleton, etc.);
- Performance Requirements, including performance specifications, cost group description, process criteria, norms, guidelines, relational diagrams, temperature, voltage, etc prescriptions (in detail, resistance specifications of bullet-proof glass).

Project documents commentary:

A strict difference should be made between a prescriptive statement of requirements (the Dutch PvE) and a Performance Based Statement of Requirements (prestatie specificaties). Together they form the overall Statement of Requirements (SoR). In this case, most requirements were already made explicit by the user organization (NNM) and had little to do with the RGD view on performance specifications. These requirements are focussed on design solutions instead of just user processes and matching building performances.

Project process introduction:

Procurement

Procurement was based on performance requirements and NNM requirements. The focus was a Design & Build contract in order to combine the knowledge of contractor, architect and advisors. Full development was handed over to the project developer. The contractor was part of the same organization as the developer. Advisors were contracted by the developer but external advisors did support the RGD and NNM as well.

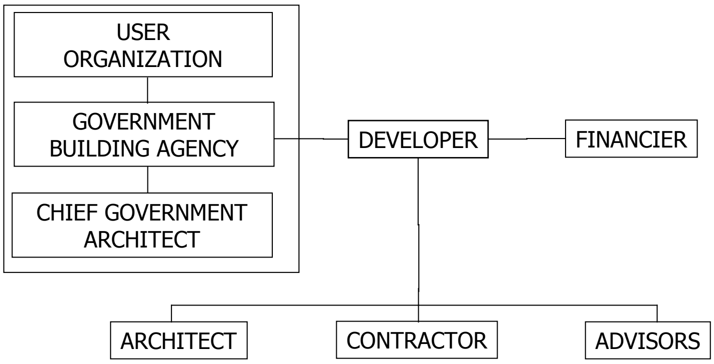

Figure 5: simplification of the organization chart

Definition

The Statement of Requirements was created by the Naturalis organization itself for most parts. RGD and the architect were advisor. Because the museum is a unique and complex building, the NNM organization had the most knowledge about the housing itself in a functional and serviceable manner. Building technology, architectural aspects and structure were defined by an advisor assigned by the RGD and the RGD itself. The RGD was responsible for non-specific requirements and aspects regarding standard office space. These requirements were stated within an "integrally" standard Statement of Requirements. The NNM created solution based statements regarding all specific aspects of the museum. Most wishes of the user were translated into SoR documents without being performance based (Karreman, 2003).

Concept and final design

Selection of the architect was (and is) a task of the Chief Government Architect who is responsible for the architectural quality of the building and its surroundings. During the conceptual phase and different design stages the user organization and RGD were able to assess the design and learn from advancing insight.

Realization

The RGD was involved only on a quality control level. Advisors from all different disciplines within the building process executed an assessment. The user was part of the assessment team and created an own project team, which contracted external advice besides RGD. This team assessed all documents and reports on the assessment were sent to the developer. The developer responded on reports. This fact made communication efficient and helped both sides to trust each other. Little as possible was left for discussion. Despite the effort and the efficient way of working some misfits were implemented in the design and even in the final product (see: building evaluation). There were no legal procedures regarding misfits because the performance level was fulfilling the demand but the quality wished by the user organization and RGD was not met on every aspect (Karreman, 2003). The developer had final responsibility concerning realization.

Project process commentary:

Procurement

The project was outsourced to a developer. There was no public tender due to the fact that the developer owned the land and as such could claim all real estate development in situ. The project was to be leased from a private owner instead of having the building in ownership by the RGD. The fact the developer was part of a multinational contracting and developing company did not make the process more transparent regarding costs. The advisor on building technology has doubts on the cost and quality relation (Le Comte, 2003).

Definition

From the side of the RGD, the input concerned non-specific demands regarding standard work processes like office space. The RGD (SoR) input is called the "integral SoR". From the part of the user organization, came a Statement of Requirements concerning all specific parts of the museum. Those demands were prescriptively formulated (bound to a solution). The user-requirements where translated into a Statement of Requirements without a performance based approach (Karreman, 2003). From a contractual point of view you will need "hard" prescribed demands in combination with performance based specifications in order to use the statements as a contractual validated document (Karreman, 2003). The input of performance specifications was of such a small scale the user (Nora van Klingeren) and architect (Egbert Dijkstra) could not remember those being used.

Concept and final design and realization

The architect is not enthusiastic regarding the cooperation with the contractor. Although there where no real complaints or arguments between both, the architect prefers to work traditionally in order to claim control over the architectural quality of the design. There has been intensive communication between both parties and external advisors (Technical Management) but it was mostly costs control input from the part of the contractor. Although the advisor emphasizes the fact cooperation facilitates better communication and eventually better products, the cooperation in this case is not something unique to Performance Based Building (Le Comte, 2003). The focus of the contractor has been experienced by the architect as restrictive regarding creativity. A "quality service" of the contractor was responsible for assessment of the architectural design on behalf of the contractor and developer. Naturally the team has tried to steer on its own methods of realization in order to save both time and costs. The role of the architect is troubled by the fact the contractor had a strong position as a supplying party under the same flag as the developer. Communication and cooperation with the RGD was sufficient, the architects says, especially preparation before the project started (Dijkstra, 2003).

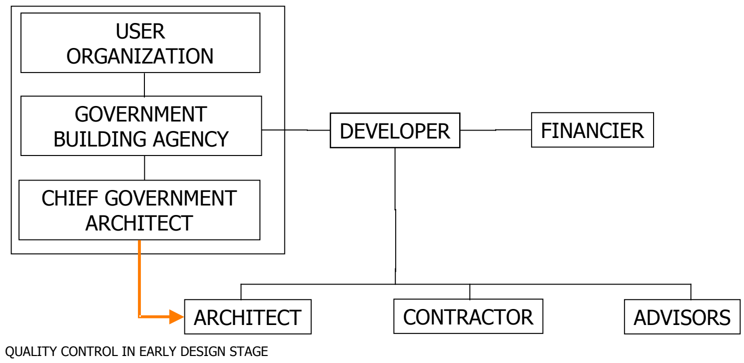

Figure 6: relation between CGA and Project Architect

Bureau Chief Government Architect is responsible for the architectural quality of the building and its influence on the surroundings. In this case the Chief Government Architect had the control instrument of selecting the architect and of the assessment of the conceptual design. The Bureau bypasses the RGD and developer in this specific control aspect. The influence of the Chief Government Architect is extensive because of its position towards future projects. The RGD was merely involved concerning quality control. The control over quality was executed by advisors on all different disciplines. A project team, created specifically for assessment, represented the user. The project team consulted external knowledge as well. The team reported to the developer by handing over the commentary on project documents. The developer was to react based upon the teams' commentary. This dialogue was a basis for trust between demand and supply. There were never any legal procedures started, because eventually the performance specification was met.

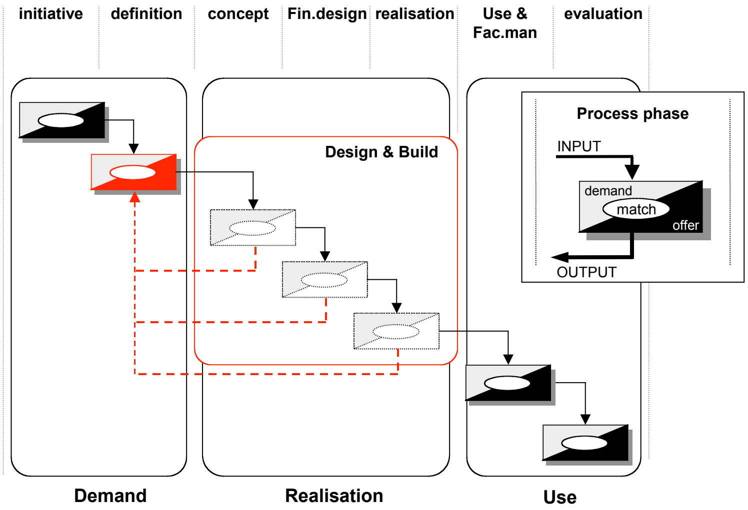

Figure 7: integral contracting

The integration of design- and realization knowledge can be traced back to the example of the innovative cooling concept in the storage tower. The climate requirements were not being fulfilled at first but as a result of an innovative technical concept requirements were met. Because of a separate budget, shifts were made possible. Up until final design and matching performance specifications the architect and technical advisor worked closely together. After the design was complete, solutions were also brought up by the contractor (Le Comte, 2003). The freedom in calculation of prices was used in this case in a positive way by the developer but can be used with negative consequences towards the client; it all depends on the developers' attitude (Dijkstra, 2003). The conceptual idea is claimed by Technical Management as well as the architect, Fons Verheijen (Dijkstra, 2003).

Concept and Final Design were assessed by the quality team, in every phase and regarding every discipline. The team had a well-structured way of assessing every aspect and was managed by a coordinating advisor from the RGD. During the evaluations, the team focused on compliance with norms and regulations. This is partly based on tacit knowledge. There was no special assessment tool used (Karreman, 2003). The quality control remains a bottleneck. Using a Design & Build contract is no guarantee for a high quality building; still the RGD needs to stay on top of things in order to get what they want (Le Comte, 2003).

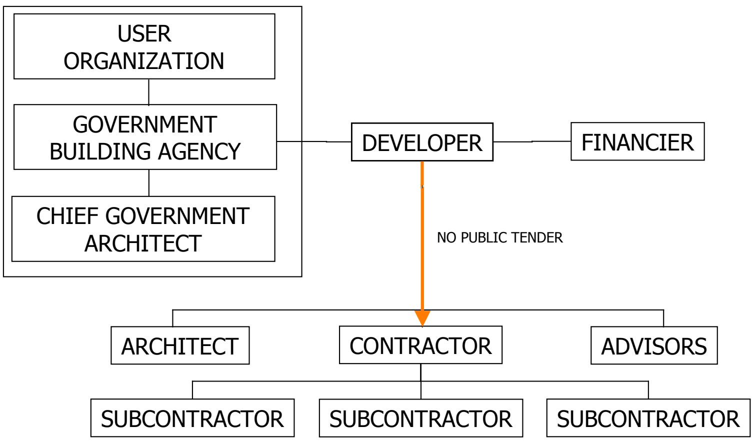

Figure 8: relation between developer and contractor

In the Naturalis project, the realization of the building was handed over to the developer completely. That is something the project manager would not do again. First of all, the fact that the developer and contractor were part of the same organization is disputable. There are no indications that the bid was the lowest possible. Even though costs specialists of both parties checked it, this is not the ideal method regarding total development costs, the project manager says. In addition it seems a whole lot was subcontracted which can increase the price for the developer and eventually the rental costs for the user (Karreman, 2003).

Verification/evaluation/assessment/measurement/audit process:

The assessment of the buildings performance (2003) is based on interviews with participants (Facility Managers of the RGD and the user organization). Aspects of dissatisfaction are a mixture of construction failures related to technical mistakes and problems as a consequence of failing specifications, evaluation/assessment and checking/testing. The building was still troubled with remainders of the project delivery at the time of the evaluation. The problems nowadays are being re-claimed by the RGD on the previous owner.

1) The estimate of the museums visitors.

Requirement:

No requirement found in performance specifications

Routing is part of the prescriptive requirements of the NNM-SoR

Occupancy.

The 150.000 visitors a year turned out to be 250.000 visitors causing numerous problems with spatial aspects like routing and functional aspects like the amount of toilet groups, supporting museum employees and their facilities.

The occupancy estimates are very hard to predict before project start, because it concerns a totally new facility. But related problems can be prevented if the estimate was more emphasized (van Klingeren, 2003).

2) The public elevator did not match the user processes.

Requirement:

66. Transport installations

66.1 Transport installations

- Amount and size of the needed persons/goods elevators need to be based on the transport situation. The following aspects need to be taken into account:
- Separate elevators for areas closed or open to the public.
- The capacity of person elevators needs to be calculated based on the densest five minutes a day (for example the early morning traffic), and an average waiting time of 30 seconds may not be exceeded.
- Minimum of one elevator with a load bearing capacity and size for transport of parts regarding computers, vaults, medical stretchers, respectively skeletons. These (goods) elevators need to reach all floors of the building.
- Regarding transport the reachable floor space needs to be at least 1400 mm width and 2400 mm in length. The access door of the elevator needs to be 1300 mm width and 2100 mm in height. The load bearing capacity needs to be a minimum of 1600 kg.
- The access doors of the person's elevators need to be 1000 mm width at least.
- The capacity of the person's elevators needs to be calculated with the help of the elevator simulation capacity calculation "PC LSD" (Personal Computer Lift Simulation & Design Suite) made by LDP Lift designers Ltd, Dr G.C. Barney. The calculation report needs to be checked by the RGD.

Functionality and serviceability.

The public elevator was not designed for baby carriages or buggies to be transported and could not cope with the amount of visitors demanding vertical transportation. Lift capacity had to be increased at RGD costs (Karreman, 2003).

These issues are related to the occupancy, and of course the visitors' movements, but in this case the estimated amount was probably too high to be coped with by the elevator. The match between the capacity calculation outcome and the actual design is not clear.

3) Specific demands.

Requirement:
No requirement found in performance specifications

Toilets are part of the prescriptive requirements of the NNM-SoR

Functionality and serviceability.

There was not the right amount, or well-situated toilets created for small children. Parents had to move several floor levels to reach toilets, not a practical solution with small children.

A building, which facilitates child entertainment, should be focused on this user group. The users' age requires different design solutions. The functionality and serviceability of the building did not meet the users demand.

4) The public routing in the building, the occupancy and the process.

Requirement:
No requirement found in performance specifications

Routing is part of the prescriptive requirements of the NNM-SoR

Functionality:

The routing in the building is not satisfactory. Pedestrian streams in opposite directions use the same walkway. As a result congestion occurs at the entrance. The entrance hall is situated in the renovated "Pesthuis" with the existing physical constraints. These constraints do not support the process of incoming and outgoing visitor streams.

5) Storage is a critical process to a Museum organization.

Requirement:
No requirement found in performance specifications

Storage is part of the prescriptive requirements of the NNM-SoR as a specific museum aspect with great deal of attention even from external advisors.

Spatial needs.

In the Naturalis case, the lack of storage space (for exhibit materials) is solved by containers placed outside the building. The exhibit materials stored are valuable en can be re-used in coming exhibits. The storage towers are used only to store the collection.

The additional aspects of a work process like creating an exhibit should be taken into account as well. By describing the process and all doings during the process the designer can get a clear image of the additional aspects of the process.

6) Specific organization processes require specific solutions.

Requirement:
90. Requirements concerning buildings physics
Functional and technical requirements
90.14 Element
50.14.11 Ventilation system
G01 For spaces with a laboratory function or equal use the following is acquired:

- Per space separate air exhaust.
- Incoming air holes and outgoing air holes need to be as far apart as possible.

Storage is part of the prescriptive requirements of the NNM-SoR as a specific museum aspect with great deal of attention even from external advisors.

Design solutions and process.
The building houses a space in which dead animals are to be stuffed after taking of the skin and flesh. Stranded whales for instance are taken to Naturalis in order to use the bones and other parts of the animal for scientific research. Although the space is separated from other spaces, the used air is partly taken in by the rest of the building because air outlets are too close to one another or airstreams cause problems. Special requirements have been met by special technical design solutions but in practice the demand of non-polluted air is not met.

The burden of one process to another process needs to be taken into account before choosing a design solution. In this case the user organization would build the specific space outside the museum building in advance.

7) Materialization and process demand should match.

Requirement:
00.01.6 Regulations, norms, guidelines and publications
00.01.6.02 Norms
…
NEN 1081/82 83 Security prescriptions for elevator installations

Design solution and process.
The fire elevator, which should be used in case of emergency by fireman for vertical transport, tends to break down when the temperature in the elevator shaft rises. On a warm and clear day the sun can heat up the steel façade of the shaft, which causes temperature problems.

The design solution should match the process demands for safety and emergency processes in order to prevent serious disruptions to the user organization because of non-qualifying safety measures. The fire department is responsible for assessment of the safety measures. If the standard is not met the building can be closed to the public by the fire department. The fact the elevator can be dangerous in case of fire is obvious. Design solutions regarding safety requirements, in particular, should be proven before realization.

8) Supportive functions (non representative) have no priority.

Requirement:
No requirement found in performance specifications

Functionality.
The service entry was not sufficiently designed. Measurements and routing are not optimal to fit the process of reception and waiting room. Eventually the entrance was rebuilt after draft complaints. A tourniquet was placed.

9) The amount of installations is of influence to spatial needs.

Requirement:
No requirement found in performance specifications

A "*Roof plan*" was missing.

Spatial needs.
Roof is overcrowded by installation material. There is hardly any space left for proper maintenance or movement. The amount of pipes and shafts resting on the roof surface cause damage to the finish and can eventually cause leaks.
Integration of building services knowledge and architectural solutions do not match despite the Design & Build contract. Solutions regarding building services are implemented in a later stage of the design process not matching the architectural concept.

10) Manual controllable aspects demand for matching functionality.

Requirement:
90. Requirements concerning Buildings Physics
Functional and technical requirements
…
50.13 Space
50.13.2 Climate:
R01 – It is preferred to achieve climate requirements by natural ventilation

Functionality on the level of the workplace.
The ventilation grids, which can be controlled manually in compliance to the demand, are situated above the window on a height of 2.20 meters. The user can only reach the grids using a chair or desk to climb up to that height. In addition the quality of the grids was not matching the needed quality.

If manual control of the inner climate is asked for, it is important to not only assess the technical solution but to get insight in the functionality of the solution in order to guarantee the supportive operation of the specification asked for.

11) External influences.

Requirement:
No requirement found in performance specifications

No requirement found in NNM-SoR

External influences.
The possibility that pigeons would use the building for shelter was not foreseen. In addition, there has not been thought of a method to deal with the birds. The bird droppings cause serious damage to the building because the materials are not suited. The wood is damaged and this causes hygienic problems. As a measure, nets have been installed to keep the pigeons away.

12) Aesthetic designs can become costly.

Requirement:
No requirement found in performance specifications

Maintenance and durability.
The blinds in front of the exhibit space consist of horizontal strips. The strips are extended because of the architectural concept. The airstreams along the building surface caused the strips to bend. The strips had to be secured by the fire department with ropes in order to prevent the strips from falling down or being blown away.

13) Accessibility for maintenance should be thought of.

Requirement:
Only requirements found are references to norms and guidelines concerning working conditions.

Maintenance and reachability.
The glass cleaning installation on the "road-side" of the building can only be reached using a small boat. This can hardly be described as a practical solution.

The architectural concept might take the upper hand in decision making, undermining the importance of a practical use of the building.

14) Specific spaces need specific climate control.

Requirement:
The performance specifications contain most specific building spaces and specific climate requirements (office space, laboratory, storage).

No specification found regarding pedestrian bridge

Climate control:
The walkway crossing the road from the Pesthuis to the new built part of the museum is made of glass and steel. In the summertime, this space gets overheated and in wintertime it gets too cold. The spatial layout and design solution asks for different technology in addition to the blinds and ventilation at this time. The spatial design asks for a separate climate control with sufficient capacity to cope with high fluctuations.

The architectural concept might take the upper hand in decision making undermining the importance of a practical use and climate of the building.

SoR commentary:

Process Bottlenecks

Involvement
The user organization has been deeply involved in creating the Statement of Requirements. The specific processes within a museum are the main reason. A museum asks for specific design solutions. For example the intensity of use. This specific museum needs a climate-controlled space seven days a week. Another specific aspect is maintenance of a museum. This can become a burden because of the amount of visitors each day. If a primary process needs to be stopped because of maintenance it can have direct influence on the income of the museum (van Klingeren, 2003). Because of these specific aspects, experts from the museum organization were participants in a project team. Before the NNM Statement of Requirements was created, different end-users were asked their opinion on a new build museum. After collecting wishes and demands, the work processes were analyzed and requirements were created. The Statement of Requirements formulated by the NNM organization was only sharpened by the architect in dialogue with the NNM project team (Dijkstra, 2003). The architect has tried to involve the user organization as much as possible. User involvement is a necessary aspect within a complex project according to architect Dijkstra (2003). The project team of the user organization judged all designs. In conclusion, user involvement was sufficient but only regarding prescriptive aspects of the building (Jhingoer, 2003).

The performance specifications only concerned the non-specific parts of the building. The standard office space. There has been no input from RGD Facility Management (van de Pol, 2003). The RGD Facility Management states that more input would be of great value regarding the final product and cost-quality dialogue within the design phase. On an architectural level, the architect was told to create a "social housing" level regarding office space. A low quality level was realized because of budgetary reasons. The budget is essential in design because costs calculated within design phase are always doubtful from the point of view of the one who pays (Dijkstra, 2003).

Regarding visual expectations nothing was recorded in the Statement of Requirements (or performance specifications). The whole architectural concept was a result of the architects' creativity in dialogue with the museum director and the architects own firms' staff which added value to the project (Karreman, 2003).

Differences, comparison to traditional approach/method:

The following aspects of PeBBu are the main differences in comparison to a traditional building process:

- Contracting in an early phase of the project;
- A tender consisting of full development;
- Contract including financing and rental aspects;
- Small part of the requirements are formulated in performance specifications;
- Strategy/scheme development and realisation.

Lessons learned:

The possibility of budgetary shifts made architectural interventions possible, adding value to the overall building (Dijkstra, 2003). The fact that the architect was contracted by the developer who was part of the same organization as the contractor made an integration of design and construction aspects logical. Because of the negative experience of the architect regarding the involvement of the contractor, this architect does not desire such cooperation. The interests remain opposites (Dijkstra, 2003). Although the architect experienced continued control by the developer as a cutback on its creativity and architectural value, the cooperation was a success in this project. The cooperation's success was validated by the leading architect Fons Verheijen (Dijkstra, 2003). But the amount of parties involved can make the design phase more complex. The contractor made the final drawings (detail drawings) so another designing party was involved (Dijkstra, 2003). By making the final drawings, the contractor was able to take another margin on the building costs by involving his own experience with materialization or product discount from friendly suppliers.

To get good value from facilities it is desirable to involve knowledge from all different phases of a buildings' lifecycle. This can be stated especially for the standard office space which was specified in performance based requirements. The RGD and NNM Facility Management both claim to be able to make a difference if they were involved more often. Their knowledge can help add value to the assessment of the design and prevent numerous adjustments being billed to their own organizations.

Although the design was sufficiently developed, the cutbacks made afterwards have caused some problems (Jhingoer, 2003). It is not the design which is decisive, it is the budget. If costs come out too high after calculation, cutbacks will be made. The possible knowledge input in earlier phases could then easily be ignored. The user eventually pays for aspects that were part of cutbacks made in the design phase (Jhingoer, 2003).

Innovative ways of dealing with the buildings' life cycle are not broadly based, not by the tendering parties or by demanding parties. In this case, the facilities where only seen as a cost instead of a means to get work done as efficiently and effectively as possible. But the requirements (specific aspects) were well thought of and clearly defined within the NNM-SoR. Future chances using performance based specifications are in a life cycle approach. In order to take advantage of this chance you have to formulate your requirements in a matching way and that is not being done sufficiently at the time of the project (Karreman, 2003). The performance specifications were used on a small scale holding the overall Performance Based Building targets back.

Contract specifications need to be clear to all participants and controllable to the demanding party. The way specifications can be checked is a standard problem. The fact that control is needed can corrupt the performance based idea as well as the fact that specific museum aspects were prescribed in advance. It can become laborious to create a performance specification if the demand is clearly in favour of a prescribed design solution. The "freedom" in design created by the performance specification cannot be seen separate from the contractual relationships. The fact that design and construction aspects are integrated might be a key to the success of performance-based building (Le Comte, 2003).

Best practices commentary:

Budgetary shifts were necessary in order to create the present architectural concept. The cost intensive technology which was initially thought of in cooling the storage tower had to be changed to a solution which costs less. Although both the architect and the technical advisor claimed to come up with the solution of a "cover", the technical advisor worked out the technical design solution. The innovative solution was pushed not only by a budgetary problem but also by existing codes and regulations. These guideline constraints would have resulted in cooling equipment per storage floor what would have been a highly costly solution to support the architectural quality of a storage tower. Fact is that the solution was created in cooperation between architect and advisor within the contractual situation as it was.

Because the collection consists mainly of stuffed animals, and therefore organic material, there are extremely strict climatologic requirements. A permanent and constant dampness is needed for instance. These constraints demand for a specific technical solution and no sunlight. The high physical demands would need a cooling and heating system for approximately 22.000 m^3. A highly expensive installation would be the consequence using a traditional solution. That is why the project strived for a different approach. Because it is a totally closed tower they chose to condition a 6 centimetres cavity. The cavity between isolation and concrete structure is divided in zones of 60 centimetres wide and clustered per pair. On the ground level the air is conditioned, cooled or warmed. The amount of air, which needs to be conditioned using this solution, is only 270 m^3. The concrete structure buffs the last fluctuations in air temperature. Although the circumstances for innovative solutions were supported by the Design & Build contract, the innovative solution cannot be excluded as a product of traditional processes according to the technical advisor (Le Comte, 2003). In a traditional process different parties will try to look for economical better fitting solutions than the ones prescribed. Innovation is not excluded from a traditional process, according to Le Comte.

Conclusions:

Benefits:

Clear description of technical performances

By redefining the demand in performance specifications the client (and RGD on behalf of the client) is not forced to spend time on defining design solutions. The time spend on creating performance specification was handed over to an external advisor. The goal of a uniform starting point (document) of the definition phase was achieved and control over quality was given an instrument instead of handing over all liberty to the supplying parties.

Facilitating innovative solutions

The way performance specifications were described in this case is not the best example of "solution-unbound" demand. The specifications have a focus on contractual proof, instead of a guideline to the advisors and architect. These performance specifications can be experienced as prescriptive by the advisor (Le Comte, 2003). The integral contracting facilitated product innovative solutions. In this case the Design & Build structure made it possible for budgetary shifts to occur and architectural design decisions to shift as well as a result of the performance contracting approach. The Statement of Requirements and the building costs were separated and limited the risks from a cost and quality point of view.

Setting a basis for quality?

The performance document states a basic quality level and has the benefit of steering and controlling the autonomous operating manager on the project (van Zanten, 2003). If supplying parties are contracted directly by the RGD the focus on quality has a high priority regardless of the project managers' influence. In this case the architect and advisors are placed under contract of the developer resulting in a lesser focus on quality and stronger focus on costs and time (Le Comte, 2003, Dijkstra, 2003).

Bottlenecks:

The Performance specifications are limited.

Performance specifications in this case do not cover the whole building because of the specific processes which are housed in the museum. Creating performance specifications takes time and progressive insight. Regarding laboratory aspects and the unique features of the design it might not be worth the effort of developing performance specifications. Performance specifications do not fit a one-time project.

Setting a standard for quality?

The performance document states a basic quality level regarding standardized aspects. Office space requirements were formulated in a performance based way. Despite the years of experience in development of performance specifications, the quality depends not only on the described requirement. If budgetary cutbacks are made, the control over quality lies in the process and no longer in the requirements. The specification or requirement does not come first anymore despite the contractual characteristics. A design process might be too dynamic and too many changes occur to focus on contractual aspects of performance specifications.

Focus on the end user.

Despite the small amount of performance specifications within the overall Statements of Requirements, the focus on end user could have been facilitated by a collaborative process. The project was not new to the participants in its focus on combining knowledge. The bottleneck is the way combined knowledge is used. In this case, it made the architectural design decision to use a tower as storage space and it made budgetary shifts possible. But is this the focus on the end-user Performance Based Building is aiming at? No doubt this project was a success regarding the innovative solution, but did the end-user have any gain? In order to aim on users' needs performance specifications and methods of performance-based briefing need to be developed more extensively.

Involvement of Facility Management.

The RGD Facility Management, as well as Naturalis Facility Management, think they can add value to the projects assessment, if both disciplines are involved more. The knowledge of both disciplines can be used to prevent misfits from being made as a result of bad assessment. By integrating the Facility Management knowledge in an early phase of the project it is more likely to steer on the outcome and translate the end-users experience trough the "interface" Facility Manager. The costs made in the phase of use in this project were mostly passed on to the owner (RGD) or the user organization NNM. Thus the demanding party has major interest in involving operational knowledge in the building process.

4.1.3 Case 3a: CBG Roosendall

General Information

Case Study No: 3a

CBG Roosendaal

Organization Details

Organization type:

Client Rijksgebouwendienst, Directorate South.

Project developer: Hevo Projekt Bouwmanagement B.V.

User: Tax Department Belastingdienst Roosendaal

Investor: ABN AMRO Onroerend Goed Lease B.V.

Conceptual Architect: Hoogstad Architecten

Final Architect: Bureau Bouwkunde

Contractor: B.V. Bouwbedrijf van der Linden

Advisor: Sweegers en De Bruijn B.V.

Organization name:

Central Tax Department Roosendaal

Organization contact name:

Mr. Frans Nootenboom

Organization sector:

Public sector

Organization location:

Mill Hillplein 1
4701 BS Roosendaal
PO. Box: 90121
Telephone: 076 – 530400 Fax: 076 - 5281804

Project phase:

Use

PBB focus:

Performance Based Building focus on contracting in an early phase of the project and integrating design and build capabilities through a development contract.

PBB focus regarding requirements:

Security and flexibility, the need for buildings that conform to market

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Rijksgebouwendienst

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2500 EZ The Hague, The Netherlands

Project Details

Procurement routes:

New build – Integrated contract (development contract)

Project title:

Central Building Tax Department Roosendaal

Organization contact Information:

Mr. Frans Nootenboom

Tel: 076 – 5304100 Fax: 076 - 5281804

Project date and value (approx):

Total Investment Costs: 10.181.930 Euros

Building Costs: 6.017.708 Euros

Project start: 1994

Project delivery: 1996

Project location:

Mill Hillplein 1

4701 BS Roosendaal

SoR documents:

- Standard Statement of Requirements Tax Department;
- Building bound Requirements Tax Department;
- Performance specifications RGD.

Selection Criteria/ Unique PBB aspects of this project:

Procurement and tendering was based on demand performance specifications which where the tender documents. Based on performance offer specifications the project was granted to the developer.

Date /version: 28-09-2003, Final

Case Study Detail

Case Study Contents Summary (Key points):

Process evaluation

- SoR development;
- Building process (interviews);
- Use phase evaluation (interviews).
-

Product evaluation

- Use phase evaluation (interviews);
- Post occupancy evaluation (observation).

Case study key words:

Statement of Requirements, Performance contracting, Performance Specification, Performance offer specification.

Case study document refs:

- SoR documents Central Building Tax Department Roosendaal
- Contractual documents Central Building Tax Department Roosendaal
- Additional project documentation
- Lecture HEVO Project *Bouwmanagement TUD*, 21st of January 1994.
- Spekkink, D., *Analyse Best Practices Innovatief Aanbesteden*, Rijksgebouwendienst, 2003.
- Vervaart, J., Fraikin, S., Interview: *Roosendaal CBG, Facility Management RGD*. 23-06-2003.
- Wijkhuizen, P. Interview: *Roosendaal CBG, Projectmanager RGD*. 20-05-2003.
- Zanten, van H., Interview: *PeBBu, advisor/expert*. 27-06-2003.
- Nootenboom, F., Interview: *Roosendaal CBG, Local FM/user*. 22-09-2003.

Case study website refs:

- http://www.rijksgebouwendienst.nl
- http://www.bureaubouwkunde.nl/project.html
- http://www.hoogstad.com
- http://www.Hevo.nl

Project Description

Project summary:

The Central Building Tax Department is one of the largest buildings in Roosendaal. The building is designed by Jan Hoogstad, a well known Dutch architect who was related to the project as a conceptual architect. The project is part of the urban renewal plan of the Mill Hill square in front of the building. The building has two large glass atria at the Laan van Brabant side, an important traffic vain through the hart of Roosendaal. The glass facades have given the building an open character. The atria can be seen as a trademark of Hoogstad who has used these architectural characteristics in an earlier public project, the headquarters of the Ministry of Spatial planning, Housing and the Environment of which the RGD is an agency. On the square side the Tax Department building is mildly curved and is projected against a higher part of the building. The brick materialization is in connection with the building next to the Tax Department. Underneath the square and the building a parking space is situated which is facilitated by a private (third) party. Part of the parking space is open to the public and the part underneath the Tax building is meant for the Tax organization only.

Figure 1: Roosendaal Tax Building

Background and context::

The project was delivered in 1996 and has been part of a double development contract along with the Central Building Tax Department Heerlen. The developer claimed to use the experience with performance specifications from the CBG Heerlen in the Roosendaal project and expected the project costs to benefit from the experience. Initially the RGD asked for a rental contract of five years but no financier would invest in the project because of the risk regarding the site. The location is not a prominent position in the area. The investor did not want to take the risk of the RGD to leave the building within five to ten years. The investor asked for a minimum period of twenty years for the RGD to rent the building. The alternative was a "full operational lease". In cooperation with the financier the maintenance (over a period of ten years) was made part of the rental contract. The developer guaranteed the RGD to live up to the performance level as stated in the performance specifications for the maintenance period. After a ten year period the RGD will buy the building for a 60% new costs. The realization period took 2.75 years.

Tax Department organization.

The Tax Department is part of the Treasury Department. The Tax Department organization consists of taxation and customs, facility centres and investigation service. The executive organization consists mostly of taxation and customs per region supported by a management team.

The amount of functional floor space is 7.531 m² (7.241 m² office space and 290 m² archive space) according to NEN 2580 or 6.856 m² rentable floor space and 9193 m² gross floor space. According to the contractual documents the ration rentable space/ gross space is 87 %.

Key objectives of project::

Overall project goal:

Re-house the Tax Department organization.

Key objectives regarding design:

Main goals of the development project are:

- A flexible building;
- In compliance with Tax Department security norms;

- Integrating contractors' knowledge.

Key objectives PeBBu:

Using Performance Based Building to integrate design and realization knowledge within the building process and to be able to involve the contracting parties in an early phase of the project in order to save costs and add value within the product.

The PeBBu strategy was initiated by the management of the RGD. Also the internal organization responsible for housing the Tax Department was keen on new ways of procurement and additional goals of PeBBu in general (Wijkhuizen, 2003).

Key constraints of project:

SoR Focus:

Focus within the Statement of Requirements on 'Internal requirements Dutch Tax Departments' concerning security and separation of organizational occupants and public visitors.

Project development:

The Central Building Tax Department Roosendaal was part of a development contract for two buildings along with the housing of the Tax Department Heerlen. The developer HEVO claimed to be capable of making an economically better project offer based on the experience of working with performance specifications. HEVO project was responsible for total development of the project including the search for a financier/investor. Eventually an investor was found after making the contract a Design, Build, Finance and Maintain contract. A guarantee towards the RGD on total building performance quality regarding a period of ten years was stated by the developer. The developer contracted a specialized advisor on building maintenance costs. Result is a financial survey over the years 1 till 10 and 11 till 20.

Contractual relationships where the following:

Between RGD and Hevo Project: development agreement

Between RGD and ABN AMRO: rent agreement

Between Hevo Project and ABN: transaction and exploitation agreement

Between RGD, Hevo and ABN: cooperation agreement

Hevo Project and third parties: design contracts, realization contracts, project financing contract, purchase agreement land, parking contracts.

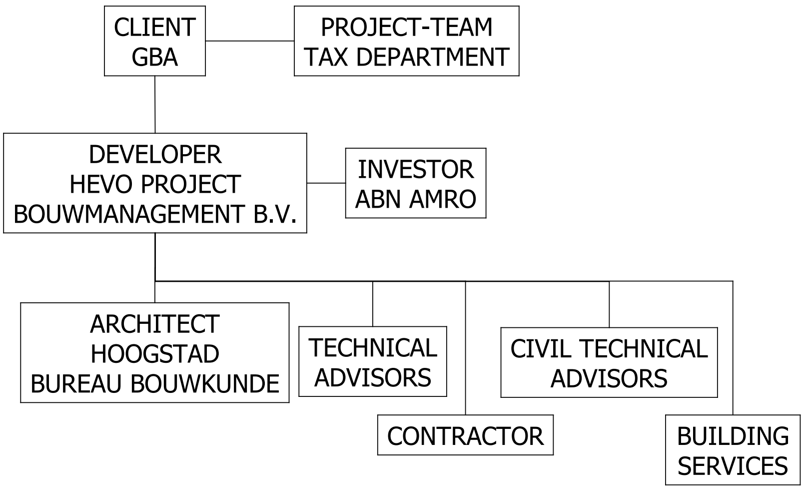


Figure 2: project organization (source: HEVO Projekt Bouwmanagement B.V., 1994)

The Statement of Requirements was created in dialogue between the RGD and the internal organization of the Tax Department responsible for housing. The Tax Department already had a standard Statement of Requirements. The RGD had a standard document containing performance specifications. In cooperation between the RGD advisors and the Project team of the Tax Department the tender document consisting of performance specifications was developed.

The RGD asked six developers to work out their offers based on the information and requirements given by the RGD. In line with the European Union legislation the contract was based on the economically best offer. The offer had to fulfil the Statement of Requirements and the performance specifications. The RGD has stated their requirements regarding the development in a tender note which were the basis for the offer specifications. After the offer was made the RGD decided on inviting the selected developer to a dialogue regarding the eventual agreement. The developer has made a total plan at his own risk. Based on the following documents: documents created by the RGD: invitation for tendering, documents created by the project developer: offer specifications and the "reaction to the specifications Van Zanten Raadgevende Ingenieurs" (report offer specifications 9th of December 1993. adjusted requirements) and numerous correspondences between RGD and developer.

The RGD is responsible, on behalf of the user organization, for the development process progress, agreements on the facilities supplied by the RGD (interior) and the assessment of the design and the building after the conceptual design, final design and realization to make sure the product is in compliance with the performance specifications. The project developer HEVO was responsible for the architectural quality and facilitating the dialogue between RGD and architect. The developer had a separate post for a supervisor. Besides quality control over the total project the supervisor was also responsible for ARBO-law (work conditions) and regulations concerning the environment. The RGD was allowed to call in assistance of the Bureau Chief Government Architect. A "structure plan", a pre conceptual lay-out created by RGD architects and the Bureau Chief Government Architect was to be developed by the architect Jan Hoogstad.

The developer bought the building site from the municipality of Roosendaal and handed over the ownership of the property to ABN AMRO Onroerend Goed Lease B.V., the owner. The RGD has a ten year rental contract including a guarantee regarding the performance quality with the owner and developer.

Project documents introduction:

The RGD used standard performance specifications and specific project related performance requirements. Spatial and functional requirements are created within the user organization in dialogue with the RGD. The Tax Department service responsible with housing developed standard performance specifications of their own as a reaction to the specifications used by the RGD which were insufficient in their opinion (Wijkhuizen, 2003).

- Project approach (CBG) document;
- Development agreement RGD & HEVO;
- Rental contract RGD & ABN;
- Cooperation contract RGD, HEVO and ABN;
- Project plan;
- Standard Statement of Requirements Tax Department;
- Performance specifications RGD;
- Performance based offer specifications HEVO;
- Project correspondence.

Focus in this case study is on performance specifications and offer specifications.

Project documents commentary:

A difference should be made between a prescriptive Statement of Requirements and a performance based Statement of Requirements which consists of performance specifications and cost group description. Together they form the overall Statement of Requirements (SoR). In the Roosendaal case most aspects of the building where captured in performance specifications. Some requirements are almost prescriptive of nature and some may seem too vague to have any contractual characteristics. In this case the performance specifications have a larger share in the Statement of Requirements than prescribed spatial requirements.

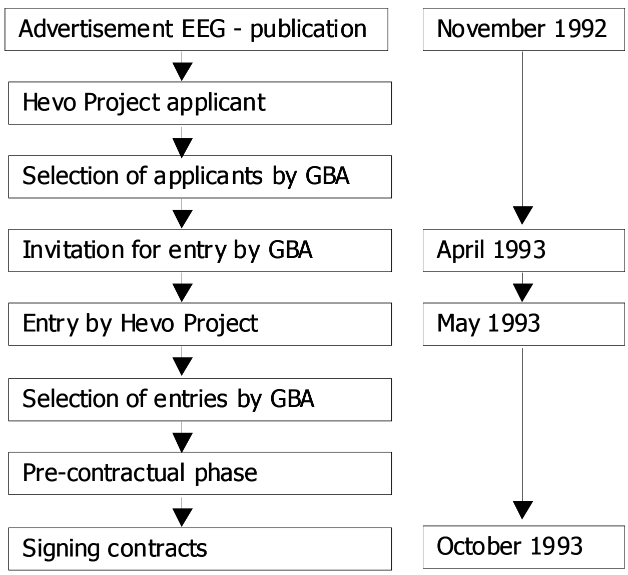
Process introduction:

Procurement and Tendering.

Procurement and tendering was based on a design concept in drawings and a scale model, performance specifications and spatial requirements. The selection of the developer was limited by a maximum number of five candidates invited for further offering. Selection criteria where:

- Experienced in similar projects;
- Requirements regarding annual turnover;
- Willingness choosing advisors in consultation with RGD;
- Completeness required data;

The process steps:



(Hevo Project Bouwmanagement B.V. 1994)

Figure 3: tender process (source; HEVO, 1994)

Content of the project offer:

Finance:

- Survey development / building costs;
- Rent offer;

- Alternative leasing;
- Insight Exploitation costs;
- Reaction to the concept development agreement;
- Plan justification architectural and urban design;
- Schematic floor plans and cross-sections;
- Outline gross floor space, net floor space and rentable floor space;
- Preparation planning and data on realization planning.

Technical:

- Technical description of construction;
- Handling performance specifications of construction;
- Handling performance specifications services.

The Roosendaal Tax Building project was developed in the early days of Performance Based Building in the Netherlands. The involvement of experts was necessary. Van Zanten Raadgevende Ingenieurs was involved as 'impartial' expert on the performance specification subject on behalf of the RGD (Wijkhuizen, 2003). The organization within the Tax Department responsible for housing consists not of experts like the RGD and is not meant to fill in the part of the RGD. Within this project this organizations is to state user wishes and demands and adjust their own standard statements. Together with architects, advisors, project management and experts they are represented within the building commission (figure 4). Requirements have been developed by the RGD in consult with the Tax Department taskforce in brainstorm sessions. The standard Statement of Requirements of the Tax Department is adjusted to the specific building circumstances in dialogue with RGD advisors. These justifications have been conferred with RGD and debated up until the requirement matched the user wishes. The involvement of the end-user was limited and end-user participation was focused more on the design selection (Wijkhuizen, 2003). The standard Statement of Requirements used by the Tax Department organization was not performance based at the time of the Roosendaal project. The transformation of performance specifications as part of the Statement of Requirements and the offer specification took place between building commission and the supply side task commission. The Building commission was contractually in the position to consult with the task force and design team members on a realization level.

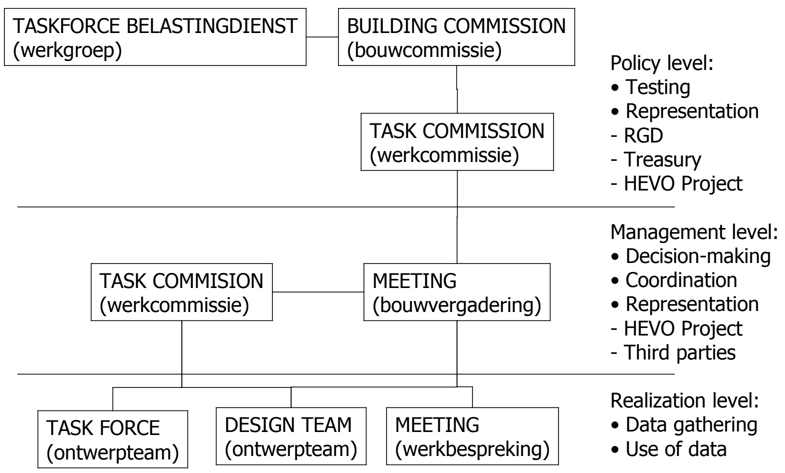


Figure 4: communication structure Roosendaal/Heerlen Project (source; HEVO, 1994)

Concept and final design.

The RGD architect (J.J. Wijfels) has given design suggestions related to the Statement of Requirements as guideline for the architect during definition. Selection of the architect is a task of the Chief Government Architect which is responsible for the architectural quality of the building and its surroundings. Hoogstad was selected as the conceptual architect and was meanly concerned with aesthetic and functional design. His experience with performance specifications in this project is nil (Hoogstad, 2003). During the conceptual phase the user organization was able to assess the design and learn from advancing experience. Based on the concept and functional requirements procurement and contracting took place. During the conceptual phase the user organization was able to assess the design in cooperation with the RGD. Based on the concept, a scale model, the spatial Statement of Requirements and performance specifications procurement and contracting took place. As the final architect Bureau Bouwkunde was selected. Bureau Bouwkunde transformed the conceptual design into a final design in dialogue with Hoogstad. The offer specifications were then already made by the supply side and most technical aspects of the building were stated.

Realization.

During realization there has been continued control as a result of interim verification moments. These checks should prevent for both client as well as developer future misunderstanding regarding the interpretation of performance specifications. Control on realization by the contractor has been a task of the developer. The RGD was responsible for user-meetings regarding information on the development of the project, agreements about RGD input (for instance the built-in aspects) and assessment of the offer to the demand specifications after various phases (concept, final design, realization). The supplying parties had contractually agreed upon the RGD being able to have contact with all parties involved and contracted by the Developer. The RGD hoped to gain control over aspects on a lower project level in order to have influence on the total supply side and not being totally dependent on the project developer.

Project process commentary:

Procurement and tendering.

Procurement and tendering was based on the performance specifications made by the RGD, conceptual drawings and a scale model made by Hoogstad and a spatial Statement of Requirements. The only party who made a bid based on textual offer specifications was the selected project developer. The Roosendaal project was also offered within the budget. Total costs for the tender procedure was 90.900 Euro and were made by the project developer. These costs are a risk taken by the supply side because there was no guarantee of getting the project or a proportionally compensation in compliance to the investment. After selection the developer felt forced to agree upon one-sided agreements stated in the contract. Because of the investment, the developer felt forced to stay in the process. Fortunately the result was satisfactory (Spekkink, 2003). The project developer doubts that he will be working this way again because of these risks (Jaskulak, 2003).

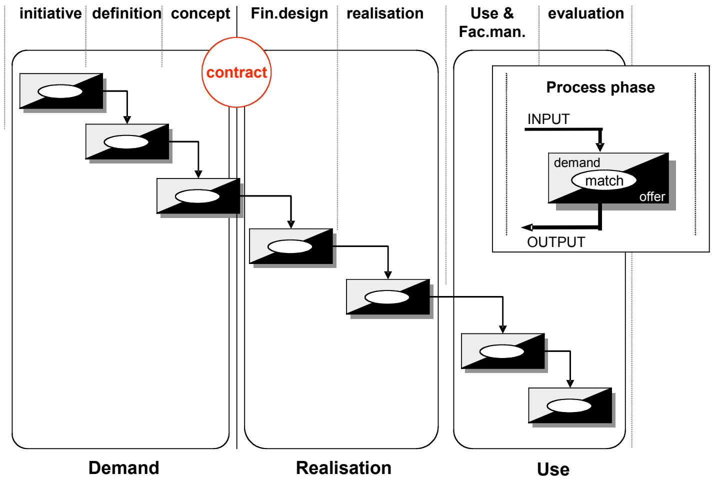


Figure 5: process; "Contract moment"

Definition.

HEVO added a statement of the prescribed measurement methods regarding the amount of rentable floor space based on a RGD norm. Assessment is done by different departments of the RGD, the architect of RGD-directorate south and the Chief Government Architect. This is stated within the contractual documents. According to Project Manager Wijkhuizen (2003) the method of measurement was not sufficiently described at the time of project definition. As a result the measurement took place in a laborious way leading to frustration at the side of the supplier who had attracted a third party advisor on building services. Analyses of the SoR documents confirm these statements.

Concept, final design and realization.

The project developer in the Roosendaal case was depending upon profit by primarily development. If the developers goal is to gain profit from development the fee of the developer related to the total set up is much more sensitive. The contractor has a wider range of possibilities to handle the profit (Wijkhuizen, 2003). This fact can make the dialogue between demand and supply more complicated than in the case of a developer who uses just development in order to gain work. The project management prefers project developers attached to a contracting organization.

During design development and realization there was continues argument between demand and supply about the performance specifications. If a solution was offered the demand side wanted to know if there were any other possibilities (Spekkink, 2003). The offer specifications were not contractually "watertight" so the demand side was in the position to steer the offer.

Verification/evaluation/assessment/measurement/audit process:

The assessment of the buildings performance (2003) is based on interviews with participants (Facility Managers of the RGD and the user organization). Aspects of dissatisfaction are a mixture of construction failures related to technical mistakes and problems as a consequence of failing specifications, evaluation/assessment and checking/testing. There have been several problems with the climate control. After renewing the building services only one room within the building copes with climate problems.

1) Functionality and serviceability of the building and maintenance.

Requirement:
Functional
Space

Maintenance
Code: F.85.00

The exterior and interior of the building need to be realized low on maintenance costs. Materialization and design details need to take into account cleaning possibilities.

Technical
Elements
Maintenance
Code: T.114.00

The facade and the glass of atria, glasshouses are reachable for maintenance work conform safety regulations according to the ARBO-law. At a building height of 9000 mm or more or if the shape of the building shuts out other methods, a installation needs to be placed for façade cleaning and maintenance.

Conformity

These requirements as a base for further plan-development. Façade lifts need to meet prevailing laws (labour inspection publication P120 "moveable scaffolding).

Functionality and serviceability:

The glass cleaning installation was not allowed to be placed on the inner side of the atria. Hoogstad, the architect, did not want the installation to be placed because of visual quality (Nooteboom, 2003). The rail for attachment is present by the way. Once a year a tower wagon is brought in to clean the glass. All this on RGD expense.

Assessment of these requirements had to be executed in all phases. Apparently the architect's vision on the aesthetics of the building is able to overrule the functionality and the performance specifications. Fact is that the glass will be cleaned, meeting the requirement, but it is a concern of local facility management instead of an integral solution in the design. The requirement is being fulfilled, but not by the design itself. As a result the solution is a costly one. The requirement should state more about a solution or should be able to oblige the architect to come up with an integral solution.

2) Missing elements can disrupt the functionality and serviceability of the building.

Requirement:
Functional
Space
Maintenance
Code: F.85.00

T ior of the building need to be realized low on maintenance costs. Materialization a to take into account cleaning possibilities.

Functionality and serviceability:

The outside of the glass facades need to be cleaned with a tower wagon because the rail around the building to install a cleaning installation is not present above the glass façade parts. Working with a wagon is a problem because the ground in front of the building (2 meters from the building facade) is owned by the municipality. A heavy wagon can easily damage the shrubbery or get stuck in the mud in times of heavy rain.

It is not clear what decision and who's decision it was that causes the rail to stop above the glass facades. Fact is that there is no possibility in the present situation to use the façade lifts to clean the glass.

3) Routing and measurements can be an obstruction to the level of functionality of the building.

Requirement:
Functional
Space
Spatial aspects
Code: F.45.00
For the benefit of internal transport the doorways of "transport routes" (hallways, archives, canteen, computer room, etc.) a free passage need to be minimally 1200 mm width and 2100 mm high.

Internal transport: The following spaces need to be easily and quickly reachable from the unloading bay: the doorways (frame) needs to be adjusted to transport of goods (width 1200 mm, height 2100 mm), this adjusted doorways will also be placed in:

First aid room;

- Archive;
- Canteen;
- General workshop;
- Printing room;
- Mail room;
- Central computer room.

The spatial design of the hallways needs to meet the previous requirement. If a staircase is part of a "transport route" the previous is also applicable. Structural transport of goods needs to be prevented in the public areas and employee workrooms.

Functionality and serviceability:
The routing in the building is far from practical. Because of fire compartments almost all doors have door-closers attached. Regarding internal transport too many doors have to be passed in an unpractical way. The main reason is the position of the service elevator on only one side of the building. The elevator itself is a problem as well because of the measurements of the hallway in front of the elevator access. When the elevator doors are opened in order to get goods in or out the goods can no longer pass through the hallway. The elevator is blocking itself. Pallets have to be transported through the public entrance and lobby.

In practice the requirement is not able to prevent physical damage to the hallways, doors and building parts which stick out. The lift cannot fulfil the needs of local facility management because of the hallway measurements. Instead of prescribing measurements within the requirement the description could concern damage and a forward view on use.

4) The building sanitary facilities do not match the needs for cleaning processes.

No specification found

Functionality and serviceability:

There is too little space for cleaning support. On every floor the sinks within the toilet rooms have been modified in order to support cleaning activities. This way cleaners no longer need to move vertical in order to reach a place for cleaning support as it was before adjustments.

5) Faults in realization have costly effects and result in obstruction in use.

Technical
Building
Buildingtechn. + Building physics
Code: T.4.00

The building envelope, including crawl space etc, need to be watertight conform NEN 2778

- Assessment of this specification from realisation up to and including use.

Technical disabilities:

Leaks occur in the parking space below the building. The reason is probably a dilatation joint which allows water to come through. In times of heavy rain, pools can be seen on basement floors. The problem is a long term one because of the position of the leak. Underneath the leak numerous pipes and shafts go through which makes an intervention costly.

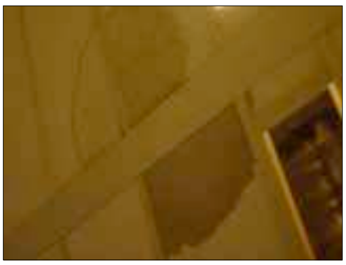
The issue concerns a mistake made in the realization according to local facility management. The specification cannot be blamed and probably the assessment neither. What can be learned is the influence of realization faults on the phase of use. Because of the critical position of the leak and the fact there are arguments about who to blame the hindrance towards users stays. Crucial design aspects should be looked at in advance (Nooteboom, 2003).

6) General requirements regarding water and moisture are not met.

Technical
Elements
Buildingtechn. + Building physics
Code: T.55.00

To prevent damage to the building structure moist accumulation, for example as a result of condensation, may not occur in or around building parts (elements), structure, pipes, etc.

Technical
Building
Technical and aspects regarding building physics
Code: T.3.00
…
Local leaks are to let through a maximum of 0.5 l/m^{1}s per 100 mm.



Technical disabilities:

Leaks have occurred in the main computer space which requires strict climate control. Moisture is a problem within this space and computer installations had to be covered several times to avoid damage.

The specifications described above are not covering the misfit. If the demand wants the specification to be contractually "watertight" it might be worthy to describe specific facilities and specific needs. On the subject ‘security’ this is being done.

7) The functionality of the parking facilities does not fulfil the user’s needs.

No specification found

The practical solution of sharing parking space between private users and the Roosendaal Tax Department organization is handed over to the supplier (project correspondence and contracts).

Functionality and serviceability:

The parking space is owned by a private party who opens the rented (Tax Department) part for public after work hours. Employees of the Tax Department who need to do overtime have to report this to the private owner. This is a practical problem. Because of the special security requirements of the Tax Department the employees who park their cars underneath the building need to pass double security systems.

This issue concerns a practical imperfection for the end-users but cannot be blamed on lack of specifications or insufficient assessment. The solution was to be found within the dialogue between the Tax Department, RGD and the supplying parties. It might be possible to state these requirements as a guideline for the developer on the level of serviceability. This example shows the position of performance specifications and the level of use. Performance specifications were merely used to indicate technical building aspects instead of a focus on the end-user and the level of serviceability.

8) Climate requirements are not met throughout the whole building.

Technical
Building
Working conditions
Comfort
Code: T.36.00

In compliance with the ASHRAE Standard 56-1981 50 and the NEN-ISO 7730, the following marginal values for asymmetrical radiation are needed:

- As a result of ‘heated sealing’: lower than 5° C difference towards a small horizontal surface at 0.6 m height above the floor.
- As a result of a window or other cold surface: lower than 10° C difference towards a small vertical surface at 0.6 m height above the floor.

Technical
Building
Working conditions
Comfort
Code: T.37.00

The minimal surface temperature of floors during work hours needs to be between 17 and 19° C. During a maximum of 30 hours per winter the surface temperature is allowed to be between 15 and 17° C. The surface temperature may not exceed 29° C.

Building physics:

Only one room in the building has had complaints regarding the climate. In the winter the room does not need any heating but in the summer the temperature rises far above a pleasant temperature. Extra cooling has been placed but still is not sufficient.

Climate complaints where a major issue right after project delivery. All building services were revised and tuned again. Complaints were eliminated except for one room. Fact is that climate requirements are not met within some areas. The example can only validate the enormous effect on costs the building services have. A problem might be that the rigid specifications will trouble the supplier concerning the risks of mismatches and the money spent on advisors.

9) Spatial requirements do not always match the user's process.

No performance specifications found. Subject is related to the Spatial Statement of Requirements.

Functionality and serviceability:
The atria are only used for climate characteristics, but not in a functional manner. Because of a lack of storage space the user organization uses the atria floors as storage space.

A shortage of storage space is a common problem according to local facility management. It is not clear if the lack of storage space is a misfit within the spatial demands or a clear decision made in the definition phase. It seems the costly square meters within the building are commonly intended for work use instead of storage. The fact local facility management needs extra space in order to cope with storage needs as a result of internal movements or reorganization may indicate the misfit should be taken into account in future projects. Although the initial investment in storage space might seem costly at project start, the functionality and serviceability is depending upon sufficient spatial requirements. The demand should not have to be integrated within performance based statements but could be taken into account in the spatial Statement of Requirements.

10) Vandalism needs to be taken into account within the design.

Requirement:
Building
Buildingtechn. + Building physics
Code: F 27.00
The façade of the building needs to be finished in such a way pollution as a result of graffiti can be prevented to a minimum and can easily be restored in case it does appear. Parts of the building which are situated within a zone sensitive for vandalism need to be suitable detailed and materializes.

- Assessment of this requirement in all phases including use and maintenance.

Functionality and serviceability:

As a result of vandalism glass windows on the square side of the building are broken numerously. Once or twice every month, damage is done to the building. The glass is not standard and has to be made or ordered specially. Nowadays the supplier has the construction drawings of these components in order to save time on replacement. The fact all windows have different measurements has a price tag as well.

If the building is situated in a risky area there is no doubt it is important to take vandalism into account. Adjustments and/or repair in the phase of use are costly and can be disturbing for organization employees. Although this case shows the ability of local facility management to steer on supply the problem cannot be prevented and costs are made frequently.

SoR commentary:

Process Bottlenecks

Involvement.

User, RGD, owner and developer have different financial responsibilities regarding the building. This is usually a problem for the employee of the user organization. Costs are made in the phase of use which could be prevented in the Statement of Requirements according to the RGD facility manager Vervaart. The owner is also able to bill the demanding party for stating their requirements. A vague requirement can be costly because the RGD has to fulfil the needs of the organization. The additional charges made by additional or adjusted requirements are a concern of the RGD or the end user. The performance based requirements should be focussed upon future uncertainties. Vervaart and Fraikin (2003) state some of the examples shown in the building evaluation might have been prevented if the RGD Facility Management was involved more often. Measurement and comparison of functional capabilities of different facilities are unsatisfactory within the project processes from start to finish. To get good value from facilities it is desirable to involve knowledge from all different phases of a buildings lifecycle.

Development of performance-specifications and offer-specifications

Both demand and supply side have used external advisors to validate their specifications ("Report offer-specifications", F70.00, sound isolation, p.6). The following examples illustrate continues discussion about the performance level, the formulation and ability to fulfil demand.

Mismatches or disputes about the Statement of Requirements:
Examples from "Report offer-specifications"

1. The flexibility demand cannot be fulfilled throughout the building because some building functions have specific requirements regarding building services, like copy rooms, library, mail room. (F33.00 agreements special spaces, p. 4)

2. HEVO states to make additional calculations because the internal warmth assumptions at project offer were set on 35 W/m^2 and not the 44 en 55W/m^2 which was asked for. (F65.00, comfort, p. 5)

3. HEVO states to prove the energy performance norm are meeting requirements (as part of the performance specification) in a later stage by calculation (T13.00, energy performance norm, p. 6)

4. RGD stated the assumption that the developer will fulfil the performance requirements even if the offer specification does not explicitly tell so. (Appendix subject of discussion 20-10-93, F73.00)

5. "Two installations per building unit need to be placed otherwise the demand specification will have no effect. An opportunity for savings is hidden in the clustering of installations which, if not functioning, will be operational for 50% (Appendix subject of discussion 20-10-93, T68.00, Heating and Cooling installations)

In conclusion there is stated that the qualitative aspects are not always clear to both parties even after explaining and written clarification. When there is any vagueness or uncertainty the report claims the performance based requirements are normative and Hevo will match those requirements (appendix: "bespreekonderwerpen" 20-10-93, conclusion). Demand specifications may be unclear, missing or too rigid in the eyes of the supplier. Offer specifications on the other hand may as well be vague, missing or not fulfilling in the eyes of the demand side. Main problem is continued argument about whether or not requirements will be fulfilled.

Differences, comparison to traditional approach/method:

The following aspects of PeBBu are the main differences in comparison to a traditional building process:

- Contracting in an early phase;
- A tender consisting of full development;
- Contract includes financing and rental aspects;
- Part of the requirements is formulated in performance specifications.

Lessons learned:

Involvement.

A performance based Statement of Requirements is seen as a contractual agreement, just like a traditional SoR. When a requirement is a little vague or simply does not contain enough information and the supply side is expected to come up with alternative solutions these solutions will have a price tag, according to project manager Wijkhuizen. It is recommended by the facility/object manager to have own control over the contractor instead of all control in the hands of a developer. Innovative solutions in the construction industry as a goal of Performance Based Building should not be expected based upon a contract or Statement of Requirements. Only if the developer/contractor is confronted with a technical problem he will search for innovative solutions. "*A simple building does not ask for innovation*" (Vervaart, 2003). The role of an architect is crucial concerning innovative designs. But most architects are not interested in the contractor's or developer's involvement (Jaskulak, 2003). Control over the interpretation of the performance based requirements by the contractor is important. The role of architect is just as important. The architect needs to be able to steer the contractor in its solutions. But the architect can be a problem maker as well. When an architect has chosen a solution and a contractor claims to have a "better" solution (for all parties) usually the architect's alternative wins the debate (Vervaart, 2003).

Performance specifications and contract specifications.

The basic contract between the RGD and HEVO consisted entirely of performance specifications the way they were formulated by the RGD and Tax Department. During the development there was continued debate about the requirements. If a design solution was brought up by the supplying party the RGD project manager asked for alternatives. The supplying parties have learned first to create contract specifications before signing contractual agreements (base on demand specifications). (Spekkink, 2003). Of course the supply side admits the contract specifications cannot cover everything because of advancing insight but it helps the supplying parties to decide upon a chosen offer specification. Continued argument results in frustration on both sides. To avoid frustration and a jammed process of dialogue Wijkhuizen decided to involve an impartial advisor and "mediator" between demand and supply. Using a mediator quickened the dialogue process between RGD project management and the developer and contractor.

Innovative ways of dealing with the buildings life-cycle are not broadly-based, not by the tendering parties nor by demanding parties. Because of a missing contract for facility management the innovation and increase of functionality and serviceability of a building and its services is behind. Users, or in this case the internal organization of the Tax Department responsible with housing defined functional requirements based on process descriptions stated in a standard Statement of Requirements. Interpretation was up to the architect. A standard office space is expected and by combining the architect's role with the contractors focus on cost reduction and profit as a goal a standard office is what the user will get. Innovation on the level of serviceability was not a target within the process. Although a maintenance guarantee over a period of ten years was part of the contract, the foreseeing view on the phase of use was limited. The maintenance guarantee did not concern facility management which can become costly as a result of lack of integration as seen in this case.

Conclusions:

Benefits:

Lesser costs for the RGD in early phase of the building process.

Because of redefining the demand in the shape of performance specifications the client (RGD on behalf of the client) is not forced to spend time on defining design solutions. A contracting party can make an offer in an early phase based on previous experiences. A result is a uniform starting point (document) of the definition phase. Noted the process will always be depending on progressive insight of all participants (Wijkhuizen, 2003).

Being able to select not only upon lowest price.

Because the bid documents contain only performance specifications and spatial requirements but no traditional design the demanding party is able to choose upon most preferable offer instead of being forced to tender upon the lowest bid (Wijkhuizen, 2003).

Facilitating innovative solutions.

Performance specifications do not specially invite tendering parties to think of innovative product solutions but the key factor is the requirements are no longer a constraint by prescribing the solution. Performance specifications facilitate product innovative solutions.

Setting a basis for quality?

The performance document states a basic quality level and has the benefit of steering and controlling the autonomous operating manager on the project.

Bottlenecks:

Control over the supply specifications is a problem.

Lesser costs in early phase of the building process are disputable because of the amount of time spent on assessment by the RGD and cooperating advisors. The contractual characteristics of the specifications required remain disputable. Project leader Wijkhuizen (2003) states the performance specifications were not fully developed and gave the supplier numerous options to interpret the specifications. The supplier (Jaskulak, 2003) validates the fact the performance specifications were not consistently formulated.

Participants at the demand side want to steer the supply, meaning those participants spend a lot of time on checking up on the offer. The process architecture for Performance Based Building will only be successful, as a result of achieving the theoretical goals, if the client lets go of the urge to control.

Participants need to support PeBBu goals.

Performance Based Building sets out goals which cannot easily be achieved without the proper basis. The focus on performance instead of the solution must be integrated throughout the process. Acquired are willing participants. The people "in the field" need to step down from their traditional role of "guard" or even "opponent". The demanding party needs to trust the supplying parties to come up with a solution that is in the interest of the user. The idea of contractors and developers "sabotaging" the quality needs to be overcome. Not only needs the natural barrier between client and developer to change but also the relationship between architect and contractor. Performance Based Building asks for the participants to believe in the goals and focus on the demands of the end-users.

Setting a basis for quality?

The performance document states a basic quality level but has to deal with the bottleneck of an autonomous operating manager on the project which can still change certain aspects within the performance specifications based on his own experience. As this case study proofs the role of RGD's project leader and cooperating advisors is crucial. If the one responsible for assessment of definition and design is focused on getting what he wants instead of getting what is stated in a performance based way it is hard to have a smooth process of demand and offering.

A formal approach.

Working with performance specifications asks for a more formal approach in the process (communication). Traditionally participants could easily make arrangements during a meeting but the performance document is not suitable for that approach and makes agreements of supply solutions necessary (van Zanten, 2003). Project correspondence validates this statement. For instance, the numerous times a specification is being argued in letters back and forth between demand and supply illustrates the problem.

4.1.4 Case 3b: CBG Heerlen

General Information

Case Study No: 3b

CBG Heerlen

Organization Details

Organization type:

Client: Rijksgebouwendienst, Directorate South.

Project developer: HEVO Projekt Bouwmanagement B.V.

User: Belastingdienst Heerlen

Investor: ABN AMRO Onroerend Goed Lease B.V.

Contractor: B.V. Bouwbedrijf van der Linden

Architect: OD 205 architectuur B.V.

Organization name:

Central Tax Department Heerlen

Organization contact name:

Mr. J. Peters

Organization sector:

Public sector

Organization location:

Kloosterweg 22
6412 CN HEERLEN

P.O. Box 4486
6401 CZ HEERLEN

Telephone: 045 - 5603270
Fax: 045 - 5603150

Project phase:

Use

PBB focus:

Performance Based Building focus on contracting in an early phase of the project and integrating design and build capabilities through a development contract.

PBB focus regarding Requirements:

Security and flexibility, the need for market conform buildings.

Compiled by:

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Intern TU Delft Faculty of Architecture, Department of Real Estate & Housing

Mail address

Rijksgebouwendienst

PO Box 20952
2500 EZ The Hague, The Netherlands

Project Details

Procurement routes:

New build – Integrated contract (development contract)

Project title:

Central Building Tax Department Heerlen

Organization contact information:

Mr. J. Peters

Tel: 045 - 560 32 70

Project date and value (approx):

- Total Realization Costs (ex BTW): 8.037.270 Euro
- Net Building costs: approximately 5.603.958 Euro (plot and additional costs not included)
- Project start: 1994
- Project delivery: 1996

Project location:

Kloosterweg 22
6412 CN Heerlen

SoR documents

- Standard Statement of Requirements Tax Department;
- Building bound Requirements Tax Department;
- Performance specifications RGD.

Selection Criteria/unique PBB aspects of this project:

Procurement and tendering were based on demand performance specifications which were the tender documents. Based on performance offer specifications the project was granted to the developer.

Date/version:

19-10-2003, Final

Case Study Details

Case study contents summary (key points):

Process evaluation

- SoR development;
- Building process (interviews);
- Use phase evaluation (interviews).

Product evaluation

- Use phase evaluation (interviews);
- Post occupancy evaluation (observation).

Case study key words:

Statement of Requirements, Performance contracting, Performance Specification, Performance offer specification.

Case study document refs:

- SoR documents Central Building Tax Department Heerlen
- Contractual documents Central Building Tax Department Heerlen
- Additional project documentation
- Lecture Hevo Project Bouwmanagement TUD, 21st of January 1994.
- Spekkink, D., *Analyse Best Practices Innovatief Aanbesteden*, Rijksgebouwendienst, 2003.
- Vervaart, J., Fraikin, S., Interview: *Heerlen CBG, Facility Management RGD*. 23-06-2003.
- Wijkhuizen, P. Interview: *Heerlen CBG, Projectmanager RGD*. 20-05-2003.
- Zanten, van, H., Interview: *PeBBu, advisor/expert*. 27-06-2003.
- Peters, J., Fraikin, S., Interview: *Heerlen CBG, local FM/user*. 26-08-2003.

Case study website refs:

- http://www.rijksgebouwendienst.nl
- http://www.od205.com
- http://www.Hevo.nl

Project Description

Project summary:

The Central Building Tax Department is designed by architect Jansen of OD205. The building is situated near the Heerlen train station and is positioned on a main traffic route. The building is built in dark bricks and has alcoves at the end-facades. Steel grilles guide the visitors towards the main entrance. The interior is highly flexible and consists of open space with replaceable interior walls.

Figure 1: Heerlen Tax Building

Background and context:

The project was delivered in 1996 and was part of a double development contract with the Central Building Tax Department Roosendaal. The developer claimed to use the previous experience with performance specifications gained at the CBG Roosendaal project in the Heerlen project and expected the project costs to benefit from the experience. The investor asked for a minimum period of twenty years for the RGD to rent the building. The alternative was a "full operational lease". In cooperation with the financier/investor, the maintenance over a ten years period was taken into the rental contract. The developer guaranteed the RGD to live up to the performance level as stated in the performance specifications for the maintenance period. After a ten year period the RGD will buy the building for a 60% of new costs. The realization period took 2,75 years.

Tax Department organization.

The Tax Department is part of the Treasury Department. The Tax Department organization consists of taxation and customs, facility centres, and an investigation service. The executive organization consists mostly of taxation and customs per region supported by a management team.

The amount of gross floor space is 10.933 m^2 resulting in approximately 9290 m^2 rentable floor space (office space, horizontal routing/hallways, sanitary space).

Key objectives of project:

Overall project goal:

Re-house the Tax Department organization.

Key objectives regarding design:

Main goals of the development project are:

- A flexible building;
- In compliance with internal security norms;
- Integrating contractors' knowledge.

Key objectives PeBBu:

Using Performance Based Building to integrate design and realization knowledge within the building process to be able to involve the contracting parties in an early phase of the project in order to save costs and add value within the product.

The PeBBu strategy was initiated by RGD management. Also the internal organization responsible for housing the Tax Department were keen on new ways of procurement and additional goals of PeBBu in general (Wijkhuizen, 2003).

Key constraints of project:

SoR Focus:

Focus within the Statement of Requirements on 'Internal requirements of Dutch Tax Departments' concerning security and separation of organizational occupants and public visitors.

Project development:

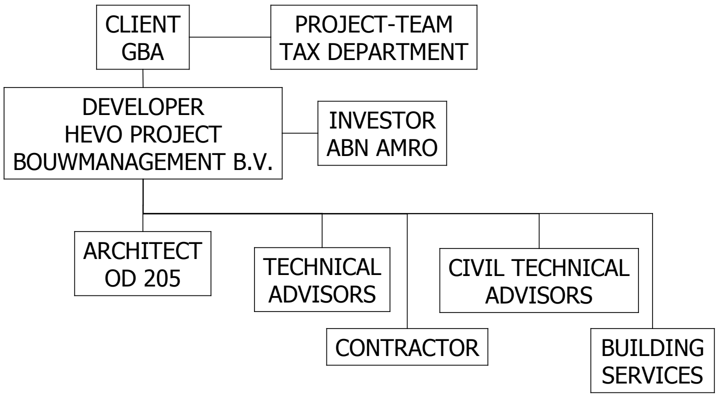

Figure 2: *project organization* (source: HEVO Projekt Bouwmanagement B.V., 1994)

The Central Building Tax Department Heerlen was part of a development contract for two buildings along with the housing of the Tax Department Roosendaal. The developer HEVO claimed to be capable of making an economically better project offer based on both projects as a result of the experience of working with performance specifications. HEVO project was responsible for total development of the project including the search for a financier/investor. An investor was found by HEVO after making the contract a Design, Build, Finance and Maintain (DBFM) contract regarding the development. A guarantee towards the RGD on total building performance quality regarding a period of ten years was stated by the developer. The developer contracted a specialized advisor on building maintenance costs which resulted in a financial survey over the years 1 till 10 and 11 till year 20.

Contractual relationships where the following:

Between RGD and HEVO Project: development agreement

Between RGD and ABN AMRO: rent agreement

Between HEVO Project and ABN: transaction and exploitation agreement

Between RGD, HEVO and ABN: cooperation agreement

HEVO Project and third parties: design contracts, realization contracts, project financing contract, purchase agreement land and parking contracts

The Statement of Requirements was created in dialogue between the RGD and the internal organization of the Tax Department responsible for housing. The Tax Department already had a standard Statement of Requirements. The RGD had a standard document containing performance specifications. In cooperation between the RGD advisors and the project team of the Tax Department the tender document consisting of contractual performance specifications was created.

According to European legislation, the contract was based on the economically best offer. The offer had to fulfil the Statement of Requirements and the performance specifications. The RGD has stated their requirements regarding the development in a tender note which was the basis for the offer specifications. After the offer was made, the RGD decided on inviting the developer to a dialogue regarding the eventual agreement. The developer had made a total plan at his own risk based on the following documents:

invitation for tendering, documents created by the project developer: offer specifications, the "reaction to the offer specifications" and numerous correspondences between RGD and developer.

The RGD was responsible on behalf of the user organization regarding the development process progress, agreements on the facilities supplied by the RGD (interior) and the assessment of design to make sure the product was in compliance with the performance specifications. The project developer HEVO was responsible for the 'architectural quality' and facilitating the dialogue between RGD and the architect. Besides quality control over the total project, a supervisor of the project developer was also responsible for ARBO-law (work conditions) and regulations concerning the environment. The RGD was allowed to call in the assistance of the Bureau of the Chief Government Architect. A "structure plan", a pre conceptual lay-out created by RGD architects and the Bureau of the Chief Government Architect was to be developed by the architectural firm OD205.

The developer bought the building site from the municipality of Heerlen and handed over the ownership of the property to ABN AMRO Onroerend Goed Lease B.V., the owner. The RGD has a ten year rental contract including a guarantee regarding the performance quality with the owner and developer.

Project documents introduction:

The RGD used standard performance specifications and specific project related performance requirements. Spatial and functional requirements are created within the user organization in dialogue with the RGD. As a result of the project the Tax Department service responsible with housing developed standard performance specifications of their own as a reaction to the specifications used by the RGD which where insufficient in their opinion (Wijkhuizen, 2003).

- Project approach (CBG) document;
- Development agreement RGD & HEVO;
- Rental contract RGD & ABN;
- Cooperation contract RGD, HEVO and ABN;
- Project plan;
- Standard Statement of Requirements Tax Department;
- Performance specifications RGD;
- Performance based offer specifications HEVO;
- Project correspondence.

Focus in this case study is on performance specifications.

Project documents commentary:

A difference should be made between a prescriptive Statement of Requirements (the Dutch PvE) and a Performance Based Statement of Requirements which consists of performance specifications and cost group description. Together they form the overall Statement of Requirements (SoR). In the Heerlen case most aspects of the building were captured in performance specifications. Some requirements are almost prescriptive by nature and some may seem too vague to have any contractual characteristics. In this case the Performance specifications have a larger share in the Statement of Requirements than prescribed spatial requirements.

Project process introduction:

Procurement and Tendering.

Procurement and tendering were based on a design concept in drawings, a scale model, performance specifications and the spatial requirements. At first only the Roosendaal Tax Building was to be contracted but, following an initiative of the developer, Heerlen was contracted as well. The selection of the developer was limited by a maximum number of five candidates invited for further offering. Selection criteria where:

- Experienced in similar projects;
- Requirements regarding annual turnover;
- Willingness to choose advisors in consultation with RGD;
- Completeness of required data;

The process steps:

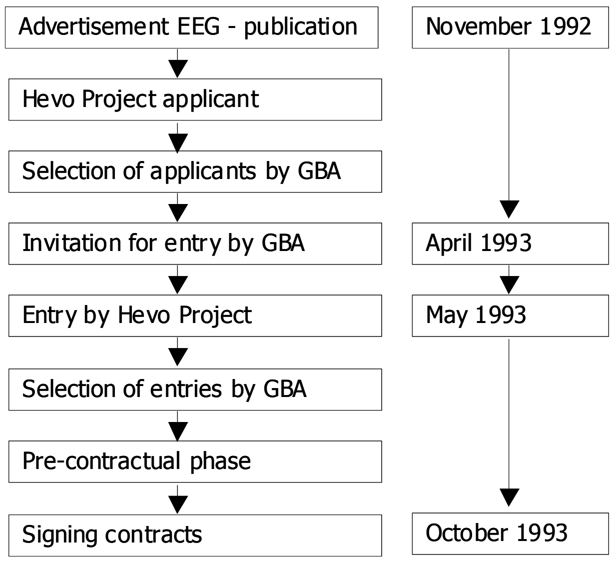

Figure 3: *tender process* (source: HEVO, 1994)

Content of the project offer:

Finance:

- Survey development / building costs;
- Rent offer;
- Alternative leasing;
- Costs-in-use - Analysis;
- Reaction to the concept development agreement;
- Plan justification for architectural and urban design;
- Schematic floor plans and cross-sections;
- Outline of gross floor space, net floor space and rentable floor space;
- Preparation planning and data on realization planning;

Technical:

- Technical description for construction;
- Handling performance specifications for construction;
- Handling performance specifications for services.

The Heerlen Tax Building project was developed in the early days of Performance Based Building in the Netherlands. The involvement of experts was necessary because of the lack of experience. Numerous advisors were involved at the demand side as well as the supply side. The Tax Department has its own separate organization responsible for housing. This organization consists not of experts like the RGD and is not meant to fill in the part of the RGD. Within this project this organization was responsible to state the user wishes and demands and to adjust their own standard statements. Together with architects, advisors, project management and experts, they are represented within the building commission (see figure 4). Requirements are being developed by the RGD in consultation with the Tax Department taskforce in brainstorm sessions. The standard Statements of Requirements of the Tax Department are adjusted to the specific building circumstances in dialogue with RGD advisors. These justifications have been discussed with RGD and debated up until the requirement matched the user's wishes. The involvement of the end-user was limited and focussed more on the design selection (Wijkhuizen, 2003). The standard Statement of Requirements used by the Tax Department organization was not performance based at the time of the Heerlen project. The transformation of performance specifications as part of the Statement of Requirements and the offer specifications took place between the building commission and the supply side task commission. The building commission was contractually in the position to consult with the task force and design team members on a realization level.

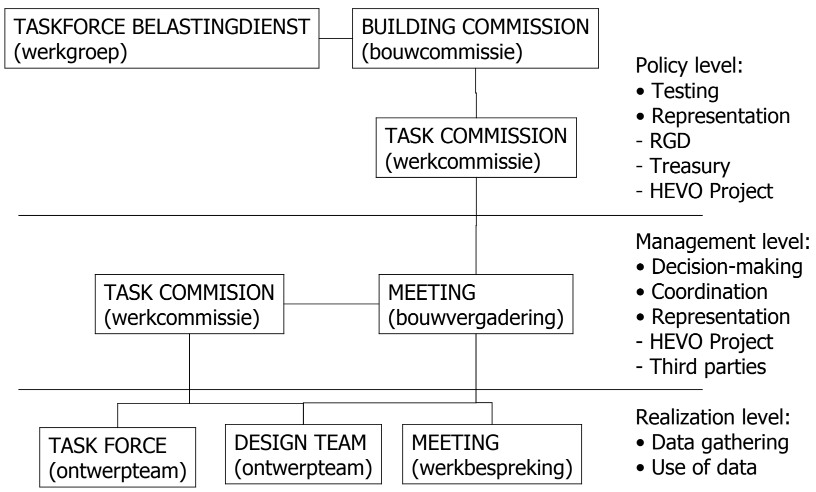

Figure 4: communication structure Roosendaal/Heerlen Project (source: HEVO, 1994)

Concept and final design.

Selection of the architect was a task of the Chief Government Architect who is responsible for the architectural quality of the building and its surroundings. At first a young bureau was selected by the Chief Government Architect but the developer objected because of the little experience the bureau had and the contractual responsibility of the developer towards the client. The objection was complied with and OD205 was selected as the architect. In later phases the Bureau of the Chief Government Architect was not prominently involved (Lim, 2003).

During the design phase the user organization was able to assess the design and learn from advancing insight in cooperation with the RGD. The offer specifications were made by the supply side and most technical aspects of the building were stated.

Realization.

During realization there has been continued control as a result of interim verification moments. These checks should prevent, for both client as well as developer, future misunderstanding regarding the interpretation of performance specifications. Control on realization by the contractor has been a task of the developer. The RGD was responsible for user-meetings regarding information on the development of the project, agreements about RGD input (for instance the built-in aspect) and assessment of the offer in relation to the demand specifications after various phases (concept, final design, realization). The supplying parties had contractually agreed upon the RGD being able to have contact with all parties involved and contracted by the Developer. The RGD hoped to gain control over aspects on a lower project level in order to have influence on the total supply side and not being totally dependent on the project developer.

Project process commentary:

Procurement and tendering.

Procurement and tendering were based on the performance specifications made by the RGD, conceptual drawings and a spatial Statement of Requirements. The only party who made a bid based on offer specifications during the Roosendaal project was the final project developer, HEVO. Because of working with just a conceptual design and performance specifications, the demanding party is able to base their selection on the "most preferable offer' instead of just looking at the lowest bid. This is a result of European Union prescripts and regulations. The Heerlen project was also offered in addition. Total costs for the tender procedure made by the project developer were 90.900 Euro. These costs are a risk taken by the supply side because there was no guarantee of getting the project or a proportional compensation in compliance to the investment. After selection the developer felt forced to agree upon one-sided agreements stated in the contract. Because of the investment the developer felt forced to stay in the process, fortunately the result was satisfactory (Spekkink, 2003). The project developer doubts of working this way again because of these risks (Jaskulak, 2003).

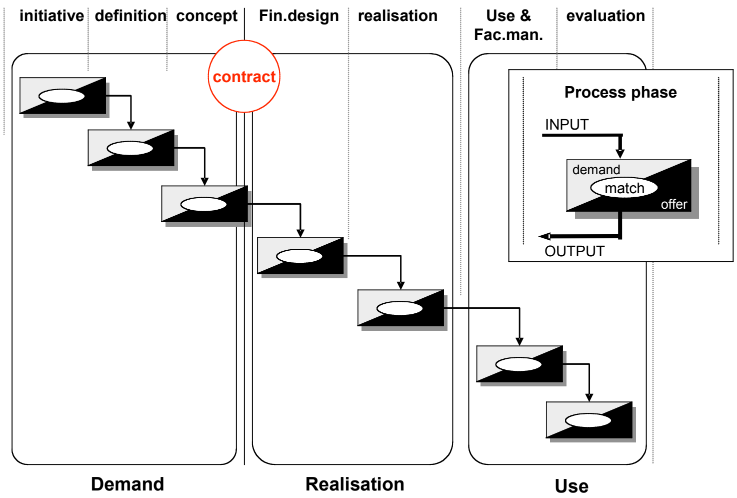

Figure 5: process: "Contract moment"

Definition.

HEVO added a statement of the prescribed measurement methods regarding the amount of rentable floor space based on a norm (RGD norm). Assessment is done by different departments of the RGD, the architect of RGD-directorate south and the Chief Government Architect. This is stated within the contractual documents. According to Project Manager Wijkhuizen (2003) the method of measurement was not sufficiently described. As a result the measurement took place in a laborious way leading to frustration at the side of the supplier who had attracted a third party advisor on building services. Analyses of the SoR documents confirm these statements.

Concept, final design and realization.

The project developer in the Heerlen case was depending upon profit by primarily development. If the developer's goal is to gain profit from development, the fee of the developer related to the total set up is much more sensitive. The contractor has a wider range of possibilities to handle the profit (Wijkhuizen, 2003). This can make the dialogue between demand and supply more complicated. The project management prefers project developers attached to a contracting organization.

During design development and realization there has been continued argument between demand and supply about the performance specifications. If a solution was offered the demand side wanted to know if there were any other possibilities (Spekkink, 2003). The offer specifications were not contractually "watertight" so the demand side was in the position to steer the offer.

Verification/evaluation/assessment/measurement/audit process:

The assessment of the buildings performance (2003) is based on interviews with participants (Facility Managers of the RGD and the user organization). Aspects of dissatisfaction are a mixture of construction failures related to technical mistakes and problems as a consequence of failing specifications, evaluation/assessment and checking/testing.

1) Exterior surfaces and pedestrians.

Requirement:

No specification found on safety of surfaces (neither in prescribed SoR documents nor in Performance specifications)

Safety:

The entrance ramp as well as the elevated parts in front and the back of the building are made of natural stone without a coating for pedestrians to have a grip as they walk on it. People were losing their footing in the early days of use when rain had made the surface wet. An antiskid coating has been added to guarantee the safety of clients and employees who enter the building. The specific security requirement was not prescribed within the Statements of Requirements. Half of the initial costs for adjustments were made by the owner who was obliging towards RGD. The other half and future investments are charged to the RGD.

Safety issues can easily be described within the performance specifications in addition to all references to standard safety codes. Using the performance specifications as a tool to steer the design it can help supplying parties to come up with a proper solution.

2) Measurements regarding the loading dock.

Requirement:

Functionality

Terrain

Code F.9.00

The entrance routes need to be separated for personnel and visitors.

Functional

Space

Spatial aspects

Code: F.45.00

For the benefit of internal transport, the doorways of "transport routes" (hallways, archives, canteen, computer room, etc.) need to be minimally 1200 mm width and 2100 mm high, to provide a free passage.

Internal transport: The following spaces need to be easily and quickly reachable from the unloading bay: the doorways (frame) need to be adjusted to transport of goods (width 1200 mm, height 2100 mm), this adjusted doorways will also be placed in:

- First aid room;
- Archive;
- Canteen;
- General workshop;
- Printing room;
- Mail room;
- Central computer room.

The spatial design of the hallways needs to meet the previous requirement. If a staircase is part of a "transport route", the previous requirement is also applicable. Structural transport of goods needs to be prevented in the public areas and employee workrooms.

Accessibility.

The loading dock at the back of the building is merely a door on a raised level. There had to be made several adjustments for primary accessibility at first but still the dock could not be used in an appropriate way. The measurements of the space behind the door and the door itself (on a transport route) are made too small for large goods to pass. The goods have to be transported through the main hall as additional burden. The facility does not meet transport and routing needs.

Although performance specifications are clearly defined the performance level is not met. The requirement seemed to be ignored. There have been disputes between user and architect but it makes no difference to the final product (Peters, 2003).

3) The main entrance and accessibility for handicapped.

Requirement:
Functional
Building
Spatial aspects
Code: F.25.00
The building needs to be fully accessible to handicapped excluding the detention circuit. The design needs to be of a standard which will receive a vignette of the Dutch Handicapped Council (Stichting Nederlandse Gehandicapten Raad) in Utrecht.

Accessibility.

Physically disabled people have to park at the back of the building because there is not any special parking space near the main entrance. They need to move around the building to have access as a result of missing accessibility at the back of the building. The front entrance does not have a railing for disabled people to hold on to, a clear requirement as well.

The performance specifications regarding the accessibility for handicapped are clearly defined but the performance level is not met. The Tax Department has frequently physically disabled visitors who have trouble with these misfits (Peters, 2003). Performance based specifications dealing with measurements and finishing of materials are designed to meet user demands and guarantee a safe and convenient use.

4) The glass cleaning installation is not used.

Requirement:
Technical
Elements
Maintenance
Code T.114.00

The exterior facades and facades of greenhouses need to be reachable for technical maintenance and cleaning procedures on a justified safe manner in compliance with the ARBO-Law. At a building height of 9000 mm or more or in case of special exterior shape there is no other method appropriate, there need to be an installation present to support façade maintenance. Exterior lifts need to meet the safety prescriptions (Labour inspection publication P120 "moveable hanging-scaffolds").

Functionality and serviceability:
The cleaning facilities for window cleaning are looked upon as dangerous by the cleaners. They are not willing to use the installation so cleaning has to be done with cranes. RGD is responsible to pay the cost to facilitate this way of cleaning.

Life cycle costs still have a predictive role within the statement of requirements and the contractual agreements. The example shows the fact there has not been paid enough attention to the cleaning facilities. Additional costs are usually paid by the user organization or the organization responsible, the RGD. This shows costs in the phase of use are based on the design phase. This fact should validate the need for knowledge integration in an early design stage.

5) The building climate is in need of moisturized air.

Requirement:
No specific specification found for workplace humidity level.
Only:
Functional
Space
Working conditions
Comfort
Code: F.65.00

The inner climate regarding office space needs to meet the Predicted Mean Vote (PMV)requirements between -0.5 and +0.5 during work hours (calculation conform NEN-ISO 7730). Maximum exceeding outside this domain:

- summer period: 150 hours
- winter period: 150 hours

When executing the TO-calculations the internal warmth load needs to be of the same value as using the

Energy-performance norms.

Agreement on:
The requirements for realization.
Hr PMV-values needs to be integrated with the design documents handed to the supplying party.
Calculating the PMV conform ISO-ISO 7730.
Calculating the exceeding hours according to the RGD-report nr. TK 11117 (April 1991).
Basis for calculations according to the RGD-report nr. TK 12010 "Temperature Simulation Programs" (September 1989). Calculating with the programs VABI 114, SUNCODE or equals as approved by the RGD.

Climate requirements.
At the time there was not any moisturizing used in workplace environment following the advice of the company doctor. A demand for moisturized air did come later on. This means costly adjustments to the building services.

Additional costs for rebuilding or other adjustments are usually made by the user organization or the one organization responsible, RGD. *"There was a mistake in the demand and the performance specification"* (Vervaart, Fraikin, 2003). Again the example shows costs in later phases are made in the design phase. This fact should validate the need for knowledge integration in an early design stage.

6) The building climate has little flexibility in capacity.

Requirement:
No specification found.
Only:
Technical
Installation aspects (building services)
Electro technical installations   Code: T.76.10

The facilities need to have a 20% reserve capacity at project delivery.
(And requirements related to misfit 5)

Climate requirements and installations.
The building climate specifications use a minimum factor without foreseeing the need for more capacity as a result of expansion of occupants and computers. In addition the installations are situated within a lowered part of the roof. Because of this position, the installations have trouble losing their heat and shut down because of high temperatures.

Often the user organization pays for additional costs. Every added occupant means exponential addition of costs. The initial decisions made can prevent the need for immediate changes/adjustments. Concerning the position of the installations, the example shows the power of an architect and his vision on architectural quality. The space created for HVAC installations, etc. is not sufficient because of the fact all heat stays within the space. Expansion or replacing installations on the roof is not allowed because of the architectural quality (visual quality) of the building (Peters, 2003).

7) Aesthetic aspects are able to corrupt the functionality and serviceability of the building.

Requirement:
No specification found.

Functionality.

The building has alcoves at both end-facades. This only concerns an aesthetic design decision. These alcoves offer a sheltered place for homeless at night. The alcoves were initially a popular sleeping area but after taking measures against the homeless by placing pyramid shaped stones the trouble dropped for a while. Nowadays the homeless use wooden boards to create a smooth surface on top of the stones (Peters, 2003).

Aesthetic decisions have effect on the shape of the building and therefore have influence on the use of the building by occupants, visitors or mere public. The Heerlen railway station has been a centre of drug related crime for years because of the geographic location of the city of Heerlen.

Specifying the issue can have effect on the way suppliers think of a future problem. If performance specifications are used to have a communicative advantage towards the architect, the specifications should be complete. The example shows the specifications need to be developed regarding use phase issues involving the urban situation. Trouble can become more than just graffiti.

SoR commentary:

Process Bottlenecks

Involvement.
The bottlenecks in the Heerlen project do have a lot of similarities with the Roosendaal project which was contracted by the same developer but slight differences should be noted. Because the complexity of the Heerlen building is less than the Roosendaal project the amount of misfits and the scale is of lesser influence to the occupants' satisfaction.

The main problem is responsibility in the phase of Facility Management just as it is in the Roosendaal project, because the same participants are involved and the same contractual agreements were used. User, RGD, owner and developer have different financial responsibilities regarding the building. This is usually a problem for the employee of the user organization. Costs are made in the phase of use which could be prevented in the Statement of Requirements according to the RGD facility manager Vervaart. The owner is also able to bill the demanding party for stating their requirements. A vague requirement can be costly because the RGD has to fulfil the needs of the organization. The additional charges made by additional or adjusted requirements are a concern of the RGD or the end user.

The performance based requirements should be focussed on future uncertainties. Vervaart and Fraikin (2003) state some of the examples shown in the building evaluation could have been prevented if RGD end-users were involved more. Although contractor, developer, architect and RGD are still involved in the phase of use, the interest cannot be seen directly in the final product. Measurement and comparison of functional capabilities of different facilities can be improved like the building evaluation shows.

To get good value from facilities it is desirable to involve knowledge from all different phases of a buildings lifecycle. The communication between architect, RGD and developer is sufficient but the amount of participants can become a burden according to Lim (2003). Integrating contracts involves a developer as "extra" party which can have influence on the amount of links the information has to go through. In addition the actual dialogue concerning the match between contract specifications and design bypasses the RGD in this case (Lim, 2003). Primarily the developer and user organization (internal housing organization Tax Department) were dialogue participants towards the architect. The role of the Bureau of the Chief Government Architect was limited in the preliminary and final design phases according to Lim (2003). The Architect's bureau has a clear vision on workplace and interior. During the design development concessions regarding this view, are made in dialogue with the user organization.

Development of performance-specifications and offer-specifications.

Detailed drawings were made by OD205 according to the bureau's policy. The reason for this is partly the control over quality. A contractor tends to steer on own experience with products and friendly suppliers (Lim, 2003). This made the final design more in favour of "quality" instead of time and costs. Nevertheless numerous differences can be found in project correspondence. The translation of performance requirements into offer specifications and finally contract specifications requires a dialogue between demand and supply. The danger lies within the fact that numerous aspects are not well defined within the final contractual specifications but remain on a level of certain freedom. "The performance level will be matched" or "The required specification will be fulfilled" (HEVO, *Offer specifications Final Design, CBG Heerlen*, 17 November 1994) is merely shifting the solution towards a later phase in the project. A later stage in the project is accompanied by a higher time pressure on the RGD project leadership which can lead to unfinished solutions. The continued uncertainty on the demand side regarding the fulfilling of requirements asks for contracting external advisors and is time consuming for RGD project management (Wijkhuizen, 2003).

Differences, comparison to traditional approach/method:

The following aspects of PeBBu are the main differences in comparison to a traditional building process:

- Contracting in an early phase;
- A tender consisting of full development;
- Contract includes financing and rental aspects;
- Parts of the requirements are formulated in performance specifications.

Lessons learned:

Involvement.

A Performance based Statement of Requirements is seen as a contractual agreement just like a traditional SoR. When a requirement is a little vague or simply does not contain enough information and the supply side is expected to come up with alternative solutions, these solutions will have a price tag according to project managers Wijkhuizen and Vervaart. It is recommended by the facility/object manager to have own control over the contractor instead of all control in the hands of a developer.

Innovative solutions in the construction industry as a goal of Performance Based Building should not be expected based upon a contract or Statement of Requirements. Only if the developer/contractor is confronted with a technical problem will he search for innovative solutions. *"A simple building does not ask for innovation"* (Vervaart, 2003). The role of an architect is crucial concerning innovative designs. But most architects are not happy with the contractors or developers involvement (Jaskulak, 2003). Control over the interpretation of the performance based requirements by the contractor is important. The role of architect is just as important. The architect needs to be able to steer the contractor in its solutions. But the architect can be a problem maker as well. When an architect has chosen a solution and a contractor claims to have a “better” solution (for all parties) usually the architect’s alternative wins (Vervaart, 2003).

If both architect and contractor are placed under a developer, the contractual arrangement can lead to a situation in which design and realization knowledge are combined, but in this case the developer had already filled out the demand by stating contract specifications. The fact that the Heerlen project is not a complex office building slows down the innovative boost (Lim, 2003). What kind of innovation are you looking for as a demanding party? Just facilitating the options and leave these up to the supplying parties to work out is not any guarantee to product or process innovation.

The demand for a market conform office building can be an obstacle for the architects’ creativity. It is all about the amount of functional floor space. The emphasis changes to different aspects of the design according to Lim (2003) when the standard office building is required. Every Statement of Requirements asks for a dialogue with the user organization because of the advancing insight, Lim states (2003) but the role of the architect changes underneath the developer. If the architect wants to make architectural changes and asks the Bureau of the Chief Government Architect for cooperation, the change is claimed to be demand through the eyes of a developer. Demand asks for an offer and additional offers cost money.

Performance specifications and contract specifications.

The basic contract between the RGD and HEVO consisted entirely of performance specifications as they were formulated by the RGD and the Tax Department. During the development phase, there was continues debate about the requirements. If a design solution was brought up by the supplying party the RGD project manager asked for alternatives. The supplying parties have learned first to create contract specifications before signing contractual agreements (base on demand specifications) (Spekkink, 2003). Of course the supply side admits the contract specifications cannot cover everything because of advancing insight but it helps the supplying parties to decide upon a chosen offer specification.

Innovative ways of dealing with the building’s lifecycle are not broadly-based, not by the tendering parties nor by demanding parties. Because of a missing contract for facility management the innovation and increase of functionality and serviceability of a building and its services is behind. Users, or in this case the internal organization of the Tax Department responsible for housing, defined functional requirements based on process descriptions stated in a standard Statement of Requirements. Interpretation was up to the architect, but the architect tried to involve the user in order to analyze user requirements in addition to the total brief (Lim, 2003). A standard office space is expected and, by combining the architect’s role with the contractors, focus on cost reduction and profit as a goal, the user will get a standard office. Innovation on the level of serviceability was not a target within the process. Although a maintenance guarantee over a period of ten years was part of the contract, the foreseeing view on the phase of use seems limited. The maintenance guarantee did not concern facility management, which can become costly as a result of lack of integration as seen in this case. If innovation regarding serviceability is a target, the contract should involve more aspects of serviceability than the “Heerlen contracts” provided.

Conclusions:

Benefits:

Lesser costs for RGD in early phase of the building process.

Because of redefining the demand in the shape of performance specifications the client (RGD on behalf of the client) is not forced to spend time on defining design solutions. A contracting party can make an offer in an early phase based on previous experiences. A result is a uniform starting point (document) of the definition phase. Noted the process will always be depending on progressive insight of all participants (Wijkhuizen, 2003).

Being able to choose not only upon lowest price.

Because the bid documents contain only performance specifications and spatial requirements but no traditional design, the demanding party is able to choose the most preferable offer instead of being forced to tender on the lowest bid (Wijkhuizen, 2003).

Setting a basis for quality?

The performance document states a basic quality level and has the benefit of steering and controlling the autonomous operating manager on the project.

Bottlenecks:

Time and money spend on "quality control".

Lesser costs in early phase of the building process are disputable because of the amount of time spent on assessment by the RGD and cooperating advisors (Wijkhuizen, 2003). The contractual characteristics of the specifications required remain disputable. Project leader Wijkhuizen (2003) states the performance specifications were not fully developed and gave the supplier numerous options to interpret the specifications with time and money as a basis.

Participants on the demand side want to steer the supply, meaning those participants spend a lot of time checking the offer. The design process for Performance Based Building will only be successful, as a result of achieving the theoretical goals, if the client lets go of the urge to control.

Participants need to support PeBBu goals.

Performance Based Building sets out goals which cannot easily be achieved without the proper basis. The focus on performance instead of the solution must be integrated throughout the process. Willing participants are supportive. The people "in the field" need to step down from their traditional role of "guardian" or even "opponent". The demanding party needs to trust the supplying parties to come up with a solution that is in the interest of the user. The idea of contractors and developers "sabotaging" the quality needs to be overcome. Not only need the natural barrier between client and developer to change but also the relationship between architect and contractor. Performance Based Building asks for the participants to believe in the goals of Performance Based Building and focus on user demands.

Setting a basis for quality?

The performance document states a basic quality level but has to deal with the bottleneck of an autonomous operating manager on the project who can still change certain aspects within the performance specifications based on his own experience. As this case study proves the role of the RGD project leader and cooperating advisors is crucial. If the one responsible for assessment of definition and design is focused on getting what he wants instead of getting what is stated in a performance based way it is hard to have a smooth process of demand and offering.

Changing the role of the architect.

Because the architect is integrated within the development contract, just like the contractor, both roles should be combined. Although communication between both parties did not lead to any problems, the incentives for combining knowledge are not present. The contractor and developer share the focus on time and costs in contrast with the architect who is focused merely on quality. This makes it difficult for the architect to move within the stated parameters. If the architect wants certain "qualitative aspects" to be involved in design solutions, he is not easily heard by supplying parties. As a result, the architect has only one place to go, the demand side. If the Bureau of the Chief Government Architect or the RGD support certain adjustments or additions in the design in order to realize added value, it will be claimed as added costs by the developer.

A formal approach.

Working with performance specifications asks for a more formal approach in the process (communication). Traditionally participants could easily make arrangements during a meeting but the performance document is not suitable for that approach (van Zanten, 2003). Project correspondence validates this statement. For instance, the numerous times a specification is being argued in letters back and forth between demand and supply illustrates the problem.

4.2 Case Study in UK

Compendium of PBB Statements of Requirements (SORs)
A Case Study from the United Kingdom Ministry of Defence
Josephine Prior PhD and Kathryn Bourke MPhil

4.2.1 Executive Summary

Introduction

Prime Contracting is about a Single Point of Responsibility to the Client, applied through an Integrated Supply Chain. Contracts are let for a 7 year period with the option of extending to 10 years. Prime Contracting relies on understanding Client needs and using Key Suppliers to develop innovative solutions in the context of a Maximum Price / Target Cost for the whole life of the facility.

Ministry of Defence – Management of The Estate

The Ministry of Defence Estate occupies approximately 240,000 hectares valued at £14 billion. The diversity of the estate is typified by the nature of the facilities such as accommodation, (service families, barracks, office and technical) as well as the activities it supports such as training, communication, storage, welfare, strategic operations etc. It also protects heritage in listed and scheduled structures and Sites of Special Scientific Interest. The Ministry of Defence manages its estate through the Defence Estates agency. Its average annual spend on construction procurement and property or facilities management is £1.4 billion (Defence Estates *Prime Contracting*.)

Procurement Routes in the Ministry of Defence

The United Kingdom Government now demands that *all (public sector) procurement must be made solely on the basis of value for money, in terms of Whole Life Costs* (HM Treasury, November 2000). This means that there is a duty on suppliers to deliver services to clear standards which cover both cost and quality by the *most effective, most efficient, and most economic* means available. While not explicitly stated, this duty also embraces environmental issues.

All major construction procurement within the Ministry of Defence (MoD), both new build and refurbishment, must be procured through either:

- Public Private Partnerships (PPP, including Private Finance Initiative or PFI);
- **Prime Contracting**; or
- Design & Build.

Prime Contracting

Prime Contracting is a procurement route adopted by the Ministry of Defence (MoD) in the UK since 1999. A trial was undertaken between 1996 – 1999 titled the “Building Down Barriers” project or Construction Supply Network Project (CSNP). This case study focuses on this pilot project and its development towards Regional Prime Contracts.

Prime Contracting is a form of Public Private Partnership and has the following features:

- No private finance;
- Publicly funded through taxation;
- Similar to Design & Build;
- Includes public and private sector joint responsibility for design development from the early stages of procurement;
- Maximum Price Target Costing;
- Includes operation and management of the facilities for a period of up to 7 years.

Types of Prime Contract

Prime Contracting projects within the Ministry of Defence fall into three major groups (Defence Estates, *Prime Contracting on the MoD Estate*):

- ***Stand Alone Prime Contracts*** are primarily those which are either complex in nature, or high in value and therefore justify having a dedicated team for delivery. Examples include new technical facilities, redevelopment of a garrison, new runways and so on.
- ***Functional Prime Contracts*** are those which identify the need for a similar item to be procured and is over the whole of the Estate. For example *SLAM - Single Living Accommodation Modernisation*, which modernises barracks blocks for single members of military personnel (Constructing Excellence.
- ***Regional Prime Contracts*** provide capital development, maintenance and management of all included assets within a broad regional area. There are five Regions in the UK, and for each region a single contract is to be let to a Prime Contractor covering all maintenance and management activities and appropriate capital works projects over a 7 or 10 year period. Major capital works (the definition of major varies) will be undertaken through Stand Alone Prime Contracts or other Public Private Partnership or Design & Build Contracts.

The Building Down Barriers Project

The key objective of the *Building Down Barriers* project and all subsequent Prime Contracts is the delivery of the required facility to the Client with no surprises on either:

- timescale,
- whole life cost, or
- performance.

The Building Down Barriers Project came about because for at least 70 years there have been client concerns about the impact on their commercial performance by the inefficiency and waste in the construction industry (Cain, 2003). The traditional Ministry of Defence procurement programme was flawed for many reasons (Andrews, 2001). These included inefficiency and waste with only 40 to 45% of spending giving rise to service delivery, and the rest disappearing to pay fees and overheads. Wherever there was no single point of responsibility, it was hampered by the number of interfaces, imprecise allocation of risk, and vulnerability to fraud and malpractice.

Once upon a time, the Ministry of Defence procured a Training Pool for the use of soldiers. The pool was duly constructed, filled with water and handed over for use. After a short time, it had to be closed for repair because the water was dirty, and the filters were thought to be to blame. During the exercise to repair the filters, the pool was completely drained. As it dried, the tiles on its surface began to fall off. When the Ministry of Defence complained to their suppliers, they were told that the tiles were never intended to be allowed to dry out. The pool should have been repaired without draining.

The filters were replaced, the tiles were replaced and the pool was refilled and re-opened for use. But soon the water was dirty again and the filters were blamed once more. When the cause was properly investigated, it turned out that the pool was being used by fully clothed soldiers, rushing in from exercises outdoors and throwing canoes into the water. No-one had told the suppliers of the pool that this is how it was to be used. Quantities of mud were regularly being deposited into the water, and this is what was blocking the filters because they were not suitable for that kind of use. The users had not communicated their real requirements to their suppliers.

In 1996 Ministry of Defence identified two pilot projects for testing the Building Down Barriers concept. These were the ***Aldershot Garrison Sports Centre*** and the ***Wattisham Sports and Recreational Facility***. Functionality was demonstrated at every stage of the design process using 3-D visualisation, which avoided the usual problem of end users struggling to understand two dimensional drawings, "*and the end users were delighted with the actual functionality of the completed buildings which exceeded anything they had experienced before*" (Cain, 2003).

Prime Contract Documents

There are six key documents to every Prime Contract:

- Core Conditions of Contract
- ***Strategic Brief (s)***
- ***Output Specification***
- Project Brief(s)
- Project Execution Plan
- Project Programme

In addition to these key documents, further documents need to be produced as part of the procurement process.

The case study focuses on the **Strategic Briefs** and **Output Specifications**. The reason for not considering the other documents is that study of these two sets shows how quickly in reality the focus of design is forced to move from a *Performance based approach* to a *Prescriptive approach*. The Output Specifications are to a great extent constrained by the imposition of prescriptive solutions in the Joint Services Publications. The Joint Services Publications constitute part of the "Mandatory Ministry of Defence Standards" which must be adhered to. The Joint Services Publications themselves are a mixture of prescriptions and performance based requirements. For instance, we have in JSP 315 Scale 39 for Service Catering facilities:

- … two 13 amp double sockets in kitchen office; … (prescriptive);
- … larders to be temperature controlled to +10 to +12^{o}C; … (performance based).

The Strategic Brief

The Strategic Brief is prepared by the Client. It is the document which conveys to the Prime Contractor the *Purpose* and the *Functional Requirements* of the new facility (Building down barriers Toolkit, 1999). Another name for it is the *Statement of Functional Needs*. The Strategic brief must contain the following:

- Client details;
- Statement of purpose, setting out client objectives to be met;
- Scope of project;
- Baseline price.

The client should consult representatives of the users while preparing the Strategic Brief. Users' views are important. They help define:

- clear patterns of usage; and
- minimum acceptable standards of building performance.

This consultation is best achieved through Value Management workshops (Hayles C et al, 2000, a,b,c, and Kernohan D et al, 1996).

The Building Down Barriers pilot project at Wattisham gives a good example of a Strategic Brief (Building Down Barriers Toolkit, 1999). The purpose of the new facility is simply described, "*The army needs to be* *able to train two regiments of soldiers on the Wattisham airfield site*". There is no mention of a new facility, only a statement of need at a location.

The next section of the Wattisham Strategic Brief then goes on to define details of users, their requirements and some data on performance indicators, including:

- numbers of soldiers in a regiment;
- numbers of women in a regiment;
- numbers of soldiers to be trained each day;
- numbers of soldiers needing showering and changing facilities;
- the ambient temperature needed in different parts of the facility;
- the training equipment required;
- the size of each item;
- frequency of use of each training item;
- etc.

There was no mention even that a new *building* was required. The Prime Contractor was able to assess the existing facility with a view to refurbishing it, and to compare that option with the possibility of demolishing the old facility and replacing it with a new one.

Nothing in this Strategic Brief constrained the Prime Contractor from considering (with help from Army Staff responsible for training on the site) any sensible option in the effort to find the best possible solution to the client's need "*to train two regiments of soldiers*".

Making the functional requirements explicit and defining terms

A Prime Contracting project always begins with a statement of the Client's need expressed as an *Output Specification*, and not in design or engineering terms. The Output Specification is a statement of requirements which says what the facility is there to do, for instance:

- house x number of people, of which y are men and z women; and
- enable a, b and c activities;
- with d aesthetic requirements.

The Output Specification should not say:

- how big the building should be;
- what shape it should be;
- how heavy a load the floor should bear.
-

Such design and engineering issues are best dealt with by a combination of members of the supply chain, each one having some specialist knowledge which the client does not normally possess, in collaborative discussion with the client's key representatives.

A design can be judged against the Output Specification as it develops, by always asking the question "does this do what the Client wants?" The emphasis on functional performance in principle minimises the all too common problem that a design, as it develops from an "outline brief" couched in design terms, becomes something that does not work for the client once it is built.

Using Value Management to establish the Client 's primary objectives

The Regional Prime Contract (Scotland) which followed the *Building Down Barriers* pilot projects used the Function Analysis System diagramming Technique F.A.S.T. (Hayles and Simister, 2000, c) to develop and express the Principal Client Objectives (Ministry of Defence, December 2001).

Output Specifications

The Output Specification for a Prime Contract has the following features:

- the aim of the Output Specification;
    - states the client's requirements in *output* terms as far as possible;
    - includes a statement of performance or quality objectives; and
    - provides information needed to propose and price innovative solutions.

- the structure of the Output Specification states:
    - aim and objectives;
    - scope;
    - **detailed requirements**.

- the Output Specification should be read alongside documents related to the particular work including, but not limited to:
    - instructions to companies tendering for work;
    - strategic briefs;
    - project management plan;
    - contract terms and conditions;
    - supplementary contracts for the specified work;
    - other documents referred to by any of the above.

The **detailed requirements** form the largest part of the Output Specification document. For the Regional Prime Contract (Scotland), they are expressed in tables. The Core Works (new build or major refurbishment) contract is under six subject headings:

A *Description* A high level statement of the fundamental objectives.
B *Function* A more detailed breakdown of high level objectives.
C *Output* A three tiered set of information for each individual *Function*:
D *Service Requirements* detailed description of *Function*;
E *Performance Standard* qualitative or quantitative measures against which performance can be judged;
F *Constraints or Relevant information*.

Statements of Requirements

Although the *Description, Function* and *Service Requirements* are very open, the *Performance Standards*, with the exception of "Fit for purpose" are often couched as if they were prescriptions. An example is "*Areas to be comparable or better than JSP 315 Scale 3, standard Z*", where JSP is the Joint Services Publication Handbook which sets out precise ways of achieving these scales and standards.

The Strategic Brief for a generic Demonstration Project to deliver and service An Officers' Mess Kitchen (Defence Estates, July 2003) illustrates clearly the tension between the need to provide an output based specification, and the need to comply with existing mandatory Ministry of Defence Standards on Kitchen Design. The Strategic Brief and Output Specification Table fill some 14 pages, including a list of 5 separate Ministry of Defence Codes, Standards and Publications, and 7 Technical Documents relating to Health and Safety and other catering and kitchen related standards. It is therefore only possible to give two examples of Output Specifications and their links to "mandatory Ministry of Defence Standards" to illustrate the point. The first of these is for an Officers' Mess Kitchen, and the second is for Officers' Mess Dining Space.

The Strategic Brief includes sections on the following:

- background for the project;
- core work aim and objectives;
- scope and background of the core work;
- constraints within which the project is to be delivered;
- Prime Contractor's interface and co-ordination requirements; and
- Government furnished details.

The "mandatory Ministry of Defence Standards" which have to be adhered to include:

- Policy documents:
- Design Maintenance Guidance (DMG) 18: Catering Design Guide;
- Other Design Maintenance Guidance publications, DMG 8, DMG 15, DMG 16, DMG 22;
- **Joint Services Publication JSP 315 Scale 39**, **29**, 40, and 46 for minimum military requirement;
- Ministry of Defence Fire Standards Manual;
- Defence Estates Functional Standards.

As an aid to clarity we will consider only a small part of the Joint Services Publication JSP 315 Scale 39 for Service Catering Facilities, and JSP 315 Scale 29 for Messes: Officers' – public rooms.

JSP 315 Scale 39 begins with a general introduction giving the scope of its application with cross references to other Scales which must also be taken into account when making design decisions. JSP 315 Scale 39 is 46 pages long, and divided into 7 parts dealing with every aspect of the provision of both accommodation and equipment relating to the preparation, storage and serving of food.

JSP 315 Scale 39, shows that the mandatory Ministry of Defence Standards are a mixture of output based requirements, and prescriptions. For instance under "temperature monitoring", we see that "a temperature monitoring system is to be provided". There is no hint as to how this should be done, or what equipment should be used. The supplier is free to meet the requirement in any way that they choose. In contrast to this under "Electric power" the demand is for "two 13 amp double socket outlets in kitchen office". This is a prescription. An output based specification would be expressed in terms of access to power to enable, say, a computer, a radio, a certain amount of task lighting, or whatever functions the office needs to support.

The Prime Contractor is thus constrained to certain prescriptive solutions at an early stage by Ministry of Defence mandatory Standards. The fact that the mandatory Standards are a mixture of output based and prescriptive statements is confusing.

If we now look at the part of the mandatory Ministry of Defence Standards which refer to dining accommodation and reception areas for Officers, the degree to which Standards are prescribed is even more stark. Joint Services Publication JSP 315 Scale 29 for Messes: Officers' – public rooms begins with a general introduction giving the scope of its application with cross references to other Scales which must also be taken into account when making design decisions. The requirements are set out in a large table:

- Accommodation
- Area
- Mechanical and Energy Services
- Planning Notes, Special fittings and so on.

The specific requirements for lighting, planning notices and special fittings are set out as follows:

Illumination:

- 175 lux entrances;
- 100 lux corridors;
- 50 lux dustbins;
- supplementary light over:
  - mirror;
  - notice boards;
  - reception desk.
- Individual light for:
  - telephone kiosks;
  - telephone hoods.

Planning Notices, Special Fittings etc.

o Planned to give reasonably spacious entry; (performance based)
o External doors self-closing; (performance based)
o Draught proof lobby; (prescription)
o One mirror, 1360 x 460 mm at each entrance; (prescription)
o Notice board and letter rack … (prescription)

In addition to the highly prescriptive specification of lighting and its distribution throughout the entrance hall, there is a prescribed requirement for a mirror of a particular size, as well as a letter rack and notice board. These prescriptions are mixed up with more output based requirements for the entrance hall such as "Planned to give reasonably spacious entry."

Conclusions and Recommendations

The Prime Contracting initiative represents a significant advance on the traditional approach to construction for the Ministry of Defence. Its main focus is on the delivery of construction quality and value through a single point of responsibility. This is achieved through an Integrated Project Team which allows it also to increase the performance basis of the initial approach to design decisions through the use of a Strategic Brief and Output Specifications. In summary:

- Application of the Performance Based Building approach is inhibited by the imposition of prescriptive "Mandatory Standards", and work would be required to remove these;
- Mixing the Performance Based approach with the Traditional Prescriptive Approach limits the implementation of innovative performance based solutions, which may be better than the traditional;
- More attention needs to be paid to match Functionality and Serviceability in the delivery of Performance Based Buildings.

4.2.2 Case Study from the United Kingdom Ministry of Defence

Case Study	**Compiled by: BRE**	**Date: 2 September 2004**
ORGANISATION DETAILS	**PROJECT DETAILS**	**CASE STUDY DETAILS**
Organisation Type: Client / owner	**Statement of Requirement Context:** Mixed – main contract	**Case Study Summary:** Review of background to and current status of Prime Contracting Initiative, including Building Down Barriers Project and current procurement.
Organisation Name / Description: Defence Estates – an agency of the UK Ministry of Defence responsible for managing the whole built estate of the Ministry of Defence	**Project Title:** Prime Contracting	**Case Study Key words:** o Cluster o Construction Supply Network Project o Detailed Requirements o Integrated Project Teams o Output Specification o Prime Contractor o Principal Client Objectives o Risk Management o Single Point of Responsibility o Smart Acquisition o Strategic Brief o Statement of Functional Needs

		○ Statement of Functional Requirements ○ Statement of Performance ○ Supply Chain Management ○ Maximum Price / Target Cost ○ Value for Money ○ Value Engineering ○ Value Management ○ Whole Life Cost
Organisation Sector: Public sector	**Project Date and Value (approx):** 2002 – 2010 £1.4 billion total annual spend on construction procurement and facilities management.	**Case Study Document Refs:** See Section 12.
Organisation Location: Across whole of UK, with responsibilities also in Germany and Northern Ireland.	**Project Location:** ○ *Building Down Barriers* in South East of England ○ Prime Contracting across whole UK.	**Case Study Website Refs:** www.ams.mod.uk www.defence-estates.mod.uk www.mod.uk www.publicservice.co.uk www.constructingexcellence.org.uk www.ogc.gov.uk/sdtoolkit www.defence-estates.mod.uk/downloads/DEEP Evaluation Record.pdf
Project Phase	○ *Building Down Barriers* projects complete and in use; ○ Prime Contracting (Scotland) contract let; ○ Prime Contracting (South West) contract let.	
PBB focus regarding Building Process	Prime Contracting is about a Single Point of Responsibility to the Client, applied through an Integrated Supply Chain. Contracts are let for a 7 year period with the option of extending to 10 years. Prime Contracting relies on understanding Client needs and using Key Suppliers to develop innovative solutions in the context of a Maximum Price / Target Cost for the whole life of the facility.	
PBB focus regarding Requirements	Client Requirements are articulated, developed and agreed using the F.A.S.T. diagramming technique, Value Management and Value Engineering.	

Compiled by:		
o Josephine Prior PhD	priorj@bre.co.uk	Building Research Establishment
o Kathryn Bourke MPhil.	bourkek@bre.co.uk	Bucknalls Lane Garston Watford WD25 9XX

1. Background and Context	**Ministry of Defence – Management of The Estate** The Ministry of Defence Estate occupies approximately 240,000 hectares (including 200,000 hectares of leasehold and 125,000 hectares of 'with use' rights) valued at £14 billion. The diversity of the estate is typified by the nature of the facilities such as accommodation, (service families, barracks, office and technical) as well as the activities it supports such as training, communication, storage, welfare, strategic operations etc. It also protects heritage in listed and scheduled structures and Sites of Special Scientific Interest. The Ministry of Defence manages its estate through the Defence Estates agency. Its average annual spend on construction procurement and property or facilities management is £1.4 billion (Defence Estates *Prime Contracting*.) According to a recent survey by Building Magazine (Issue 05, published on 6 February 2004) Defence Estates, in 2003: • ranked 5th (by total spend) of the top 25 public sector bodies procuring construction in the UK; • ranked 18th (by total spend) in the top 100 public and private sector construction clients in the UK; • ranked 3rd in the top 7 most admired public sector clients in the UK; • spent £2.4 billion on construction. **Procurement Routes in the Ministry of Defence** The United Kingdom Government now demands that *all (public sector) procurement must be made solely on the basis of value for money, in terms of Whole Life Costs* (HM Treasury, November 2000). This means that there is a duty on suppliers to deliver services to clear standards which cover both cost and quality by the *most effective, most efficient, and most economic* means available. While not explicitly stated, this duty also embraces environmental issues. All major construction procurement within the Ministry of Defence (MoD), both new build and refurbishment, must be procured through either: • Public Private Partnerships (PPP, including Private Finance Initiative or PFI); • Prime Contracting; or • Design & Build. **Prime Contracting** Prime Contracting is a procurement route adopted by the Ministry of Defence (MoD) in the UK since 1999. A trial was undertaken between 1996 – 1999 titled the "Building Down Barriers" project or Construction Supply Network Project (CSNP). This case study focuses on this pilot project and its development towards Regional Prime Contracts (see below). Prime Contracting is a form of Public Private Partnership and has the following features:

- No private finance;
- Publicly funded through taxation;
- Similar to Design & Build;
- Includes public and private sector joint responsibility for design development from the early stages of procurement;
- Maximum Price Target Costing;
- Includes operation and management of the facilities for a period of up to 7 years.

Types of Prime Contract

Prime Contracting projects within the Ministry of Defence fall into three major groups (Defence Estates, *Prime Contracting on the MoD Estate*):

- ***Stand Alone Prime Contracts*** are primarily those which are either complex in nature, or high in value and therefore justify having a dedicated team for delivery. Examples include new technical facilities, redevelopment of a garrison, new runways and so on.
- ***Functional Prime Contracts*** are those which identify the need for a similar item to be procured and is over the whole of the Estate. For example

  SLAM - Single Living Accommodation Modernisation, which modernises barracks blocks for single members of military personnel (Constructing Excellence.
- ***Regional Prime Contracts*** provide capital development, maintenance and management of all included assets within a broad regional area. There are five Regions in the UK, and for each region a single contract is to be let to a Prime Contractor covering all maintenance and management activities and appropriate capital works projects over a 7 or 10 year period. Major capital works (the definition of major varies) will be undertaken through Stand Alone Prime Contracts or other Public Private Partnership or Design & Build Contracts.

Definition of a Prime Contractor

Defence Estates (see *Prime Contracting on the MoD Estate p.4*) define a Prime Contractor as a single organisation (often a consortium) which has:

"*overall responsibility for the management and delivery of a project, using:*

- *a system of incentives; and*
- *collaborative working to:*
  - *integrate the activities of its Supply Chain members;*
  - *achieve a project that is:*
    - *on time;*
    - *within budget;*
    - *in accordance with the specified outputs; and*
    - *Fit for Purpose.*"

The Prime Contractor is responsible for:

- Sub-contract selection
- Procurement management
- Design, co-ordination and overall system engineering and testing
- Planning, programming and cost control
- Total delivery, fitness for purpose and adherence to lifetime cost predictions.

Management of Prime Contracts

To fulfil its objectives the Ministry of Defence is seeking to involve industry in a much

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o Public Private Partnership initiatives;
o “SMART acquisition”; and
o applying the principles of Prime Contracting.
Defence Estates will use Prime Contracting methods for the procurement of substantially all construction and maintenance services by late 2005. Prime Contracting projects are managed through Integrated Project Teams. The Integrated Project Team usually comprises:
o a Defence Estates project manager;
o the Prime Contractor;
o representatives of the ultimate user;
o Cluster Leaders – key suppliers from the Prime Contractor’s supply chain
o a Principal Service Provider – typically one or more multi-disciplinary consultancies;
o any other necessary technical and commercial support.</td></tr>
<tr><td>2. Key Objectives of Project</td><td>Prime Contracting is based on seven underlying principles including:
o value through competition;
o understanding clients’ real needs;
o developing long-term supplier relationships;
o integrating project activities into clusters;
o using target costing;
o implementing continuous improvement; and
o developing human resources.

The key objectives of Prime Contracting (Holti et al, 1999) are to end relationships which are:
o short-term;
o contractually driven;
o single project; and
o adversarial.

Prime Contracting will create relationships which are:
o long-term;
o multiple project;
o based on trust and co-operation.

Prime Contracting will create strategic supply chain alliances which:
o incorporate continuous improvement targets to:
  o reduce costs;
  o enhance quality;
o focus on:
  o whole life cost, and
  o functional performance.

Continuous improvement, based on a systematic analysis of the weaknesses and strengths in existing design and construction process is fundamental to prime contracting and underpins the whole process.</td></tr>
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Benefits from Prime Contracting

Benefits for the Client are constructed assets which give:

- lower whole life cost;
- more accurate prediction of:
  - annual maintenance, and
  - energy costs.
- maximum effectiveness for the activities housed within them.

Benefits for Contractors are:

- reduction in waste;
- increase in efficiency;
- improved profitability;
- non-adversarial supply chain relationships;
- greater certainty of repeat orders, and
- delighted clients.

The Building Down Barriers pilot project set some key objectives to the benefit of both Client and Contractors:

- up to 60% reduction in labour and material costs;
- 3-fold increase in profits;
- over 100% improvement in productivity;
- 18% -25% reduction in construction time;
- 10% - 14% reduction in the cost of ownership.

Not all of these were met, but they were measured and progress was made on all fronts.

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3. Key Constraints of Project

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Existing Contracts

There are many existing contractual arrangements for the supply of services which later will be supplied through Prime Contracts. These services must be maintained until the Prime Contractor is able to adopt them. This will sometimes lead to overlaps between suppliers which will need to be managed.

Supply Chain Barriers to Prime Contracting

Supply chain barriers to adopting Prime Contracting in the UK include:

- established supply chain networks are rare,
- consortia assembled for one project rarely continue beyond it,
- construction firms are used to adversarial relationships,
- construction firms rarely work closely together as a single team from the start of the project,
- construction firms make assumptions about:
  - who can usefully contribute to different stages (e.g., specialist contractors to concept design), and
  - how profits can be made (e.g., main contractors commonly make their profit on claims from the client and on retaining payments to sub-contractors for as long as possible).

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	○ there is a lack of skills for: ○ collaborative working; ○ managing the softer issues of relationships; ○ responding to Output Specifications; and ○ responding to the imperatives of continuous improvement. **Client Barriers to Prime Contracting** There is a shortage of Client skills for managing some key elements of Prime Contracting including: ○ drafting Output Specifications, ○ drafting Strategic Briefs in output terms, ○ risk management, ○ value management and ○ collaborative working. There are also financial and cultural barriers within Ministry of Defence and Defence Estates including the existing long term under-financing of the estate. Provision of operational resources for core military objectives has taken priority (e.g. soldiers not barracks). Like all government departments, Ministry of Defence has been subject to variable funding depending on the general economic climate and taxation policies of different governments. From the inception of Prime Contracting Ministry of Defence has recognised the need to compile, record and communicate the condition and priority of constructed assets across the Defence Estate, and provide a baseline for measuring improvements. This major logistical exercise has consumed a good deal of time and resources.
4. Project Development	**The Building Down Barriers Project** The key objective of the *Building Down Barriers* project and all subsequent Prime Contracts is the delivery of the required facility to the Client with no surprises on either: ○ timescale, ○ whole life cost, or ○ performance. The Building Down Barriers approach to Supply Chain Management (Holti et al, 1999) has been developed within the Construction Supply Network Project (CSNP) supported by Defence Estates, the Department of the Environment, Transport and the Regions (DETR), and the contractors AMEC Construction and John Laing Construction. It came about because for at least 70 years (Cain, 2003) there have been client concerns about the impact on their commercial performance by the inefficiency and waste in the construction industry. The traditional Ministry of Defence procurement programme was flawed for many reasons (Andrews, 2001). These included inefficiency and waste with only 40 to 45% of spending giving rise to service delivery, and the rest disappearing to pay fees and overheads. Wherever there was no single point of responsibility, it was hampered by the number of interfaces, imprecise allocation of risk, and vulnerability to fraud and malpractice. Once upon a time, the Ministry of Defence procured a Training Pool for the use of soldiers. The pool was duly constructed, filled with water and handed over for use. After a short time, it had to be closed for repair because the water was dirty, and the

filters were thought to be to blame. During the exercise to repair the filters, the pool was completely drained. As it dried, the tiles on its surface began to fall off. When the Ministry of Defence complained to their suppliers, they were told that the tiles were never intended to be allowed to dry out. The pool should have been repaired without draining.

The filters were replaced, the tiles were replaced and the pool was refilled and re-opened for use. But soon the water was dirty again and the filters were blamed once more. When the cause was properly investigated, it turned out that the pool was being used by fully clothed soldiers, rushing in from exercises outdoors and throwing canoes into the water. No-one had told the suppliers of the pool that this is how it was to be used. Quantities of mud were regularly being deposited into the water, and this is what was blocking the filters because they were not suitable for that kind of use. The users had not communicated their real requirements to their suppliers.

In 1996 Ministry of Defence identified two pilot projects for testing the Building Down Barriers concept. These were the ***Aldershot Garrison Sports Centre*** and the ***Wattisham Sports and Recreational Facility***. Functionality was demonstrated at every stage of the design process using 3-D visualisation, which avoided the usual problem of end users struggling to understand two dimensional drawings, "*the end users were delighted with the actual functionality of the completed buildings which exceeded anything they had experienced before*" (Cain, 2003).

Both *Building Down Barriers* projects have shown significant benefits for the client (operating both as budget-holder and end-user of the facility) and for the supply chain. These benefits have been in terms of faster delivery on site, improved productivity of the site workforce, improved profitability for the supply chain, reduced through-life cost for the budget holder and improved functionality of the building for the users.

The Aldershot Garrison Sports Centre yielded the following key benefits (Constructing Excellence, 2001) through good communication between the client and the supply chain:

- the Sports Centre was completed on budget and ahead of programme (by two weeks);
- whole life running costs have been established at 14% below normal benchmark costs;
- a strong culture of team work contributed to the ability to meet client needs;
- labour utilisation on site was at a very high 91.6%;
- and there was a high "right first time" factor.

Changes to procurement through Regional Prime Contracts

The nature and diversity of the construction work and services undertaken by the Ministry of Defence is such that it would be difficult if not impossible to produce a standard form of contract. A set of Core Conditions was published in May 2000. Since then, the Ministry of Defence has been committed to the development and evolution of these Conditions. Internal review, consultation with Industry at workshops and the experience of the early projects as the Prime Contracting Programme has been made available have all contributed to a process of continuing assessment by the Ministry of Defence.

	As a result of this process, the Conditions have been developed, refined and expanded. The Core Provisions are still evolving drafts, and will need to be tailored to specific circumstances. They are not therefore to be regarded as standard forms of contract. The Ministry of Defence remains committed to proceeding as an intelligent client and plans to review each project critically in order to produce a flexible form of Contract which meets the need of each particular project.
	
	Specific changes include:
	o Measurement of service performance, which continues to evolve project by project including:
	    o the continuous improvement management system; and
	    o the compliance point system.
	o Additional Core Conditions include:
	    o options for the Ministry of Defence to extend the Contract.
	    o mechanisms for the Ministry of Defence and the Prime Contractor to respond over the period of the Contract to technological developments which may have a significant effect on the delivery of the service.
	    o Regional Prime Contracts identify in more detail some of the risks which the Ministry of Defence is prepared to accept under the Contract.
	    o A Condition has been added to both the Regional Prime Contract and the Capital Works project developing the principle of contingent risk and the risk log which will be included for each project.
	    o Risk is allocated to the party best able to manage it.
	    o The Dispute Resolution Procedure has been developed further including:
	        ▪ a procedure for establishing, and composing the Dispute Resolution Board;
	        ▪ removal of conciliation as an option;
	        ▪ introduction of fast track arbitration;
	        ▪ adjudication is to be included;
	        ▪ adjudication is to be based on a privatised procedure which identifies experienced expert dispute resolution specialists.
	    o Generic Conditions have been developed to combat fraud at all levels within the Prime Contracting initiative, based on the National Audit Office Report *The risk of fraud in property management*, published in May 2000.
	
	Prime Contract evolution from pilot stage project Scotland and subsequent regions
	The *Building Down Barriers* projects were both Core Works (capital) projects. The first Regional Prime Contract in Scotland extended the scope of Prime Contracts to include the provision of Core Services (maintenance). Subsequent Regional Prime Contracts are to concentrate on Core Services, with some capital works such as extensions or new build technical facilities. They are to cover the regions known as South West, South East, Central and East.

5. Project Documents – Introduction	There are six key documents to every Prime Contract: o Core Conditions of Contract o ***Strategic Brief (s)*** o ***Output Specification*** o Project Brief(s)

	○ Project Execution Plan ○ Project Programme In addition to these key documents, further documents need to be produced as part of the procurement process. For example, Defence Estates has to produce an investment case to get approval from the Ministry of Defence to develop a contract, the Prime Contractor has to produce bid documentation in response to the invitation to tender, and the Integrated Project Team (including the Prime Contractor) have to agree a Maximum Price, Target Cost schedule. The Maximum Price, Target Cost principle means that the Prime Contract is based on neither a fixed, nor a fully flexible price. An important part of this pricing strategy focuses on the identification, pricing and appropriate allocation of anticipated project risk. The Prime Contractor is invited to consider and evaluate all the possible risks to achieving the required construction or service at the time it is expected and for the whole life cost expected, and to allocate that risk to whichever party is the best able to manage it. The identified risk then has a value assigned to it in the contract price.
6. Project Documents – commentary	The case study focuses on the **Strategic Briefs** and **Output Specifications**. The reason for not considering the other documents is that study of these two sets shows how quickly in reality the focus of design is forced to move from a *Performance based approach* to a *Prescriptive approach*. The Output Specifications are to a great extent constrained by the imposition of prescriptive solutions in the Joint Services Publications. The Joint Services Publications constitute part of the “Mandatory Ministry of Defence Standards” which must be adhered to. The Joint Services Publications themselves are a mixture of prescriptions and performance based requirements. For instance, we have in JSP 315 Scale 39 for Service Catering facilities: ○ … two 13 amp double sockets in kitchen office; … (prescriptive); ○ … larders to be temperature controlled to +10 to +12°C; … (performance based). The JSP 315 Scale 39 for Service Catering Facilities are discussed in more detail in section 10. SoR – Commentary, below. **The Strategic Brief** The Strategic Brief is prepared by the Client. It is the document which conveys to the Prime Contractor the *Purpose* and the *Functional Requirements* of the new facility (Building down barriers Toolkit, 1999). Another name for it is the *Statement of Functional Needs*. The Strategic brief must contain the following: ○ Client details; ○ Statement of purpose; ○ Scope of project; ○ Baseline price. The brief will consist of: ○ a statement of purpose setting out client objectives to be met; ○ enough information to establish the scale and complexity of project; ○ data on minimum acceptable performance standards e.g. ambient temperature ranges; ○ the number of occupants;

	○ types of activities; ○ patterns of usage over a day and throughout the year; ○ any helpful site-specific data; ○ the client's baseline price, expressed as capital or through life cost. The client should consult representatives of the users while preparing the Strategic Brief. Users' views are important. They help define: ○ clear patterns of usage; and ○ minimum acceptable standards of building performance. This consultation is best achieved through Value Management workshops (Hayles C et al, 2000, a,b,c, and Kernohan D et al, 1996). The Building Down Barriers pilot project at Wattisham gives a good example of a Strategic Brief (Building Down Barriers Toolkit, 1999). The purpose of the new facility is simply described, "*The army needs to be able to train two regiments of soldiers on the Wattisham airfield site*". There is no mention of a new facility, only a statement of need at a location. The next section of the Wattisham Strategic Brief then goes on to define details of users, their requirements and some data on performance indicators, including: ○ numbers of soldiers in a regiment; ○ numbers of women in a regiment; ○ numbers of soldiers to be trained each day; ○ numbers of soldiers needing showering and changing facilities; ○ the ambient temperature needed in different parts of the facility; ○ the training equipment required; ○ the size of each item; ○ frequency of use of each training item; ○ etc. There was no mention even that a new *building* was required. The Prime Contractor was able to assess the existing facility with a view to refurbishing it, and to compare that option with the possibility of demolishing the old facility and replacing it with a new one. Nothing in this Strategic Brief constrained the Prime Contractor from considering (with help from Army Staff responsible for training on the site) any sensible option in the effort to find the best possible solution to the client's need "*to train two regiments of soldiers*".
7. Project Process – Introduction	The Prime Contracting process is summarised in Table I below, taken from *Building Down Barriers – Prime Contractor Handbook of Supply Chain Management* (Holti et al, 1999). **Table I The Prime Contracting Process** **Project Process** **Actors** **Activities**

			○ Draft **Strategic Brief**. ○ Appoint advisor.
	Definition and qualification	○ The Client Team ○ Prime Contractor	○ Select Prime Contractor. ○ Draft project programme.
	Concept Design	Prime Contractor Supply Chain Cluster Leaders	○ Explore client's functional requirements. ○ Draft project brief **Output Specification**. ○ Involve Supply Chain. ○ Develop and appraise potential solutions. ○ Provide initial Guaranteed Maximum Price based on optimum whole life cost.
	Detailed design and construction	Prime Contractor Supply Chain Cluster Leaders	○ Complete design. ○ Optimise whole life costs. ○ Develop compliance plan. ○ Undertake construction, building "right first time". ○ Hand over the facility.
	Post Hand-over	Prime Contractor	○ Monitor and maintain the building until proof of compliance.
8. Project Process – Commentary	**The Integrated Project Team, and the need for definition and measurement** The process begins with the development of an Integrated Project Team. The Integrated Project Team is a group of full time members of Defence Estates who have between them all the necessary skills and functions required to deliver the construction project, or service (Defence Estates, *Prime Contracting on the MoD Estate)*. This includes support where necessary from specialist advisers from industry. Typically the Integrated Project Team includes key Ministry of Defence procurement specialists and the Military Clients who will be using the facility, and who represent the Top Level Budget Holder, who will pay for the work. The Integrated Project Team appoints first a multi-disciplinary construction consultant known as the Principal Support Provider, and then a Prime Contractor. The Principal Support Provider and the appointed Prime Contractor each then become full members of the Integrated Project Team along with the supply chain. There has to be a mechanism to decide which suppliers should be seen as strategic long-term partners, and similarly there has to be a mechanism by which the effective management of the suppliers on a project can be achieved. This mechanism is called *Clustering*. Suppliers who work together to complete an independent part of the overall work are grouped in Clusters such as: ○ Mechanical and electrical services; ○ Ground works; ○ Frame and envelope;		

	o Internal finishes. The job of a cluster is to design and deliver an integrated part or element of the building. Designers, subcontractors and materials or components suppliers work together within the Cluster. They collaborate within the cluster to deliver best value in the Cluster Product to the client, rather than to focus on their traditional fragmented part of the whole process. A decision is always made to allocate the responsibility for the work of each cluster to one of the suppliers in the cluster, the Cluster Leader. Cluster Leaders are always strategic long-term supply partners of the Prime Contractor. They are chosen because they have the greatest opportunity to favourably influence the effective execution of the work of the Cluster. They are appointed early in a project so they can work with the Prime Contractor, the design consultants, and the Client to bring their expertise to bear on the concept design of the project. The goal is to resolve key cross-cluster interface design issues at an early stage, and so free each cluster to optimise the area of design for which it is responsible. Once the design is complete, the Cluster Leaders are responsible for working with their Cluster members to develop the price for their Cluster output. This has to be done in a structured and methodical way to meet the *Building Down Barriers* requirements that all participants must commit to, including: o driving out unnecessary costs; o ensuring quality is maximised; o ensuring *all* parties make a fair and predictable profit. The pricing process enables Cluster Members to work out where underlying costs can be reduced, for instance through removing duplication of effort during the early stages and in managing the site more effectively. The Prime Contracting process makes the standard for gauging the value of what is being delivered more rigorous in two ways: o it makes the functional requirements more explicit; o it involves a more sophisticated method of measuring the cost of providing them. **Making the functional requirements explicit and defining terms** A Prime Contracting project always begins with a statement of the Client's need expressed as an *Output Specification*, and not in design or engineering terms. The Output Specification is a statement of requirements which says what the facility is there to do, for instance: o house x number of people, of which y are men and z women; and o enable a, b and c activities; o with d aesthetic requirements. The Output Specification should not say: o how big the building should be; o what shape it should be; o how heavy a load the floor should bear. Such design and engineering issues are best dealt with by a combination of members of the supply chain, each one having some specialist knowledge which the client does not

normally possess, in collaborative discussion with the client's key representatives.

A design can be judged against the Output Specification as it develops, by always asking the question "does this do what the Client wants?" The emphasis on functional performance in principle minimises the all too common problem that a design, as it develops from an "outline brief" couched in design terms, becomes something that does not work for the client once it is built.

Measuring Performance

The performance measurement system has three key components (Defence Estates, *Prime Contracting on the MoD Estate*):

- a key performance indicator structure;
- links to continuous improvement through the Output Specification and pricing regime;
- benchmark data to be used for decision making and cost comparisons.

The types of performance measurement indicators recommended by Defence Estates include for example:

- Core works:
    - Milestone achievement;
    - Completion on time;
    - Time benefits from value engineering.

- Core Services
    - Helpdesk
        - Compliance points;
        - Availability of the helpdesk;
        - Works complete within required time;
        - Routine maintenance task completed as forecast;
        - Callers or note files of actions informed of outcome.
    - Pre-planned maintenance:
        - Statutory inspections completed;
        - Monthly reports submitted on time;
        - Improvement in time aspects of performance, for instance done faster, better, cheaper.

Notice that the only mention of *functional* performance is in the context of maintenance. There is no mention of measuring functional performance in the context of capital works

Measuring the cost of providing the functional requirements

The Prime Contracting approach uses the Through-Life-Cost of a facility as the most meaningful measure of its cost, rather than the capital cost alone. The client is again involved in the decisions necessary to balance the capital and operational costs of the facility. The Through-Life-Cost is expressed as the value it would have if all the money for operating the facility over its lifetime had to be provided now, instead of over say, 35 years. This is called Net Present Value, and allows us to take account of some economic uncertainties such as future inflation and interest rate changes.

The Prime Contracting process is predicated on the theory that it is possible to deliver facilities with Through-Life-Costs showing significant savings compared with the Through-Life-Costs of facilities procured through traditional routes.

These savings will arise through the selection of materials, electrical and mechanical equipment, finishes and construction methods which are appropriate to the design life of the facility. There will be a tendency for these materials and processes to be more expensive than might be the case on a traditional procurement, but any such increased costs should be more than off-set by the savings in construction costs which will come about through using Prime Contracting to drive out waste in materials and labour.

Optimising value through Target Costing

The basis for optimising value is a rigorous approach to managing costs during design development, to avoid the traditional practice of developing designs which:

- prove to be too expensive for the client;
- drive reductions to profit margins;
- drive neglect of build quality.

The approach is called Target Costing, and it has been used to good effect in many areas of manufacturing (Womack and Jones, 1996). Essentially it is a simple principle. The client establishes the functional requirements, and a maximum market price for the facility. The supplier sets out to design a product which both:

- matches required levels of functionality and quality;
- provides a viable level of profit for the supplier at the target price.

Costs have to be managed before they are incurred. Suppliers identify the impact of any design option from the point of view of both the level of functionality and the cost. Design options are generated and evaluated until a combination of options is found which meets both the functionality and the cost requirements.

Table 2 summarises the difference between the traditional "cost plus" and "target costing" approaches.

Table 2 Traditional Construction Costing and Target Costing compared

Traditional Construction Costing	Target Costing

driven. It is driven by separate *commercial* people.	
Quantity surveyors are responsible for cost reductions.	Cross functional teams manage costs.
Suppliers are involved late in the decision process.	Suppliers are involved early in the decision process.

The Target Costing approach to ensuring required functionality at a guaranteed maximum price, is supported by two other essential techniques:

- ***Value management*** enables a client to collaborate with the Prime Contractor and the supply chain in defining what value is attached to different aspects of the performance specification, and then offers a structured way of pooling information on the cost and functionality impact of design options, so that collective decisions can be made. It allows everyone involved in the project, especially the client to achieve optimal functionality, while remaining fully aware of the cost implications (see section 9 below for a more detailed description).

- ***Risk management*** is a mechanism for:
  - increasing certainty of the out-turn cost of the facility for the Client;
  - increasing certainty for the Prime Contractor and supply chain that they will achieve the profits they intend from the project;
  - capping overall cost.

The Client is involved closely in both Value management and Risk management. As design decisions are made, all the associated risks are identified, their potential costs are established and responsibility for managing them are assigned to the organisation best able to do it.

Developing Continuous Improvement within the Supply Chain

Continuous Improvement is the vehicle for achieving long-term performance improvement of:

- what is delivered to the client; and
- the profitability of the whole supply chain.

While the concept and practice of Continuous Improvement are familiar in manufacturing industry (Womack and Jones, 1996), it remains less well known in the construction industry. Continuous Improvement is the theme which underpins the philosophy of Total Quality Management (Goetsch and Davis). Two things characterise a Total Quality Management approach:

- preventing things going wrong instead of identifying later that they were not done properly in the first place;
- using the contributions of everyone in the business to continually seek better ways of doing things.

In practice this means paying far more attention to planning how to do things in advance than is normal, and seeing how problems can be anticipated and avoided. Work processes are identified, mapped, improved and then used to plan a programme of work.

	Continually seeking of better ways to do things needs to involve the principal companies that work together in the design and execution of a project. Up to 90% of the cost of a construction project comes from: o professional advisers; o suppliers of materials and components; o machinery; and o labour. The Prime Contractor therefore needs to show that they can drive up quality while also driving down costs. They must do this by harnessing the efforts of the principal contributors to that 90% of total project cost, by demonstrating how they will achieve Continuous Improvement in their own businesses and pass on the benefits to the end customer as well as increasing their own profitability.
9. SoR – Introduction	**The Regional Prime Contract (Scotland)**. The *Building Down Barriers* projects were both Core Works (capital) projects. The first Regional Prime Contract in Scotland extended the scope of Prime Contracts to include the provision of Core Services too. Core Services includes: o all aspects of property maintenance; o refurbishment; and o any soft Facilities Management services such as the provision of call centres. Core Works is any new build requirement. **Using Value Management to establish the Client 's primary objectives** The Regional Prime Contract (Scotland) which followed the *Building Down Barriers* pilot projects used the Function Analysis System diagramming Technique F.A.S.T. (Hayles and Simister, 2000, c) to develop and express the Principal Client Objectives (Ministry of Defence, December 2001). Function Analysis is a process by which the primary objectives of the Client and user groups can be clearly identified, agreed and understood. Functional objectives are listed on a F.A.S.T. Diagram following the technique developed by Charles Bytheway in 1964. Table 3 (below) illustrates part of the F.A.S.T. Diagram for the Regional Prime Contract (Scotland). The Key Objective or Function appears in the leftmost column. This is supported by principal objectives listed vertically in the order that they support the mission statement (the top three of an original total of seven are given). Objectives supporting the principal objectives of the *Construction* are identified and linked to them through a *how? why?* logic. Each objective is supported to the right by a series of objectives which indicate "how" it is to be objectively achieved. Each objective is supported to the left by higher level objectives indicating "why" it needs to be achieved. **Table 3 A F.A.S.T diagram for Naval Fleet Accommodation** **Objectives**

How? >> >>	**>> <<**	**<< << Why?**
Key Objective	***Principal Objective***	***Secondary Objective***
Meet Strategic Defence Objectives to provide Single Living Accommodation facilities for entitled personnel.	Provide modern, flexible accommodation to agreed standards	Functionally optimised bedroom, common and circulation space.
		Recognition of existing military standards.
		Quality, robust, construction.
		Good Soundproofing.
		Meet target occupancy rates.
	Optimise utilisation of existing Accommodation facilities	Detailed dilapidation surveys to determine remaining life and degree of re-usability.
		Fleet Accommodation Centre to be On Base, or within 20 minutes or 3 miles.
	Improve quality of life for Service personnel.	Proximity to existing base infrastructure with good social areas and quiet areas.
	A further four principal objectives follow in the completed brief.	A further 16 secondary objectives follow in the completed brief.

Output Specifications

The Output Specification for a Prime Contract has the following features:

- the aim of the Output Specification;
  - states the client's requirements in *output* terms as far as possible;
  - includes a statement of performance or quality objectives; and
  - provides information needed to propose and price innovative solutions.
- the structure of the Output Specification states:
  - aim and objectives;
  - scope;
  - **detailed requirements**.
- the Output Specification should be read alongside documents related to the particular work including, but not limited to:
  - instructions to companies tendering for work;
  - strategic briefs;

- project management plan;
- contract terms and conditions;
- supplementary contracts for the specified work;
- other documents referred to by any of the above.

Example of Detailed Requirements from the Core Works Contract

The **detailed requirements** form the largest part of the Output Specification document (Defence Estates, October 2001; Ministry of Defence, December 2001). For the Regional Prime Contract (Scotland), they are expressed in tables. The Core Works (new build or major refurbishment) contract is under six subject headings:

A *Description* A high level statement of the fundamental objectives.

B *Function* A more detailed breakdown of high level objectives.

C *Output* A three tiered set of information for each individual *Function*:

D *Service Requirements* detailed description of *Function*;

E *Performance Standard* qualitative or quantitative measures against which performance can be judged;

F *Constraints or Relevant information*.

Table 4 (below) illustrates the Output Specification relating to the accommodation required for sailors and female naval staff at junior ranks. The detailed requirements are limited for our example to the living space requirements, but in the full Output Specification, detailed requirements are set out for every individual *Function* to be covered by the Prime Contract. The full Output Specification runs to some 36 pages, excluding appendices.

You will notice that although the *Description, Function* and *Service Requirements* are very open, the *Performance Standards*, with the exception of "Fit for purpose" are often couched as if they were prescriptions. An example is "*Areas to be comparable or better than JSP 315 Scale 3, standard Z*", where JSP is the Joint Services Publication Handbook which sets out precise ways of achieving these scales. In fact these are *deemed to satisfy* solutions, and the Output Specification document stresses that where reference is made to the Joint Services Publication scales, "*these are given as guidance of the range of elements required, and are not to be taken as an indication of the required size, location, or quality of provision*".

Table 4 Part of Detailed Requirements for Junior Rates Accommodation

A Description:	**To provide Single Living Accommodation for Junior Rates**

- Personal items
- Issued items
  - personal equipment
  - Live in / live out members
- Ablutions

C Output: **Provide Living Space**

D Service Requirements:	**E Performance Standard**	**F Constraints or relevant information**
Provide Junior Rates and Women Royal Naval Staff (WRNS) with en-suite bed-sitting rooms to achieve the target occupancy level.	Fit for intended purpose and to Grade I en-suite standard. Areas to be comparable or better than JSP 315 Scale 3, standard Z. Note: The actual layout of the accommodation can vary providing the minimum floor area is met.	Specific requirements: ○ Single bed-sitting room with user controlled central heating. ○ En-suite shower room with washbasin, toilet, heated towel rail and shower. ○ Fitted with high bandwidth fibre cable services connection for telephone, television and internet access. ○ Personnel should be able to sign up to their own communications service agreement based on monthly charges. Associated requirements: ○ Access to potable water. ○ Access to a bath. ○ Access to secure storage for personal effects. Small power: ○ Sufficient for television, computer and equipment and peripherals, sound systems and other personal electrical equipment. (Suggest 2No double sockets at floor level and 2No at worktop level.) ○ An electrical shaver point. Relevant information: ○ Data room.

Example of Detailed Requirements from the Core Services Contract

The Core Services contract is under nine subject headings (A to H), (Defence Estates, October 2001). Broadly speaking they are the same as the six detailed requirements for Core Works, but with three important additions including *Priority, Rectification periods* and *Relevant information* which all relate to the need to maintain a facility in a particular condition:

A *Objective* A high level statement of the fundamental objectives.

B *Background Information* To inform bidders of relevant supporting information.

C *Major Requirement* Categories of Requirements.

D *Requirements* Detailed breakdown of outputs.

E *Relevant information* Additional information and links to related works in other output tables and other sources of data.

F *Performance Standards* Definition of the accomplishment level to be met by the service delivery.

G *Priority* Importance classification of meeting the performance standard.

H *Rectification period* The period within which the function must be returned to the specified standard.

Table 5 shows an example of from the Output Specification for the Regional Prime Contract (Scotland) for Core Services. The overall aim of the Core Services contract is to provide Facilities Management services to the sites and facilities detailed in the central database for the duration of the contract. The Core Services are divided up into nine subject headings. The following three are applicable to all facilities in the contract:

- Management system, including a Help Desk.
- Health and Safety.
- Energy and Utilities Management.

The remaining six Core Services may not be applicable to all sites and facilities included in the contract. Details of which services apply to each given situation are included in the Asset Database:

- Maintenance of buildings, infrastructure and services.
- Grounds Maintenance.
- Waste Management.
- Cleaning.
- Catering.
- Porterage.

Table 5 illustrates the Output Specification for *Energy and Utilities Management*.

Table 5: Output Specification for Energy and Utilities Management

A Statement of Service Objectives	To provide an energy management service to assist in meeting energy targets.

Service Requirement

- Adopt and comply with the Authority's policies on energy management.
- Monitor energy consumption and provide regular reports on levels of consumption as required by the Authority's representative.
- Identify any potential energy saving schemes and agree with the Authority's representative any development work where appropriate.

Relevant Information

- The Authority's Energy and Environmental Policy is provided in the Information Library.
- Information on existing patterns of energy consumption are provided in the Information Library where available.
- Individual Establishment energy plans, where existing are provided in the Information Library.

Performance Standards	Priority	Rectification Period
Achieve energy management targets from energy saving schemes identified and implemented that are within the Prime Contractor's control.	4	10 days permanent
No failure to comply with Authority's energy policies.	3	5 days permanent
No failure to operate existing Building Management Systems.	4	10 days permanent
No failure to provide energy consumption reports within agreed timescales.	4	10 days permanent

In addition to this table, there are further tables (6 to 8) setting out service priority codes (Table 6), rectification periods (Table 7), and facility function importance ratings (Table 8).

Table 6 indicates the principles behind the priority levels of service requirements and performance standards. The weightings assigned to the priorities are applied in conjunction with performance monitoring and the payment mechanism.

Table 6: Classification of Service Requirements and Performance Standards

Service Priority	Description	% Weighting
1	Failure to provide a service that gives rise to an immediate Health and Safety or security risk.	100

2	Failure to provide a serviced that prevents the Authority from conducting its normal operations or occupancy of accommodation.	50
3	Failure to provide a service that inhibits the Authority from conducting its normal operations or causes disruption to accommodation, or facility occupants.	33
4	Failure to provide a service that gives rise to inconvenience of users or beneficial occupation.	25
5	Failure to provide a service that does not impinge on operational capability.	20

Table 7 shows the Rectification Periods of service requirements and performance standards. The rectification periods are deemed to begin from the point of notification or detection by the Prime Contractor.

Table 7 Typical rectification periods

Category	Typical Rectification Periods
1	○ Respond immediately and effect temporary resolution within one hour. ○ Permanent resolution within 1 working day.
2	○ Respond and effect temporary resolution within 2 hours. ○ Permanent resolution within 2 working days.
3	○ Respond and effect temporary resolution within 1 working day. ○ Permanent resolution within 5 working days.
4	○ Respond and effect temporary resolution within 2 working days. ○ Permanent resolution within 10 working days.
5	○ Rectify within 20 working days.

Table 8 shows the relative importance of the function of a facility to an establishment.

Table 8 Facility Function Importance Rating

Rating	Description	% Weighting	Definition
1	Vital	100	Operations cannot function without full use.
2	Very Important	50	Operations are impaired without full use.
3	Important	30	Operations can be undertaken for a limited period without these facilities.
4	Less than	25	Operations can continue at a reduced

		Important		level without these facilities.
	5	Minor	20	Operation can continue without these facilities.

10. SoR – Commentary

The Strategic Brief for a generic Demonstration Project to deliver and service An Officers' Mess Kitchen (Defence Estates, July 2003) illustrates clearly the tension between the Performance to provide an output based specification, and the need to comply with existing mandatory Ministry of Defence Standards on Kitchen Design. The Strategic Brief and Output Specification Table fill some 14 pages, including a list of 5 separate Ministry of Defence Codes, Standards and Publications, and 7 Technical Documents relating to Health and Safety and other catering and kitchen related standards. It is therefore only possible to give two examples of Output Specifications and their links to "mandatory Ministry of Defence Standards" to illustrate the point. The first of these is for an Officers' Mess Kitchen, and the second is for Officers' Mess Dining Space.

Demonstration Project – An Officers' Mess Kitchen – New Build Output Specification including schedule of kitchen provision.

OUTPUT 1: OFFICERS' MESS KITCHEN

DESCRIPTION: To provide Officers' Mess Kitchen and associated accommodation

FUNCTION:

To provide **Kitchen Space** for:

- Food preparation and cooking;
- Disposal of waste;
- Washing / cleaning.

To provide **other space** for:

- Rest facilities;
- Locker facilities;
- Offices.

OUTPUT 1: OFFICERS' MESS (including Mess Kitchen, Offices and Rest / Locker areas.)

		o Wet refuse area; o Dry refuse area; o Compactor room/goods in and waste out area o Servery and pantry; o Refrigerator store; o Grocery store; o Catering contractor's office. Other requirements: o Capable of feeding 361 in one sitting of 90 minutes; o Buffet style cocktail parties for 800. Relevant information: o Data room; o Specialist catering approval of design required; o Capability of handling formal functions.
	Service Requirements	**Constraints & Relevant Information**

	Provide staff facilities including:
	o Rest room for 55;
	o Locker area for 40 kitchen staff;
	o Locker area for 15 batting staff (waiters).
		Specific Requirements
		o Changing / Locker area;
		o Showers;
		o Toilets;
		o Communal Staff Rest Room.
		
		Other Requirements:
		o Separate Cleaners' Room
		o Accommodation for:
		    o 25 female kitchen staff;
		    o 15 male kitchen staff;
		o Accommodation for 15 batting staff (waiters).
		
		Relevant information:
		4 Data room.

	Provide Office Accommodation	Specific Requirements: 5 Office for Mess manager and the Prime Maintenance Contractor; 6 Office for the Deputy Prime Maintenance Contractor, and Accounts staff, including a Safe. Relevant Information: o Data room.

The Strategic Brief has been set out in the usual way, including sections on the following:

- background for the project;
- core work aim and objectives;
- scope and background of the core work;
- constraints within which the project is to be delivered;
- Prime Contractor's interface and co-ordination requirements; and
- Government furnished details.

The "mandatory Ministry of Defence Standards" which have to be adhered to include:

- Policy documents:
  - Design Maintenance Guidance (DMG) 18: Catering Design Guide;
  - Other Design Maintenance Guidance publications, DMG 8, DMG 15, DMG 16, DMG 22;
  - **Joint Services Publication JSP 315 Scale 39**, **29**, 40, and 46 for minimum military requirement;
  - Ministry of Defence Fire Standards Manual;
  - Defence Estates Functional Standards.

- Technical Documents:
  - All appropriate British Standards and Codes of Practice and European Union Directives including Directive No. 93/43: The Hygiene of foodstuffs;
  - Health and Safety Executive – Health and safety in kitchen and food preparation area, and No. 35 – Catering Safety;
  - a further four technical documents specific to Health and Safety by Defence Estates;
  - all other technical standards referred to in clause 12 of Volume 1 of the Strategic Brief, Core Works Requirements.

As an aid to clarity we will consider only a small part of the Joint Services Publication JSP 315 Scale 39 for Service Catering Facilities, and JSP 315 Scale 29.

JSP 315 Scale 39 begins with a general introduction giving the scope of its application with cross references to other Scales which must also be taken into account when making design decisions. JSP 315 Scale 39 is 46 pages long, and divided into 7 parts dealing with every aspect of the provision of both accommodation and equipment relating to the preparation, storage and serving of food.

Part 2 of JSP 315 Scale 30 deals with the provision of accommodation for kitchens and ancillaries. It begins with a brief introduction which is followed by a list of Mechanical and Electrical requirements, and a table of areas scaled to the number to be fed at the facility. The introduction refers the reader to other sections covering scales for equipment and catering control, again based on the number of people to be fed. The Design Maintenance Guide No 18 is cited as a source of typical layouts, indicating *work flow patterns* and *space standards* but which are NOT mandatory type plans.

JSP 315 Scale 39 for Service Catering Facilities
M & E Requirements

	Requirement	Details

	○ all units are to be linked back to a programmable recording / print out / alarm system.
General	○ water, gas and electricity supplies are to be metered. (Refer to JSP 315 Scale 1 for Energy Management).

We can see from the table from JSP 315 Scale 29, that the mandatory Ministry of Defence Standards are a mixture of output based requirements, and prescriptions. For instance under "temperature monitoring", we see that "a temperature monitoring system is to be provided". There is no hint as to how this should be done, or what equipment should be used. The supplier is free to meet the requirement in any way that they choose. In contrast to this under "Electric power" the demand is for "two 13 amp double socket outlets in kitchen office". This is a prescription. An output based specification would be expressed in terms of access to power to enable, say, a computer, a radio, a certain amount of task lighting, or whatever functions the office needs to support.

The Prime Contractor is thus constrained to certain prescriptive solutions at an early stage by Ministry of Defence mandatory Standards. The fact that the mandatory Standards are a mixture of output based and prescriptive statements is confusing.

Officers' Mess – Dining Facilities

The following table sets out the Output Specification for the dining space of an Officers' Mess within the Regional Prime Contract (Scotland).

Output Specification Officers' Mess – Dining Space

Service Requirements	Performance Standard	Constraints / Relevant Information
Dining Space		
Provide dining space for up to 496 No Officers and Civilians.	○ Fit for intended purpose; ○ Areas to be comparable or better than JSP 315 standards Scale 29.	Specific Requirements: ○ Dining room to feed up to 150 No in one continuous sitting of approximately 75 minutes per meal time; ○ Cloak space; ○ Toilet facilities; ○ Capable of Catering for Functions of up to 300 No. Associated Requirements: ○ None applicable. Relevant Information: ○ Data Room; ○ Specialist Catering Advisor approval required of proposed design.

If we now look at the part of the mandatory Ministry of Defence Standards which refer to dining accommodation and reception areas for Officers, the degree to which Standards are prescribed is even more stark. Joint Services Publication JSP 315 Scale 29 for Messes: Officers' – public rooms begins with a general introduction giving the scope of its application with cross references to other Scales which must also be taken into account when making design decisions. The requirements are set out in a large table, a small amount of which is reproduced below. The table gathers information into 4 columns:

- Accommodation
- Area
- Mechanical and Energy Services
- Planning Notes, Special fittings and so on.

Accommodation	Area	M & E Services	Planning Notes, Special fittings etc.

- plus 0.1 m^2 per mess member;
- plus additional area 1.4 m^2 per seat;
- number of seats to be calculated from a formula depending on number of members.
- For example, with a mess strength of 110, with 33 living in and 77 living out:

80%x[33+(65%x77=50)] = 80%x(33+50)=80%x83=67. Rounded up to the nearest eight, gives a total of 72 seats.

lighting 225 lux over serving points;

- Additional lighting over selected pictures and exhibits as required.

Electrical power:

- One 13 amp double socket outlet for every 12 m run of wall;
- Sockets for each item of powered equipment, e.g. toasters and hotplates;
- floor mounted 13 amp socket outlets as required.

Heating: 18.5°C.

eight people, at 2.4 x 1.4m.

- The number of seats authorised for the dining room excludes those needed for the dining room extension.
- Storage provision for this furniture is made under Serial 28.
- Buffet units are normally provided as free standing furniture (Not Works Supply)
- Where mess membership exceeds 96, a built in buffet unit may be provided in lieu.

In addition to the highly prescriptive specification of power supply and the distribution of power sockets throughout the dining space, the area to be available for the dining room is prescribed on the basis of numbers of people to be accommodated for dining. In the entrance hall there is a prescribed requirement for a mirror of a particular size, as well as a letter rack and notice board. These prescriptions are mixed up with more output based requirements for the entrance hall such as "Planned to give reasonably spacious entry."

11. Summary and	**Introduction** Prime Contracting is about a Single Point of Responsibility to the Client, applied through an Integrated Supply Chain. Contracts are let for a 7 year period with the option of

Conclusions	extending to 10 years. Prime Contracting relies on understanding Client needs and using Key Suppliers to develop innovative solutions in the context of a Maximum Price / Target Cost for the whole life of the facility. **Ministry of Defence – Management of The Estate** The Ministry of Defence Estate occupies approximately 240,000 hectares valued at £14 billion. The diversity of the estate is typified by the nature of the facilities such as accommodation, (service families, barracks, office and technical) as well as the activities it supports such as training, communication, storage, welfare, strategic operations etc. It also protects heritage in listed and scheduled structures and Sites of Special Scientific Interest. The Ministry of Defence manages its estate through the Defence Estates agency. Its average annual spend on construction procurement and property or facilities management is £1.4 billion (Defence Estates *Prime Contracting*.) **Procurement Routes in the Ministry of Defence** The United Kingdom Government now demands that *all (public sector) procurement must be made solely on the basis of value for money, in terms of Whole Life Costs* (HM Treasury, November 2000). This means that there is a duty on suppliers to deliver services to clear standards which cover both cost and quality by the *most effective, most efficient, and most economic* means available. While not explicitly stated, this duty also embraces environmental issues. All major construction procurement within the Ministry of Defence (MoD), both new build and refurbishment, must be procured through either: • Public Private Partnerships (PPP, including Private Finance Initiative or PFI); • **Prime Contracting**; or • Design & Build. **The Building Down Barriers Project** The key objective of the *Building Down Barriers* project and all subsequent Prime Contracts is the delivery of the required facility to the Client with no surprises on either: o timescale, o whole life cost, or o performance. The Building Down Barriers Project came about because for at least 70 years there have been client concerns about the impact on their commercial performance by the inefficiency and waste in the construction industry (Cain, 2003). The traditional Ministry of Defence procurement programme was flawed for many reasons (Andrews, 2001). These included inefficiency and waste with only 40 to 45% of spending giving rise to service delivery, and the rest disappearing to pay fees and overheads. Wherever there was no single point of responsibility, it was hampered by the number of interfaces, imprecise allocation of risk, and vulnerability to fraud and malpractice. **Prime Contract Documents** There are six key documents to every Prime Contract: o Core Conditions of Contract

- ***Strategic Brief (s)***
- ***Output Specification***
- Project Brief(s)
- Project Execution Plan
- Project Programme

The case study focuses on the **Strategic Briefs** and **Output Specifications**. The reason for not considering the other documents is that study of these two sets shows how quickly in reality the focus of design is forced to move from a *Performance based approach* to a *Prescriptive approach*. The Output Specifications are to a great extent constrained by the imposition of prescriptive solutions in the Joint Services Publications. The Joint Services Publications constitute part of the "Mandatory Ministry of Defence Standards" which must be adhered to. The Joint Services Publications themselves are a mixture of prescriptions and performance based requirements. For instance, we have in JSP 315 Scale 39 for Service Catering facilities:

- … two 13 amp double sockets in kitchen office; … (prescriptive);
- … larders to be temperature controlled to +10 to +12°C; … (performance based).

The Strategic Brief

The Strategic Brief is prepared by the Client. It is the document which conveys to the Prime Contractor the *Purpose* and the *Functional Requirements* of the new facility (Building down barriers Toolkit, 1999). Another name for it is the *Statement of Functional Needs*. The Strategic brief must contain the following:

- Client details;
- Statement of purpose, setting out client objectives to be met;
- Scope of project;
- Baseline price.

Making the functional requirements explicit and defining terms

A Prime Contracting project always begins with a statement of the Client's need expressed as an *Output Specification*, and not in design or engineering terms. The Output Specification is a statement of requirements which says what the facility is there to do, for instance:

- house x number of people, of which y are men and z women; and
- enable a, b and c activities;
- with d aesthetic requirements.

The Output Specification should not say:

- how big the building should be;
- what shape it should be;
- how heavy a load the floor should bear.

Output Specifications

The Output Specification for a Prime Contract has the following features:

- the aim of the Output Specification;
    - states the client's requirements in *output* terms as far as possible;
    - includes a statement of performance or quality objectives; and

    - provides information needed to propose and price innovative solutions.

- the structure of the Output Specification states:
    - aim and objectives;
    - scope;
    - **detailed requirements**.

The **detailed requirements** form the largest part of the Output Specification document. For the Regional Prime Contract (Scotland), they are expressed in tables.

Statements of Requirements

Although the *Description, Function* and *Service Requirements* are very open, the *Performance Standards*, with the exception of "Fit for purpose" are often couched as if they were prescriptions. An example is "*Areas to be comparable or better than JSP 315 Scale 3, standard Z*", where JSP is the Joint Services Publication Handbook which sets out precise ways of achieving these scales.

The "mandatory Ministry of Defence Standards" which have to be adhered to include:

- Policy documents:
    - Design Maintenance Guidance (DMG) 18: Catering Design Guide;
    - Other Design Maintenance Guidance publications, DMG 8, DMG 15, DMG 16, DMG 22;
    - **Joint Services Publication JSP 315 Scale 39**, **29**, 40, and 46 for minimum military requirement;
    - Ministry of Defence Fire Standards Manual;
    - Defence Estates Functional Standards.

JSP 315 Scale 39, shows that the mandatory Ministry of Defence Standards are a mixture of output based requirements, and prescriptions. For instance under "temperature monitoring", we see that "a temperature monitoring system is to be provided". There is no hint as to how this should be done, or what equipment should be used. The supplier is free to meet the requirement in any way that they choose. In contrast to this under "Electric power" the demand is for "two 13 amp double socket outlets in kitchen office". This is a prescription. An output based specification would be expressed in terms of access to power to enable, say, a computer, a radio, a certain amount of task lighting, or whatever functions the office needs to support.

The Prime Contractor is thus constrained to certain prescriptive solutions at an early stage by Ministry of Defence mandatory Standards. The fact that the mandatory Standards are a mixture of output based and prescriptive statements is confusing.

Conclusions and Recommendations

The Prime Contracting initiative represents a significant advance on the traditional approach to construction for the Ministry of Defence. Its main focus is on the delivery of construction quality and value through a single point of responsibility. This is achieved through an Integrated Project Team which allows it also to increase the performance basis of the initial approach to design decisions through the use of a Strategic Brief and

	Output Specifications. In summary: • Application of the Performance Based Building approach is inhibited by the imposition of prescriptive "Mandatory Standards", and work would be required to remove these; • Mixing the Performance Based approach with the Traditional Prescriptive Approach limits the implementation of innovative performance based solutions, which may be better than the traditional; • More attention needs to be paid to match Functionality and Serviceability in the delivery of Performance Based Buildings.
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Defining Functionality

PART 5

5 DEFINING FUNCTIONALITY

5.1 Functionality in prior PFI UK Case Studies

Sustainability lessons from PFI and Similar Private Initiatives
Project 36/8/365

The Functionality Drivers behind each Case Study project
Josephine Prior PhD

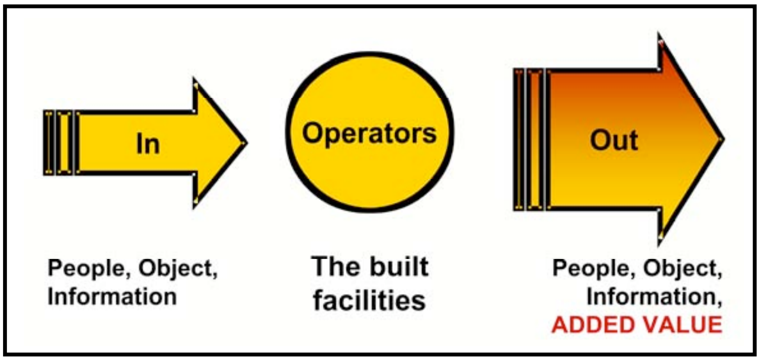
Introduction

The sole purpose of Construction is to fulfil a need. This need can be business or aspirational. The functional success of a built facility depends on how well it meets a client's need. This paper begins by defining Functionality in terms of the flow of added value to a situation. The specific functionality demanded by their clients is then described for each of the PFI Case Studies.

Concept of Flow

The Functionality of every form of built facility, including roads, railways, retail outlets, houses, hospitals, schools, offices, can be expressed in terms of Flow. Objects, information or people flow in, something is done within the physical realm of the built facility; and objects, information and people flow out with value added to them. Smooth Flow equates with high functionality and high added value; and Interrupted Flow equates with low functionality and low added value.

For instance, in a railway station, the continuous flow of passengers to and from trains adds value to journeys for as long as people can move freely. The continuous progress made by passengers in their journeys is Smooth Flow. On a Motorway, the flow of traffic adds value to journeys even if movement is slow. But any unplanned stoppage causes delay, frustration and waste. This is an example of Interrupted Flow, where progress towards the goal is not continuous. Time passes without value being added to the journey.



Smooth Flow = continuously added value
Interrupted Flow = some added value plus **waste**
Added Value = progress towards, or achievement of desired outcome

The PFI Case Studies
The Construction and Operation of Croydon Tramlink
Background
Croydon is the largest commercial centre in the South East of England[1], outside Central London. It has a population of nearly a third of a million, and more commercial office space than Sheffield, Newcastle, or Nottingham. By 1988, traffic congestion on the roads was perceived to be the most significant disincentive to companies retaining their businesses in Croydon.

The Client Need
Retaining existing businesses and jobs and attracting new ones is now a principal aim of Croydon Council's economic programme. Surveys of the local business community's perceptions of transport issues showed that companies attach great importance to ease of movement and accessibility. They also have increasing choice in deciding where to locate. When businesses leave Croydon for other locations, it damages the local economy.

The Functionality Drivers
The main Functionality Driver for Croydon Council was to reduce congestion in the town. The Council consulted widely among the local population who largely opposed proposals for road widening, but were 80% in favour of a light railway which would:

- Improve access to Croydon from the east and west leading to:
  - increasing number of visitors to the town
  - encouraging businesses and retailers to invest in the town's economy
- guarantee reliable and short journey times resulting from:
  - a roadway not shared with other forms of transport;
  - right of way, where the roadway had to be shared with cars and buses;
  - relocation of all statutory and local utilities to avoid disruption to travel during maintenance;
  - interchange links with other public transport at railway and bus stations.
- A Public Private Partnership for funding was established because Government insisted that private sector commitment to the scheme be achieved in line with its policy to achieve better whole life value for public money.
- Government policy also insists that all public procurement should be environmentally, economically and socially sustainable, as far as possible.

The Construction Solution
A light railway system was developed under Private Public Partnership between Croydon Council, London Transport and Tramtrack Croydon Ltd (appointed in November 1996 for a period of 99 years). It serves a population of around 600,000 people who will be able to save journeying time through the frequency, speed and reliablity of the service, over other private and public transport alternatives.

The Tramlink is expected to make a healthy operating profit. Allowing the private sector to keep this revenue for a set period of time after opening, enabled it to raise the necessary finance to construct the system. The total capital cost was around £200 million of which Government provided £125 m.

Improvement of the A55 Road Project, English / Welsh Border
Background
The Euro-Route E22 in Wales used to follow the A55 trunk road along the North Wales coast to Bangor[2], and then the A5 trunk road across Anglesey to the port of Holyhead. In recognition of the economic and social importance of this route, the Government decided in 1994 to extend the A55 dual carriageway across Anglesey.

The Client Need

The A5 runs through the communities of Caergeiliog, Valley and Holyhead to the main “old” port entrance at Salt Island. Traffic flow is restricted by the road width; traffic lights, pedestrian crossings, vehicles joining the A5 from side roads and a number of residential and commercial properties fronting directly on to the road. Outside the villages, many side roads and farm tracks join or cross the A5. In some places the sub-standard alignment of the A5 leads to poor visibility and increased driving hazards. During the period 1991 to 1995 there were 2 deaths, 15 serious and 83 slight Personal Injury Accidents on the A5 between Bryngwran and Hoyhead.

The Functionality Drivers

The main Functionality Drivers for the Welsh Office were to:

- reduce journey times and operational costs for private and commercial road users including public transport;
- assist economic regeneration;
- enhance road safety and reduce road casualties;
- provide relief from traffic related problems in communities along the A5;
- take account of the environmental implications of the road scheme and include appropriate mitigation measures;
- procure the scheme under the Private Finance Initiative to better enable delivery of whole life value for the public money being invested.

The Construction Solution

The decision was made to build a new dual carriageway road across Anglesey. Four different possible routes were considered and a preferred route chosen following a public enquiry in 1990. A standard Design, Build, Finance and Operate contract was let by the Highways Agency in December 1998 to a consortium called UK Highways A55. The contract period was for 30 years, and included penalty points for violations. The road was built in two years, leaving a maintenance responsibility for 28 years.

Features of the road which addressed the functionality drivers, included levelling and straightening the road to improve visibility and safety. It now by-passed altogether the villages of Caergeiliog and Valley, improving quality of life for residents by reducing traffic flow to local access levels, increasing air quality from reduced vehicle emissions and reducing noise.

Care was taken to mitigate the effects of building a new road in an area of outstanding scientific interest. One listed foot-bridge was demolished. It was recorded beforehand by archaeologists, and replaced by a new one to maintain pedestrian access across both a railway and the new road.

The relocation of the Princess Margaret Hospital, Swindon

Background

Princess Margaret Hospital was built at Okus Road in Swindon in 1959[3,4]. At that time, the hospital was on the edge of town, but has since been engulfed as the town has expanded around it. In 1974 the hospital completed the range of care it could offer including an Outpatients department, Main Ward Block and a Casualty and Orthopaedics department. By 1990, buildings had changed use, their fabric had deteriorated, and the local population had grown. The hospital was now too small to expand services, in the wrong place, very difficult to get too, and poorly laid out. It was dogged by maintenance problems estimated at £48 million to resolve.

The Client Need

Swindon and Marlborough NHS Trust decided that a new hospital was required to enable provision of higher quality health care in accessible, attractive, comfortable, practical surroundings. It needed better access for ambulances, patients, staff and visitors. The site also needed to be large enough to accommodate future expansion. Ten different site options were considered before the new site was chosen. 165,000 home occupants were then surveyed in the catchment area. 78% were in favour of the chosen site.

The Functionality Drivers

The old hospital served a population of 170,000. The new hospital needs to serve a population of 350,000, half of whom would live in Swindon, the others being distributed throughout a rural catchment area bounded by Cirencester in the north, Ludgershall to the south, Chippenham to the west and Wantage to the east. The site needs:

- an outlook to promote well being;
- good emergency access;
- to be set in a dip or behind trees to reduce visual impact;
- affordable land (every pound spent on the site is a pound less available for patient care);
- to be available to purchase within the Government time scale.

The health care functions to be provided had to include:

- Accident and emergency
- Orthopaedics
- Breast Screening
- Orthodontics
- Pharmacy
- Theatre Suites
- Pathology
- Paediatric inpatients
- Women's and children's services.
- Occupational health
- Physiotherapy, occupational therapy
- In-patient care
  - Radiology
  - Rehabilitation therapy
  - Cardiology
  - Renal Unit
  - Opthalmology
  - Audiology
  - Ear, nose and throat
    - Outpatients
  - Care of the elderly
    - Surgery
    - High dependency unit
  - Dietetics

Support functions also need to be provided including:

- Main hospital building;
- Energy centre;
- Main hospital entrance;
- Staff accommodation;
- A principal bus set down and pick up point;
- An all–movement junction
- Car parking for staff, patients and visitors;
- Peripheral screen planting
- Emergency access.

Funding was to be achieved through the Private Finance Initiative, enabling the Swindon and Marlborough NHS Trust to commission the construction of the hospital.
Sustainability was a functional requirement in response to Government policy which insists that all public procurement should be environmentally, economically and socially sustainable as far as possible.

The Construction Solution

The Great Western Hospital at Commonhead, Swindon, near Junction 15 of the M4 is to be a six storey, L-shaped building with 55,000 m of floor space. There is to be 19% more clinical space, and some services which the current Princess Margaret Hospital does not offer. It will include environmentally friendly measures such as energy saving and reduction of noise and light pollution. There will also be landscaped grounds and some special facilities for staff. The Hospital Company (Carillion) contracted to finance, design and build the hospital buildings at a cost of £100 million, and then maintain them and provide all non-clinical services for a period of 27 years.

The Cumberland Infirmary

Background

Carlisle had three hospitals operating on two sites[5]. By rationalising three hospitals on to the Cumberland Infirmary site, it was possible to gain both clinical and operational improvement to the provision of health care.

The Client Need

The Carlisle NHS Hospital Trust needed to improve the scope, quality and efficiency of its healthcare provision to people in the Carlisle catchment area.

The Functionality Drivers

Rationalisation of secondary health care provision to a single site location, including the following clinical services[6]:

- Day hospital, with integrated rehabilitation unit, occupational therapy, physiotherapy, speech therapy, disablement services, hydrotherapy pool;
- Day surgery, opthalmic surgery, and endoscopy facility;
- Unified imaging department with X-ray, CT and MRI scanners;
- Accident and emergency;
- Audiology;
- Breast Screening;
- Cardiology;
- Coronary care unit;
- Dermatology department;
- Diabetic clinic
- Dieticians;
- Ear, nose and throat department;
- Fracture clinic;
- Genito Urinary Medicine clinic
- Intensive Therapy Unit
- Maternity, including Labour, delivery, recovery, post-partum rooms plus operating theatre;
- Mortuary;
- Obstetrics and gynaecology clinic;
- Opthalmology;
- Oral and Maxillo facial surgery;
- Orthodontics;
- Outpatients;
- Paediatric clinic;
- Pharmacy;
- Public Health Laboratory;

- Renal unit;
- Rheumatology;
- Special care baby unit
- Operating theatres including for day surgery and maternity.

Supporting services included:

- Medical records storage and retrieval;
- Pathology including biochemistry, haematology and histopathology;
- Sterile services;
- Stores;
- Staff changing areas;

- Chapel;
- Individual bedside (pay) TV screens and telephones;
- Helipad.

The design needed to co-locate departments in a functional way, Accident and Emergency next to the Imaging department; and operating theatres near to the Intensive therapy unit.

The internal layout was designed for flexibility, so that walls and partitions could be moved speedily and cost effectively in the event of a change of use.

A life cycle replacement programme for components and fittings is to be operated by the management company in order to maintain the specified level of functional performance throughout the hospital's life.

The new facility had to be constructed close to the then existing facility without disrupting it or the patients.

Funding was to be achieved through the Private Finance Initiative, enabling the Carlisle Hospitals NHS Trust to commission the construction of the hospital.

Specific non-clinical service provision must include facilities management, engineering and estate, hotel services, logistics, catering, security, laundry, linen, helpdesk services, non-emergency transport, car park management, reception, telecommunications and accommodation.

Sustainability is a functional requirement in response to Government policy which requiring all public procurement to be environmentally, economically and socially sustainable as far as possible.

The Construction Solution

A three-storey, 474 bed hospital has been built on the site of the existing Cumberland Infirmary, including 33,000 square metres of new construction, and 10,000 square metres of retained buildings. Health Management (Carlisle), a consortium of the Building Property Group Ltd. and AMEC Group, contracted to finance, design and build the hospital buildings at a capital cost of £57 million, and then maintain it and provide all non-clinical services for a period of 45 years.

New Build of Barnhill School, Hillingdon

Background

A new school was needed to replace an existing school, which no longer met required standards for educating local children in the 11 to 18 age group.

The Client Need

Hillingdon London Borough Council needed to provide new space within the Borough for educating 1450 school children between the ages of 11 and 18. The Department for Education adopted the formal client role in the procurement of the school.

The Functionality Drivers

The required facilities included:

- an assembly hall;
- a dining hall;
- catering facilities;
- library;
- special needs unit;
- information technology suite;
- large sports hall;

- teaching areas for humanities, maths, science, English, modern languages, art and technology;
- facilities suitable for breakfast club and after school clubs for the pupils, starting at 0700 hrs and ending in the evening.
- The indoor environment needed to be stimulating and exciting, and avoid looking institutional;
- Circulation areas needed to enable ease of movement;
- The outdoor environment needed to create stimulating external spaces for the pupils to learn, play and relax in safely, while also enabling staff supervision;
- The Private Finance Initiative was used as the procurement route in line with Government policy to achieve better whole life value for public money;
- Government policy also requires that all public procurement should be environmentally, economically and socially sustainable as far as possible;
- The strict Department for Education and Employment guidelines for the construction of new schools had to be adhered to;
- An Environmental SEAM (Schools Environmental Assessment Method, based on the BRE Environmental Assessment Method, BREEAM) rating of at least level B was required.

The Construction Solution

A new school of floor area 12,000 square metres and able to accommodate 1450 pupils was built under the Private Finance Initiative between Hillingdon Borough Council and a consortium led by Jarvis Construction (UK) Ltd. The design concept consisted of five linked faculty buildings which form a series of enclosed private and semi-private courtyard spaces. Important functional relationships between departments were established from the outset and led to the links and interconnections, which are vital to the delivery of the school curriculum. The PFI provider will maintain the school for 25 years.

Pullar House, 35 Kinnoull Street Perth

Background

The Client Need

Perth and Kinross Council needed a new building to accommodate the 720 staff employed in the Planning and Development Services Department. The site of the old fabric dying factory was selected in the context of extensive consultation with the local community.

The Functionality Drivers

- Office accommodation was required for 720 council staff;
- A central Perth location was required within easy reach (100 m) of the main bus station;
- A Private Finance Initiative procurement route was used in line with Government policy for public procurement to achieve better whole life value;
- A BREEAM assessment was required to demonstrate good environmental sustainability;
- Government policy requires that all public procurement be environmentally, economically and socially sustainable, as far as possible;
- The Council performance specification had to be met
- The building was to be maintained by the PFI provider, Kinnoull House Ltd. on behalf of the Council.

The Construction Solution

A three storey office building, with a gross floor area of 9,900 square metres, has been constructed in the centre of Perth, on the site of an old fabric dying factory. The construction re-used the original stone street facades to form the south and west elevations. The ground, which was contaminated with diesel oil, was treated during the site regeneration. The council procured the building through a PFI scheme from Kinnoull House Ltd, a consortium set up to deliver the project and consisting of Morrison plc and the Royal Bank of Scotland.

References

1 Croydon Council *Tramlink – A light rail system for Croydon and beyond* 1996?

2 Welsh Office *A55 Bryngwran to Holyhead Environmental Statement – Non technical summary* June 1996

3 Swindon and Marlborough NHS Trust *The Great Western Hospital – Healthcare for the new century* Information Booklet, from the Redevelopment team, Princess Margaret Hospital, Okus Road, Swindon, SN1 4JU.

4 www.carillionplc.com/general-hospital/swindon

5 www.b-and-p.com/html/carlisle.html

6 Health Management (Carlisle) plc *Cumberland Infirmary Carlisle – PFI Project Summary*

5.2 Three UK Examples of Functional Statements

Three examples of Statements of Requirement
Josephine Prior PhD and Kathryn Bourke MPhil

Introduction

A performance based building project must always begin with a Statement of Requirements. The Statement of Requirements is the Client's need expressed as an *Output Specification*. It applies to all types of constructed asset, both buildings and infrastructure. The Statement of Requirements must not be in design or engineering terms. The Output Specification is a statement of requirements which says what the facility is there to do, for instance:

- house x number of people, of which y are men and z women; and
- enable a, b and c activities;
- with d aesthetic requirements.

The Output Specification should *not* say:

- how big the building should be;
- what shape it should be;
- how heavy a load the floor should bear.

Such design and engineering issues are best dealt with by a combination of members of the supply chain, each one having some specialist knowledge which the client does not normally possess, in collaborative discussion with the client's key representatives.

A design can be judged against the Output Specification as it develops, by always asking the question "*does this do what the Client wants?*" The emphasis on functional performance in principle minimises the all too common problem that a design, as it develops from an "outline brief" couched in design terms, becomes something that does not work for the client once it is built.

Statement of Requirement No. 1

The Building Down Barriers pilot project at Wattisham gives a good example of a Statement of Requirement in its Strategic Brief (Holti et al, 1999). The purpose of the new facility is simply described:

"*The army needs to be able to train two regiments of soldiers on the Wattisham airfield site*".

There is no mention of a new facility, only a statement of need at a location.

The next section of the Wattisham Strategic Brief then goes on to define details of users, their requirements and some data on performance indicators, including:

- numbers of soldiers in a regiment;
- numbers of women in a regiment;
- numbers of soldiers to be trained each day;
- numbers of soldiers needing showering and changing facilities;
- the ambient temperature needed in different parts of the facility;
- the training equipment required;
- the size of each item;
- frequency of use of each training item;
- etc.

There was no mention even that a new *building* was required. The Prime Contractor was able to assess the existing facility with a view to refurbishing it, and to compare that option with the possibility of demolishing the old facility and replacing it with a new one.

Nothing in this Strategic Brief constrained the Prime Contractor from considering (with help from Army Staff responsible for training on the site) any sensible option in the effort to find the best possible solution to the client's need "*to train two regiments of soldiers*".

In reality, a performance based sports and training facility Statement of Requirements benefits from reference to Regulations set by society to ensure that minimum standards of, for instance, safety and hygiene are met. These regulations are easy to follow and establish parameters which are measurable, thus making it easy and effective to demonstrate compliance.

Statement of Requirement No. 2

Table 1 (below) illustrates the Output Specification for accommodation required by sailors and female naval staff at junior ranks (Construction Excellence, *Project SLAM*; Ministry of Defence, *Project Strategic Brief: FASLAR*). The detailed requirements or "functions" are limited for our example to the living space requirements, but in the full Output Specification, detailed requirements are set out for every individual *Function* to be covered by the Prime Contract. The full Output Specification runs to some 36 pages, excluding appendices.

The need for new and high quality living accommodation was driven by the fact that junior service personnel were not fulfilling the investment made in their training, because they were leaving the service early. A major reason for this was poor living accommodation.

The Statement of Requirement for single living accommodation focuses on the activities which need to be supported within it. Careful thought has been given to those activities and areas which need to be private to an individual, and those which can readily be shared within a small community. It is very costly to design a whole facility from first principles. It is more practical and effective to concentrate design effort in areas where it can add most value. The Joint Services Publication Scales publish standard provisions such as recommended usable floor areas, which have evolved over the years, are achievable and easy to demonstrate, and which are known to work. Design effort can then be put into fitting out the accommodation with furnishings enabling the different activities to be achieved. But, there will be a risk that recommendations and schedules of deemed-to-satisfy solutions become prescriptions.

Table 1 Part of Detailed Requirements for Junior Rates Accommodation

A Description: To provide Single Living Accommodation for Junior Rates

B Function:

Provide Living Space:	**Provide Communal**	**Provide Administrative Space:**
		○ Management

○ Sleeping
○ Studying
○ Relaxing
○ Secure storage
  ○ Personal items
  ○ Issued items
○ Ablutions
	Space:
	○ Washing and ironing clothes
	○ Washing personal equipment
	○ Live in / live out members
		○ Servicing

C Output:	**Provide Living Space**	
D Service Requirements:	**E Performance Standard**	**F Constraints or relevant information**
Provide Junior Rates and Women Royal Naval Staff (WRNS) with en-suite bed-sitting rooms to achieve the target occupancy level.	Fit for intended purpose and to Grade I en-suite standard. Areas to be comparable or better than JSP 315 Scale 3, standard Z. Note: The actual layout of the accommodation can vary providing the minimum floor area is met.	Specific requirements: ○ Single bed-sitting room with user controlled central heating. ○ En-suite shower room with washbasin, toilet, heated towel rail and shower. ○ Fitted with high bandwidth fibre cable services connection for telephone, television and internet access. ○ Personnel should be able to sign up to their own communications service agreement based on monthly charges. Associated requirements: ○ Access to potable water. ○ Access to a bath. ○ Access to secure storage for personal effects. Small power: ○ Sufficient for television, computer and equipment and peripherals, sound systems and other personal electrical equipment. (Suggest 2No double sockets at floor level and 2No at worktop level.) ○ An electrical shaver point. Relevant information: Data room.

Statement of requirement No. 3

Table 2 Requirements for an Officers' Mess Kitchen and associated accommodation

The highest level expression of the "Function" or Statement of Requirement for the Officers' Mess Kitchen is very general, but it covers *all* the activities which must be accommodated (Defence Estates, July 2003; Ministry of Defence, 1999). It divides the requirement into:

- essential activities to do with the preparation-cooking-disposal of food, and
- activities required in support of food handling, including resting, administration and storing personal and other items.

FUNCTION

To provide **Kitchen Space** for:

- Food preparation and cooking;
- Disposal of waste;
- Washing / cleaning.

To provide **other space** for:

- Rest facilities;
- Locker facilities;

Offices.

In order to deliver the facilities to support the activities identified in the high level "Function" or Statement of Requirement, an Output Specification is produced which gives scale to the requirement. The numbers of people to be fed at one sitting is defined, and some of the detailed activities are listed.

In reality, there are basic standards of hygiene and cleanliness for a kitchen and its support areas which must be adhered to for health and safety reasons. The quantities of food needed to feed given numbers of people are well known. The necessary space for their storage and preparation is also well understood. Therefore it is efficient and effective in design and delivery terms to follow standards and guidelines which are tried and tested and can be demonstrated easily to have been delivered. Solutions to meeting these guidelines are documented and prescribed.

OUTPUT 1: OFFICERS' MESS (including Mess Kitchen, Offices and Rest / Locker areas.)

Service Requirements	Constraints & Relevant Information
KITCHEN SPACE Provide kitchen and ancillaries to feed up to: ○ **361 Officers daily** ○ **800 Officers at functions**	Specific Requirements: ○ Kitchen area; ○ Crock wash area; ○ Larder area; ○ Vegetable preparation area; ○ Kitchen store area; ○ Kitchen office for chef; ○ Crockery, glass and kitchen linen store; ○ Cleaners' room and chemical store; ○ Wet refuse area; ○ Dry refuse area; ○ Compactor room/goods in and waste out area ○ Serving area and pantry; ○ Refrigerator store; ○ Grocery store; ○ Catering contractor's office. Other requirements: ○ Capable of feeding 361 in one sitting of 90 minutes; ○ Buffet style cocktail parties for 800. Relevant information: ○ Data room; ○ Specialist catering approval of design required; ○ Capability of handling formal functions.

Conclusion
All three of these forms of Statement of Requirement are taken from the Defence Estates Case Study. They deal with in turn:

- Sports and training facilities;
- living accommodation; and
- kitchen and food preparation facilities.

It is clear from each example that a general high level Statement of Requirement is made which relates only to the activities and functions which the facility needs to support. The Statement of Requirements describes the activities and functions that the facility needs to enable; it does not describe what should be provided. It is also clear that it would be possible to express some of the more detailed elements contributing to the delivery of the facilities in output terms too, but that we quickly arrive at a situation where deemed-to-satisfy solutions and prescriptions arise.

In practical terms there are some good reasons for the prescriptions which are given. Real life places significant constraints on time and money in the production of a constructed facility. Society demands that certain minimum regulatory standards are at least achieved, if not, surpassed. These standards are so important that deemed-to-satisfy and prescriptive solutions have arisen over time and with experience to give confidence that the minimum regulatory standards are achieved in given circumstances. It is then easy to show that a standard has been achieved, or to confidently predict that the standard will be met (with a prescribed solution), even if its performance is not actively measured. A decision has to be made as to where scarce resources should be applied at the design stage. It is sometimes more efficient to use tried and tested prescriptive solutions than it is to insist on a performance based approach at every level. This is why the Joint Services Publications are a mixture of performance statements, deemed-to-satisfy solutions and prescriptions.

The supply chain for any given building or construction project consists of a series of interconnected client supplier relationships. Most members of the chain are:
- suppliers to someone higher up the chain (i.e. nearer to the main client who pays for the work), and
- clients to those lower down (i.e. those who supply what they need to get the job done) (Austin et al, 2001).

Whether a given solution is a performance based innovation, or a prescription will depend largely on expertise of individual supplier to deliver. Where the requirement rests outside ready expertise, prescription will be used. Where requirement rests well within ready expertise, innovation may be used.

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5.3 Examples of Functional Statements from ASTM Standards on Whole Building Functionality and Serviceability

Functional Statements

Excerpts from ASTM Standards on Whole Building Functionality and Serviceability (2000)

Aspect: A.1. Support for Office Work

Functional Requirement

To support typical office work, occupants require technical support workplaces (additional to workplaces for individuals and groups) for photocopying, training, conducting interviews, and for storage, shipping and receiving. May require added technical support workplaces.

Aspect: A.2. Meetings and Group Effectiveness

Functional Requirement

To function effectively and productively when tasks require ad hoc or formal workgroups or project groups, occupants require meeting and conference rooms, group workrooms, and layouts suitable for group work and that facilitate informal meetings and interaction.

Aspect: A.3. Sound and Visual Environment

Functional Requirement

The sound and visual environments must ergonomically support people doing typical office work, including intensive use of visual display units. Required are suitable levels of speech privacy and speech intelligibility, freedom from distraction, disturbance and vibration, suitable lighting and freedom from glare, view to distance and outside, and local control over certain features of the environment. Fitup options must not be limited by the physical features needed to achieve suitable conditions.

Aspect: A.4. Temperature and Indoor Air

Functional Requirement

Temperature and indoor air must be ergonomically suitable for typical office work. Occupants must be able to adjust the indoor environment for comfort, and for work outside normal hours.

Aspect: A.5. Typical Office Information Technology

Functional Requirement

The facility must provide technical support for the typical equipment of office information technology. This includes one small computer and related equipment, cables and power for each person.

Aspect: A.6. Change and Churn by Occupants

Functional Requirement

The facility must accommodate increasingly rapid change in occupants' working method, including frequent relocation of staff and realignment of workstations, and do so with minimal cost and disruption.

Aspect: A.7. Layout and Building Features

Functional Requirement

Building configuration and grids, HVAC, and other features, must all enable occupants to do economical, efficient and functional layouts and space use.

Aspect: A.8. Protection of Occupant Assets

Functional Requirement

Building must permit appropriate level of protection of occupant premises and the information and other assets therein. This includes control of access to occupant premises, capability for appropriate security zoning within occupant premises, and security of building systems, such as cleaning, maintenance and renovation services, garbage, and key and control systems.

Aspect: A.9. Facility Protection

Functional Requirement

The site, building exterior, and building interior outside occupant premises, must provide an appropriate level of control and other protection.

Aspect: A.10. Work Outside Normal Hours or Conditions

Functional Requirement

Occupants must be able to do normal office tasks at specified times outside normal scheduled working hours and days. Under abnormal conditions, such as external or internal failure of services, (power outage, storm, etc.), some organizations need to have some employees continue to work during normal scheduled hours, and also outside scheduled hours.

Aspect: A.11. Image to Public and Occupants

Functional Requirement

Occupants require a workplace with an image that is functionally appropriate, and comparable to other organizations in the locality with similar business and scope.

Aspect: A.12. Amenities to Attract and Retain Staff

Functional Requirement

Occupants require the level of amenities that are appropriate, in the locality and the business environment, to assist in recruiting and retaining quality employees.

Aspect: A.13. Special Facilities and Technologies

Functional Requirement

Occupants require use of special services or facilities, such as large conference centre, teleconference facilities, simultaneous translation, satellite and microwave links, computer centre, or communications centre and media centre.

Aspect: A.14. Location, Access and Wayfinding

Functional Requirement

The facility must be readily accessible for all who work and visit, including public transit if in an urban site, and parking for those who drive. Staff and visitors must easily find their way within the building. If there are many visitors each day, or many visitors who are unfamiliar with the facility, then the requirements are particularly stringent.

Aspect: B.1. Structure, Envelope and Grounds

Functional Requirement

The building must be structurally strong enough to support the normal range of office contents; and some occupants have heavy loads such as open-shelf files, libraries or safes. The building envelope and grounds must be in good condition and function normally.

Aspect: B.2. Manageability

Functional Requirement

The building must be capable of meeting owner's requirements for reliable, economical operation, maintenance and energy efficiency.

Aspect: B.3. Management of Operations and Maintenance

Functional Requirement

Facility management must operate and maintain the facility through a series of conscious decisions that respond to the needs of the occupants, the budget limits of the organization, and the plans for the real property assets.

Aspect: B.4. Cleanliness

Functional Requirement

Facility management must operate the building so that an appropriate level of cleanliness is maintained, outside and inside, and in special spaces and functions such as toilets, washrooms, and waste disposal.

Impact of UK Building Regulations on PBB

PART 6

6 IMPACT OF UK BUILDING REGULATIONS ON PERFORMANCE BASED BUILDING

Josephine Prior PhD and Mike Clift RIBA

Introduction

The United Kingdom of Great Britain and Northern Ireland, consists of four separate countries, England, Wales, Scotland and Northern Ireland. Until recently, all were governed centrally from the Westminster Parliament in London. In recent years, Scotland and Wales have each adopted a devolved Government at national level. As far as operation of Building Law is concerned, England and Wales operate together and have their own Building Regulations. Scotland has for many years operated a slightly different legal system, including Building Regulations. Northern Ireland is again different, although in practice, the Building Regulations are very similar to those operating in England and Wales.

The United Kingdom Government develops and maintains Building Regulations for England and Wales which are predicated on a performance basis (see references, Office of the Deputy Prime Minister). The regulations set minimum allowable standards in specific areas including Health and Safety; the Conservation of Fuel and Power; and Provision of Access for disabled people. They are regularly updated with continual raising of the minimum standards.

This paper describes:

- the relationship between Performance and Building Regulations;
- Her Majesty's Treasury procurement rules and their relationship to performance;
- The specific ways in which the regulations deal with:
    - fire safety and engineering;
    - provision of access for disabled people; and
    - building materials through the European Construction Products Directive;
- The development and application of the United Kingdom Building Regulations;
- The Construction Design and Management (CDM) regulations.

Encouraging Performance in excess of Building Regulation requirements

In addition to Building Regulations, there are also non-mandatory design standards that are widely used, e.g. lighting levels, internal temperatures, usually set and developed by professional bodies such as the Chartered Institution for Building Services Engineers (CIBSE). In addition environmental standards such as BREEAM (Baldwin et al, 1998),are emerging as an 'added value' option for clients of certain building types including offices, housing, superstores and industrial buildings. A new version for general retail outlets is now in development.

BREEAM encourages environmentally sensitive design by awarding credits for designs which demonstrably achieve higher standards in defined areas, than those required by the Building Regulations. Like the Building Regulations, BREEAM is continually updated raising credit standards to keep them in excess of those required to meet the Building Regulations.

Architects and Structural Engineers are increasing their use of a performance basis to specification in design by avoiding the specific selection of products. This ensures the widest range of tenders, and may result in increasingly complex works packages. There is widespread use of the National Building Specification (NBS) guidance published by Royal Institute of British Architects. Building Control Officers visit the site to make sure the building is built to the design specification, and that it appears to satisfy at least the minimum performance demanded by the Building Regulations. Service engineers use Performance Based Design to allow the contractors to select the most suitable plant to match ductwork design and availability and cost.

Her Majesty's Treasury Procurement Rules
UK Government clients at both central and local levels are being encouraged to adopt output or performance specifications for their briefs. Planning authorities inspect plans to ensure that the design complies with town and regional planning regulations.

The United Kingdom Government in its Treasury Guidance Note No.7, on Whole Life Costs (November 2000) now demands that all (public sector) procurement must be made solely on the basis of value for money, in terms of Whole Life Costs. This means that there is a duty on suppliers to deliver services to clear standards which cover both cost and quality by the most effective, most efficient, and most economic means available.

Procurement is defined as the whole process of acquisition from third parties (including logistical aspects) and covers goods, services, and construction products. This process spans the whole life cycle from initial concept and definition of business needs through to the end of the useful life of an asset or the end of a services contract. (Peter Gershon, 1999).

Government departments have a wide range of possible options when purchasing. Outsourcing and the Private Finance Initiative have shifted the focus to thinking in terms of whole services such as the management of prisons rather than buying the goods and services necessary to deliver or manage the service. Her Majesty's Treasury recommends a comprehensive procurement strategy to cover this new holistic approach which should include:

- An analysis of key goods and services, their cost and priorities, which the department or agency needs to deliver its objectives and services;
- An assessment of the way these are purchased;
- The performance of key suppliers;
- The scope to improve value for money and quality of service.

Government also favours the use of Supply Chain Management as a technique for improving both value for money and quality in its purchases. Supply Chain Management is the process by which every stage of the procurement of goods and services is managed from beginning to end with the aim of improving the quality of the product or service being bought, to eliminate waste and excessive costs and to improve delivery times. It can extend from the end customer to the second or third level of sub-contractors. Prime Contracting (Defence Estates, Prime contracting on the MoD estate; Holti et al, 1999) is a good example of this.

Performance based procurement
The UK government has increasingly turned to building and construction procurement methods involving private finance. These methods include: Design Build Fund Operate (DBFO); Build Operate Transfer (BOT); Build Operate Own Transfer (BOOT); Private Finance Initiatives (PFIs); Public Private Partnership (PPP). The definition of quality in terms of performance criteria raises legal problems for construction procurement . The development of practical performance criteria is fraught with problems; and the legal framework may lay down liabilities in differing ways depending on whether the building, or constructed asset is specified according to a prescribed result, or by its performance. In the UK the duty on a designer may vary between a duty of care (design only) and a duty to provide a building fit for the purpose intended (design and construction).

The "Occupier Brief"
The United Kingdom Government is experimenting with a so called 'Occupier Brief', , through the Office of Government Commerce. The Occupier Brief describes the quality level that a facility has to have on delivery, in terms of performance specifications. It has to be considered in conjunction with an 'Output Brief' that describes the level of quality that has to be maintained during the period of use of the facility. The

Occupier Brief sets the standards and requirements of performance of the spaces occupied by the client organisation. It includes the following features:
A careful description of the (structure of) the client organisation
Design requirements for space;
Design requirements for engineering services;
Requirements for the information technology to be applied.

The Occupier Brief is set up in the context of a DFBM (Design-Finance-Build-Maintain) contract with a consortium that has to deliver and maintain fully facilitated workplaces for the organisation to be accommodated. Typical facilities include schools, hospitals, railways and roads.

Regulations on fire safety and engineering

Performance based fire safety design continues to develop in England and Wales and continues to be supported or underpinned by Approved Document B which is deemed-to-satisfy guidance and was last updated in 2000. Consequently much of the performance based fire safety design work is orientated towards providing an equivalent level of safety to the Approved Document. National Standards or Codes of Practice continue to be developed which again are effectively relatively prescriptive documents which are called up by the Approved Document. Codes of Practice or Application Guidelines for Fire Safety Engineering design of buildings have also been published by BSI; these are essentially Framework documents outlining procedures which should be followed.

Acceptance pr approval of designs is carried out by Local Authority Building Control or by Approved Inspectors; but there is still a significant regional variation in standards/judgement at the design assessment stage.

Many of the calculation or modelling techniques for use in fire safety engineering are still at an early stage of development as is the whole subject of fire safety engineering. There is a greater emphasis on 'Risk Assessment' as a means of mitigating potential events. The risk assessment approaches adopted tend to be very subjective – largely because there is not quantitative data available on frequency of events reliability of systems etc. Therefore the emphasis is on reducing risk to an acceptable level as opposed to attempting to quantify some form of performance.

Legislation will soon be enacted (Regulatory Reform Bill) which will result in a shift in emphasis on responsibility for risk assessment and safety away from the regulators and enforcers and on to the owners/managers and occupiers of buildings.
Performance based fire safety design continues to develop in England and Wales and continues to be supported or underpinned by Approved Document B which is 'deemed to satisfy' guidance and was last updated in 2000. Consequently much of the performance based fire safety design work is orientated towards providing an equivalent level of safety to the Approved Document. National Standards or Codes of Practice continue to be developed which again are effectively relatively prescriptive documents which are called up by the Approved Document. Codes of Practice or Application Guidelines for Fire Safety Engineering design of buildings have also been published by BSI; these are essentially Framework documents outlining procedures which should be followed.

Provision of access for disabled people

In October 2004, part III of the Disability Discrimination Act will come into force in England and Wales. It means that all service providers will have a duty to ensure that all people have equal access to goods, services and facilities, by making reasonable adjustments to the physical features of their buildings, and / or by revising management practices.

Many asset holders and service providers do not have a clear understanding of their obligations towards disabled people, or which issues to consider when making their existing buildings more accessible. To counter this, the Construction Industry Research and Information Association of the UK (CIRIA, 2004) has updated its 1996 publication *Buildings for all to use*. New regulations and standards have come into force including the new parts of the Disability Discrimination Act, Part M of the Building Regulations (to be released shortly), and British Standard BS 8300:2001 *Design of buildings and their approaches to meet the needs of disabled people. Code of Practice*, and a range of specific guidance for heritage buildings and others. The revised publication will include the new legislation and latest best practice (CIRIA News, Issue 4, 2003).

Building Regulations and materials
The United Kingdom carries out a great deal of research, development, certification, standards and regulatory work on materials. The Government is proactive in setting minimum performance standards for materials within the Building Regulations. It also has a prominent role in developing European Harmonised Standards through the Construction Products Directive. Much of this work has been done in the past, and continues to be done today by the Building Research Establishment (BRE), which employs many experts in the properties and testing of both natural and artificially made construction materials. The British Standards Institute (BSI) has an international reputation for developing performance and operational standards of all sorts. The British Board of Agrement (BBA) is an internationally renowned certification body. Recently the BRE Trust which used to be known as the Foundation for the Built Environment (FBE), has taken over the ownership of the Building Research Establishment which was privatised in 1997. The BRE Trust also owns BRE's sister company, BRE Certification, which was created when BRE purchased the Loss Prevention Council (LPC).

Building Regulations, their development and application
The United Kingdom Building Regulations are made under powers provided in the Building Act 1984, and apply in England and Wales. The current edition of the regulations is The Building Regulations 2000 (as amended) and the majority of building projects are required to comply with them. They exist to ensure:

- the health and safety of people in and around all types of buildings (i.e. domestic, commercial and industrial);
- conservation of energy;
- access and facilities for disabled people.

The Building Regulations Division of the Office of the Deputy Prime Minister is responsible for the formulation of the regulations and prioritising and programming reviews of the regulations.

The Building Regulations Advisory Committee (BRAC), is an 'advisory non departmental public body'. The Committee advises the Secretary of State on the exercise of his power to make Building Regulations. In practice BRAC is consulted on all matters concerned with changes to the Building Regulations - both technical and procedural.

The main work of BRAC is conducted in five committee meetings per year; whilst advice on more technical aspects is developed and carried forward through working parties comprising BRAC members, co-opted members where appropriate, and officials of the Building Regulations Division. The main BRAC meetings are attended by observers from other government departments and advisory organisations including the BRE Trust (used to be known as the Foundation for the Built Environment), of which BRE is a wholly owned subsidiary.

Ideas for new regulations or changes to existing ones are handled by the Building Regulations Division.

Builders, developers and owners are required by law to obtain **building control approval** - an independent check that the Building Regulations have been complied with. There are two types of building control providers - the Local Authority and Approved (private) Inspectors

Practical guidance on ways to comply with the functional requirements in the Building Regulations is contained in a series of Approved Documents.

Each Document contains:

- general guidance on the performance expected of materials and building work in order to comply with each of the requirements of the Building Regulations;
- practical examples and solutions on how to achieve compliance for some of the more common building situations – deemed to satisfy.

The Approved Documents are grouped as follows:

Approved Document (AD)	**Content**
Approved Document A	Structure
Approved Document B	Fire safety
Approved Document C	Site preparation and resistance to moisture
Approved Document D	Toxic substances
Approved Document E	Resistance to passage of sound
Approved Document F	Ventilation
Approved Document G	Hygiene
Approved Document H	Drainage and waste disposal
Approved Document J	Combustion appliances and fuel storage systems
Approved Document K	Protection from falling collision and impact
Approved Document L1/2	Conservation of fuel and power
Approved Document M	Access to and use of buildings
Approved Document N	Glazing
Approved Document for Regulation 7	Workmanship

Table 1 Approved documents

The guidance in the documents does not amount to a set of statutory requirements and does not have to be followed if the designer or builder wants to carry it out in some other way, providing it can be shown that it still complies with the relevant requirements. The guidance will be taken into account when the Building Control Service is considering whether the plans of the proposed work, or work in progress, comply with particular requirements.

However, there is a legal presumption that if the guidance has been followed, then this is evidence that the work has complied with the Building Regulations. It is still the job of the Building Control Service to consider whether the plans and work comply with the relevant requirements in Schedule 1 to the Building Regulations – not whether they necessarily follow the specific guidance or a specific example in an Approved Document.

'Building Work' is defined in Regulation 3 of the Building Regulations. The definition means that the following types of work amount to 'Building Work':

- erection or extension of a building;
- installation or extension of a service or fitting which is controlled under the regulations;
- alteration project involving work which will be relevant to the continuing compliance of the building, service or fitting with the requirements relating to structure, fire, or access and facilities for disabled people;
- insertion of insulation into a cavity wall
- underpinning of the foundations of a building.

The following Table describes Schedule I to the building Regulations 2000. It includes a list of all the Requirements from A to N, and a brief explanation of each one.

Schedule I of Building Regulations 2000 - requirements	**Explanatory note**
Structure **A1 Loading** (1) The building shall be constructed so that the combined dead, imposed and wind loads are sustained and transmitted by it to the ground - (a) safely; and (b) without causing such deflection or deformation of any part of the building, or such movement of the ground, as will impair the stability of any part of another building. (2) In assessing whether a building complies with sub-paragraph (1) regard shall be had to the imposed and wind loads to which it is likely to be subjected in the ordinary course of its use for the purpose for which it is intended.	This requirement gives basic parameters for the structural design of mainly domestic scale traditionally constructed buildings – ie masonry walls and concrete foundations, timber roofs and floor construction *Section 1 Sizes of structural elements for certain residential buildings and other small buildings of traditional construction* Mainly only relevant to domestic and small scale buildings *Section 2 External wall cladding* This section is primarily concerned with heavy cladding systems such as concrete panels, but some aspects are applicable to lightweight curtain walling. It provides guidance on supporting and fixing of external wall cladding which would present a hazard if it became detached. It sets out four basic requirements for cladding: • it must safely support dead, imposed and wind loads and transfer them to the structure • it should be securely fixed • there should be provision for accommodating differential movement between the cladding and structure • the cladding and its fixings should be of durable materials - the fixings need a service life at least equal to the life of the cladding. It notes that where the wall cladding is required to support other fixtures eg antennae, full account should be taken of the loads and forces arising from them. *Section 3 Re-covering of roofs* This acknowledges the fact that because a new roof covering may be heavier or lighter than the one it is replacing, the supporting roof structure should be inspected to ensure it is capable of sustaining the new load. *Section 4 Codes standards and references for Requirements A1 and A2* This section lists codes, standards and other references for structural design and construction of all buildings. It includes those relevant to loading, structural work for timber, masonry, reinforced, pre-stressed or plain concrete, steel, aluminium, foundations, ground movement and existing buildings.
A2 Ground movement The building shall be constructed so that ground movement caused by - (a) swelling, shrinkage or freezing of the subsoil; or (b) land-slip or subsidence (other than subsidence arising from shrinkage), in so far as the risk can be reasonably foreseen, will not impair the stability of any part of the building.	(a) Although not directly referenced, this refers to the effect that expansion and construction of subsoil could have on the stability of the structure (b) In Section 4 Codes standards and references for *Requirements A1 and A2*, there is also information on a series of reviews and geotechnical conditions carried out under Government sponsorship covering land slip and subsidence.
A3 Disproportionate collapse The building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause.	*Requirement A3* applies only to a building having five or more storeys (each basement level being counted as one storey) excluding a storey within the roof space where the slope of the roof does not exceed 70° to the horizontal. This sets out how to approach disproportionate collapse such as the accidental removal of a support. The collateral impact should be not be disproportionate – considered to be not more than 15% of the area of a floor or 70 sq m whichever is less.
Fire safety **B1 Means of warning and escape**	The regulation considers three building types in this section – dwelling houses, flats and maisonettes, and buildings other than dwellings eg office buildings.

Schedule I of Building Regulations 2000 - requirements	**Explanatory note**
The building shall be designed and constructed so that there are appropriate provisions for the early warning of fire, and appropriate means of escape in case of fire from the building to a place of safety outside the building capable of being safely and effectively used at all material times.	Means of escape to a place of safety outside the building is considered under horizontal escape and vertical (staircase) travel to an exit. The regulation makes reference to BS 5588 Fire precautions in the design and construction of buildings. Most office buildings over one storey high are designed with two or more protected staircases leading directly to the outside. The actual number of stairs is dictated by travel distances, the need to avoid dead ends - where there is only access to one stair which may be blocked - and the number of occupants on a floor. In an office building, the maximum travel distance where escape is possible in more than one direction is 45 metres although there are some other issues that might reduce this to 30 metres and 18 metres for a single stair situation. Corridor widths are determined by the number of persons needing to use them and are the minimum width between any fixed obstructions and measured at 1500mm above the floor level. Handrails can protrude by up to 100mm. Stairway widths are determined by the numbers using them and the floors being served. The main structure, escape corridors and stairways are protected from fire - see B3.
B2 Internal fire spread (linings) (1) To inhibit the spread of fire within the building the internal linings shall - (a) adequately resist the spread of flame over their surfaces; and (b) have, if ignited, a rate of heat release which is reasonable in the circumstances. (2) In this paragraph "internal linings" mean the materials lining any partition, wall, ceiling or other internal structure.	There are three classes of lining materials - 3, 1 and 0, which is the 'best' or least combustible. The choice of materials for walls and ceilings can have a significant effect on the spread of fire and its rate of growth – even though they may not be the initial cause of the fire. This is very important in circulation spaces and escape routes where rapid spread could prevent occupiers from escaping. However the provisions do not generally apply to the finishes of floors and stairs because they are not involved in a fire until it is well under way. In any case the stairway is protected from fire for a given period, therefore until people should have escaped. Class 0 is appropriate for escape routes. Thin facings (0.5 mm or less) do not generally affect the classifications so walls and ceilings can be papered. Use of thicker laminates needs to be substantiated by tests. There are two properties of lining material that influence fire spread – the rate of flame spread over the surface when it is subjected to intense radiant heat and the rate at which it gives off heat when burning. Generation of smoke and fumes must also be considered – although not covered by this Regulation.
B3 Internal fire spread (structure) (1) The building shall be designed and constructed so that, in the event of fire, its stability will be maintained for a reasonable period. (2) A wall common to two or more buildings shall be designed and constructed so that it adequately resists the spread of fire between those buildings. For the purposes of this sub-paragraph a house in a terrace and a semi-detached house are each to be treated as a separate	(1) Under fire conditions, the premature failure and collapse of the structure of a building can be avoided by designing the structural load bearing elements to have a minimum standard of fire resistance, in order to; • minimise the risk to the occupants, some of whom may have to wait for some time during evacuation - particularly if the building is a large one; • reduce the risk to fire fighters, on search or rescue operations; • reduce the danger to people in the vicinity of the building, from falling debris or the impact of a collapsing structure on nearby buildings.

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
building. (3) To inhibit the spread of fire within the building, it shall be sub-divided with fire-resisting construction to an extent appropriate to the size and intended use of the building. (4) The building shall be designed and constructed so that the unseen spread of fire and smoke within concealed spaces in its structure and fabric is inhibited.	Load bearing elements include structural frames, floors and load bearing walls. The roof and the bottom floor are not normally treated as structure under this regulation. The structure which supports the roof need not be fire resistant - except where it is supporting an external wall. Cladding which transmits only self-weight and wind loads may need fire resistance to satisfy the need to prevent spread of fire beyond a boundary. The structure in an office building would normally have a minimum period of fire resistance of 30, 60, 90 or 120 minutes depending on height. Compartment walls/floors, which are the fire-resisting walls and floors used to separate one fire compartment from another, are treated as structure for the purpose of this regulation, even though they are not necessarily load bearing – see (3). (3) The spread of fire within a building can be controlled by sub-dividing it into compartments separated from one another by walls and/or floors of fire-resisting construction. This prevents rapid fire spread which could trap occupants of the building; and reduces the chance of fires becoming large. Openings through compartment walls and floors should be minimised and fitted with fire resistant doors to the same standard. Holes for services should be: • sealed with eg intumescent sealants, • sleeved or fitted with fire dampers in the case of air ducts, or the services are made from a suitable non-combustible material such as cast iron or steel. (4) Voids above other spaces in a building, such as above a suspended ceiling, below a raised floor, in a roof space or within a cavity walling/cladding system, can provide a ready route for smoke and flame spread. Cavity barriers are fitted at intervals to restrict the spread. Openings through them should be kept to a minimum and should be treated generally in the same manner as penetrations through compartment walls.
B4 External fire spread (1) The external walls of the building shall adequately resist the spread of fire over the walls and from one building to another, having regard to the height, use and position of the building. (2) The roof of the building shall adequately resist the spread of fire over the roof and from one building to another, having regard to the use and position of the building.	(1) This sets out requirements to restrict the radiant heat of a fire in one building spreading the fire to other buildings nearby. The height of the building and the distance from the boundary dictate the amount of unprotected area of the external wall, such as doors and windows. There are requirements for restricting the combustibility of external walls to minimise the chances of them being ignited from an outside source and from spreading fire up the external face of the building. (2) This sets out rules aiming to prevent fire spreading from one building to another across the roof or from burning material landing on the roof.
B5 Access and facilities for the fire service (1) The building shall be designed and constructed so as to provide reasonable facilities to assist fire fighters in the protection of life. (2) Reasonable provision shall be made within the site of the building to enable fire appliances to gain access to the building.	In low rise buildings without deep basements access for fire brigade can be met by a combination of the normal means of escape, and the measures for vehicle access which facilitate ladder access to upper storeys. In other buildings the problems of reaching the fire, and working inside near the fire, need additional facilities to avoid delay in getting to the seat of the fire and to provide a safe operating base near to it. These additional facilities include firefighting lifts, firefighting stairs and firefighting lobbies, which are combined in a protected shaft.
Site preparation and resistance to moisture **C1 Preparation of site** The ground to be covered by the building shall be reasonably free from vegetable matter.	Turf and vegetable matter needs to be removed from the ground to be covered by a building to a sufficient depth in order to prevent later growth. Below ground services such as drainage, gas and water supplies should be strong or flexible enough to cope with roots. Joints should resist penetration by roots.

Schedule I of Building Regulations 2000 - requirements	Explanatory note
C2 Dangerous and offensive substances Reasonable precautions shall be taken to avoid danger to health and safety caused by substances found on or in the ground to be covered by the building.	If gaseous or solid contaminants are present they need to be removed, the building sealed from the source, or filling under the building with a material that will not adversely react to the contaminant. Gases such as radon and methane should be vented away from under the building.
C3 Subsoil drainage Adequate subsoil drainage shall be provided if it is needed to avoid (a) the passage of the ground moisture to the interior of the building; (b) damage to the fabric of the building.	Ground covered by buildings should be drained if the ground water could affect the building fabric. Otherwise the design of the building must be able to prevent ground water from entering the building or passing to materials that would be adversely affected by water.
C4 Resistance to weather and ground moisture The walls, floors and roof of the building shall adequately resist the passage of moisture to the inside of the building.	Moisture from the ground floor must be stopped from reaching the inside through walls and floors – rising damp. Moisture from rain and snow must be prevented from reaching the inside by the roof and walls – ie rain penetration. Moisture, including water vapour, must not be allowed to damage a material or structure to the point that it would create a danger to health or safety. It must not be allowed to permanently reduce the performance of insulating material.
Toxic substances **D1 Cavity insulation** If insulating material is inserted into a cavity in a cavity wall reasonable precautions shall be taken to prevent the subsequent permeation of any toxic fumes from that material into any part of the building occupied by people.	This is to ensure that the risk to health of persons in buildings is reduced from formaldehyde fumes given off by urea formaldehyde cavity foam installations.
Resistance to the passage of sound **E1 Protection against sound from other parts of the building and adjoining buildings** Dwelling-houses, flats and rooms for residential purposes shall be designed and constructed in such a way that they provide reasonable resistance to sound from other parts of the same building and from adjoining buildings. **E2 Protection against sound within a dwelling-house etc.** Dwelling-houses, flats and rooms for residential purposes shall be designed and constructed in such a way that – (a) internal walls between a bedroom or a room containing a water closet, and other rooms;and (b) internal floors, provide reasonable resistance to sound. **E3 Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes**	*Requirement E* of the regulations covers resistance to the passage of sound. The requirements of this part only apply to residential buildings (including in this case, hotels and the like) and to schools. *Requirement E* of the regulations does not apply to offices.

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
The common internal parts of buildings which contain flats or rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable. **E4 Acoustic conditions in schools** (1) Each room or other space in a school building shall be designed and constructed in such a way that it has the acoustic conditions and the insulation against disturbance by noise appropriate to its intended use. (2) For the purposes of this Part - "school" has the same meaning as in section 4 of the Education Act 1996[4]; and "school building" means any building forming a school or part of a school.	
Ventilation **F1 Means of ventilation** There shall be adequate means of ventilation provided for people in the building. **F2 Condensation in roofs** Adequate provision shall be made to prevent excessive condensation - (a) in a roof; or (b) in a roof void above an insulated ceiling.	*Requirement F1:* The provisions described in the guidance are aimed at: • extracting water vapour and other pollutants from where they arise in the building • enabling rapid dilution of damp or polluted air • providing a continuous supply of fresh air to the building by natural means, mechanical ventilation or, in non-domestic buildings, air conditioning systems. Guidance is given in two sections applying to domestic and non-domestic buildings respectively. The notes that follow concern the non-domestic guidance. The guidance is presented as a set of recommendations of general application, augmented by particular advice for spaces used for special purposes and for car parks. In the general recommendations, ventilation parameters are offered according to the purpose of the space: • sizes and design features are given for openable windows and for ventilators intended for rapid ventilation and background ventilation by natural means; • extract rates for mechanical ventilators and their controls are described where (in rooms such as kitchens and bathrooms) they are recommended as an additional provision or where they wholly or partially replace the natural ventilation (including where rooms cannot have windows owing to their location). Particular parameters are given for spaces where people congregate in large numbers. The use of passive stack ventilation is acknowledged in place of some fans. Where certain specialist activities take place, the document advises that requirement F1 can by complied with by following design guidance in other sources. References are offered for: • workplaces and in particular building services plant rooms • commercial kitchens There is also special guidance for the ventilation of smoking rooms ADF cites external references for the design of mechanical ventilation/air conditioning plant, and identifies sources of contamination that designers should seek to avoid when locating air inlets for such systems. *Requirement F2:* The aim of the guidance is that condensation should be controlled such that it does not degrade the performance of thermal insulation and the structure. Guidance is given on the ventilation of the space above the insulation in pitched and flat roofs. Depending on the roof design, this may entail purpose made ventilation openings of specified size at the eaves and at the ridge. For flat roofs (and roofs containing accommodation where the insulation follows the pitch of the roof) minimum heights are specified for the void above the insulation.
Hygiene	This comprises three distinct parts.

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
G1 Sanitary conveniences and washing facilities (1) Adequate sanitary conveniences shall be provided in rooms provided for that purpose, or in bathrooms. Any such room or bathroom shall be separated from places where food is prepared. (2) Adequate washbasins shall be provided in (a) rooms containing water closets; or (b) rooms or spaces adjacent to rooms containing water closets. Any such room or space shall be separated from places where food is prepared. (3) There shall be a suitable installation for the provision of hot and cold water to washbasins provided in accordance with paragraph (2). (4) Sanitary conveniences and washbasins to which this paragraph applies shall be designed and installed so as to allow effective cleaning. **G2 Bathrooms** A bathroom shall be provided containing either a fixed bath or shower bath, and there shall be a suitable installation for the provision of hot and cold water to the bath or shower bath. **G3 Hot water storage** A hot water storage system that has a hot water storage vessel which does not incorporate a vent pipe to the atmosphere shall be installed by a person competent to do so, and there shall be precautions - (a) to prevent the temperature of stored water at any time exceeding 100°C; and (b) to ensure that the hot water discharged from safety devices is safely conveyed to where it is visible but will not cause danger to persons in or about the building.	*Requirement G1* Sanitary conveniences and washing facilities. The Building Regulations Requirement G1states the need to provide adequate and cleanable sanitary conveniences and their associated washing facilities, supplied with hot and cold water and installed in suitable rooms away from food preparation areas. The corresponding guidance in ADG describes the minimum facilities to meet the requirement and how they should be accommodated in relation to kitchens etc. It describes in rather general terms the desirable characteristics of fittings - for cleanliness, and the essential features of the water supply and waste discharge. *Requirement G2* Bathrooms. This requirement of the building regulations applies only to dwellings and is not therefore relevant to offices. *Requirement G3* Hot water storage. This requirement concerns the safe installation of unvented hot water storage vessels. Technical guidance on how this can be achieved is offered in ADG in two sections, depending upon the size and power rating of the system. Systems up to 500 litres and 45kW Such storage systems are to be approved proprietary units installed by competent persons. They should incorporate on of the measures to prevent overheating of the water as specified in the document. Recommendations are made for the pipework to carry away water discharged by safety systems. Pipe sizes and routes are described. Discharge pipes should be of metal and, although not a specific recommendation, could typically terminate outside of the building. Systems over 500 litres or over 45kW It is acknowledged that these will be individually designed systems inappropriate for type approval. Recommendations are given for their design which essentially mirror the guidance for the smaller systems.
Drainage and waste disposal **H1 Foul water drainage** (1) An adequate system of drainage shall be provided to carry foul water from appliances within the building to one of the following, listed in order of priority- (a) a public sewer; or, where that is not reasonably practicable, (b) a private sewer communicating with a public sewer; or, where that is not reasonably practicable, (c) either a septic tank which has an appropriate form of secondary treatment or another wastewater treatment system; or, where that is not reasonably practicable, (d) a cesspool. (2) In this Part "foul water" means waste water which comprises or includes - (a) waste from a sanitary convenience, bidet or appliance used for washing receptacles for foul waste; or (b) water which has been used for food preparation, cooking or washing. **H2 Wastewater treatment systems and cesspools** (1) Any septic tank and its form of secondary treatment, other wastewater treatment system or cesspool, shall be so sited and constructed that - (a) it is not prejudicial to the health of any person; (b) it will not contaminate any watercourse, underground water or water supply;	Much of the guidance in ADH in relation to the *Requirement H1* concerns the design and construction of suitable sanitary pipework in buildings and the drains to which the sanitary pipework connects, the latter running within the building's grounds and the surrounding lands. The aim is a system which performs at minimal risk of blockage and leakage and which prevents foul air re-entering the building. It is to be ventilated, cleanable and should not increase the susceptibility of the building to flooding. Design details for the sanitary pipework include restrictions on the route of the system, suitable pipe diameters and gradients and connection details. Provisions to avoid syphonage are described including ventilation arrangements. Clearances between windows and ventilation openings into the system are specified. *Requirements H2 to H6* inclusive: The guidance given in ADH in relation to the latter five requirements has practically no special bearing on the internal design of buildings or the services within them.

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
(c) there are adequate means of access for emptying and maintenance; and (d) where relevant, it will function to a sufficient standard for the protection of health in the event of a power failure. (2) Any septic tank, holding tank which is part of a wastewater treatment system or cesspool shall be - (a) of adequate capacity; (b) so constructed that it is impermeable to liquids; and (c) adequately ventilated. (3) Where a foul water drainage system from a building discharges to a septic tank, wastewater treatment system or cesspool, a durable notice shall be affixed in a suitable place in the building containing information on any continuing maintenance required to avoid risks to health. **H3 Rainwater drainage** (1) Adequate provision shall be made for rainwater to be carried from the roof of the building. (2) Paved areas around the building shall be so constructed as to be adequately drained. **H4 Building over sewers** (1) The erection or extension of a building or work involving the underpinning of a building shall be carried out in a way that is not detrimental to the building or building extension or to the continued maintenance of the drain, sewer or disposal main. (2) In this paragraph "disposal main" means any pipe, tunnel or conduit used for the conveyance of effluent to or from a sewage disposal works, which is not a public sewer. (3) In this paragraph and paragraph H5 "map of sewers" means any records kept by a sewerage undertaker under section 199 of the Water Industry Act 1991 (**a**). **H5 Separate systems of drainage** Any system for discharging water to a sewer which is provided pursuant to paragraph H3 shall be separate from that provided for the conveyance of foul water from the building. **H6 Solid waste storage** (1) Adequate provision shall be made for storage of solid waste. (2) Adequate means of access shall be provided - (a) for people in the building to the place of storage; and (b) from the place of storage to a collection point (where one has been specified by the waste collection authority under section 46 (household waste) or section 47 (commercial waste) of the Environmental Protection Act 1990(**b**) or to a street (where no collection point has been specified).	

Schedule 1 of Building Regulations 2000 - requirements	**Explanatory note**
Heat producing appliances **J1 Air supply** Combustion appliances shall be so installed that there is an adequate supply of air to them for combustion, to prevent overheating and for the efficient working of any flue. **J2 Discharge of products of combustion** Combustion appliances shall have adequate provision for the discharge of products of combustion to the outside air. **J3 Protection of building** Combustion appliances and flue pipes shall be so installed, and fireplaces and chimneys shall be so constructed and installed, as to reduce to a reasonable level the risk of people suffering burns or the building catching fire in consequence of their use. **J4 Provision of information** Where a hearth, fireplace, flue or chimney is provided or extended a durable notice containing information on the performance capabilities of the hearth, fireplace, flue or chimney shall be affixed in a suitable place in the building for the purpose of enabling combustion appliances to be safely installed.	The first four of these requirements are intended to ensure that combustion appliances may be used safely in buildings with minimal risks to occupants as a result of the contamination of the indoor air by the products of combustion or due to high temperatures. The requirements apply to all buildings. However, the guidance in ADJ is primarily meant to be applied to "domestic scale" installations and its scope is limited to installations of less than: 75kW input rating for gas-fired installations; 50 kW and 45 kW rated output for solid fuel and oil-fired installations respectively. The corresponding guidance in ADJ is carried in four sections of which the first is of general application whilst the remainder (Sections 2,3,4) deal respectively with the particular measures to take for solid-fuel, gas and oil-fired appliances. Where ventilators are needed to supply appliances with air from outdoors or distribute it internally, guidance is given on ventilator sizing, design and location. Measures are described to avoid extract fans installed for other purposes creating pressure gradients incompatible with appliance operation. The document provides a substantial amount of detail on the design of flues. This includes flue cross sectional areas for various appliance types, flue heights, maximum offset angles and the design and location of flue outlets. The latter are given as separations from boundaries and features of the building envelope such as windows. Suitable products and constructional details are given for fluepipes and chimneys constructed in masonry, precast flueblocks and prefabricated metal systems. Methods of testing flue condition are described along with products and techniques for their refurbishment. The need to segregate appliances and their flues from combustible materials and from people is addressed, with minimum wall thicknesses for chimneys, restrictions on the paths to be taken by flues and with guidance on the design of hearths and fireplaces. A suitable data plate is described, for display in the building, listing the characteristics of installed flues and hearths. *Requirements J5 and J6* concern tanks, bottles and pipelines to store and deliver heating oil and LPG, where these are situated outside of the building. The associated guidance is to be found in Section 5 of ADJ. Its scope is effectively limited to systems of "domestic" scale, and larger systems are covered by legislation or codes issued by other authorities. The guidance is chiefly aimed at: • preventing the ignition of the stored fuel through shielding vessels from fires that may occur, installing fire valves in supply lines and ensuring the dispersal of LPG leaks; and • controlling the risk of groundwater pollution from leaking oil.
J5 Protection of liquid fuel storage systems Liquid fuel storage systems and the pipes connecting them to combustion appliances shall be so constructed and separated from buildings and the boundary of the premises as to reduce to a reasonable level the risk of the fuel igniting in the event of fire in adjacent buildings or premises. **J6 Protection against pollution** Oil storage tanks and the pipes connecting them to combustion appliances shall – (a) be so constructed and protected as to reduce to a reasonable level the risk of the oil escaping and causing pollution; and **(b)** have affixed in a prominent position a durable notice containing information on how to respond to an oil escape so as to reduce to a reasonable level the risk of pollution	These recommendations have minimal bearing on the building design although where tanks stand alongside buildings they can restrict the options for openings into the building envelope and affect the design of eaves.

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
Protection from falling, collision and impact **K1 Stairs, ladders and ramps** Stairs, ladders and ramps shall be so designed, constructed and installed as to be safe for people moving between different levels in or about the building. **K2 Protection from falling** (a) Any stairs, ramps, floors and balconies and any roof to which people have access, and (b) any light well, basement area or similar sunken area connected to a building, shall be provided with barriers where it is necessary to protect people in or about the building from falling. **K3 Vehicle barriers and loading bays** (1) Vehicle ramps and any levels in a building to which vehicles have access, shall be provided with barriers where it is necessary to protect people in or about the building. (2) Vehicle loading bays shall be constructed in such a way, or be provided with such features, as may be necessary to protect people in them from collision with vehicles. **K4 Protection from collision with open windows etc.** Provision shall be made to prevent people moving in or about the building from colliding with open windows, skylights or ventilators. **K5 Protection against impact from and trapping by doors** (1) Provision shall be made to prevent any door or gate - (a) which slides or opens upwards, from falling onto any person; and (b) which is powered, from trapping any person. (2) Provision shall be made for powered doors and gates to be opened in the event of a power failure. (3) Provision shall be made to ensure a clear view of the space on either side of a swing door or gate.	*Requirement K1:* ADK provides guidance on stair, ladder and ramp design that includes specifications for headroom, length of flights, landing areas and handrails. *Requirement K2:* Guidance in ADK describes upstands guarding the edges of floors, including edges below opening windows, with specifications for their height and strength. *Requirement K3:* ADK describes the use of vehicle barriers and approaches to safety in loading bays. *Requirement K4:* ADK offers alternative strategies for meeting the requirement: minimum headroom to the bottom of open windows; suitable barriers; or marking hazardous zones on floors. *Requirement K5:*(applies to sliding and powered doors, although lift doors are outside the scope of the requirement) The ADK guidance outlines technical measures to limit the movement of sliding and powered doors and recommends the use of vision panels in certain manual swing doors to allow occupants to see each other.
Conservation of fuel and power **L1 Dwellings**	*Requirement L1:* This is the counterpart to Requirement L2, which is discussed below. Neither the requirement is reproduced here nor is the corresponding Approved Document discussed as their subject matter is entirely concerned with the conservation of fuel and power in dwellings.
Conservation of fuel and power **L2 Buildings or parts of buildings other than dwellings** Reasonable provision shall be made for the conservation of fuel and power in buildings or parts of buildings other than dwellings by – (a) limiting the heat losses and gains through the fabric of the building; (b) limiting the heat loss i. from hot water pipes and hot air ducts used for space heating; ii. from hot water vessels and hot water service pipes (c) providing space heating and hot water systems which are energy-efficient; (d) limiting exposure to solar overheating; (e) making provisions where air conditioning and	*Requirement L2:* Part L2 of the Building Regulations concerns the conservation of fuel and power in non-domestic buildings. There is a single requirement to conserve fuel and power by achieving sub-goals (a) to (h). The Approved Document recognises three alternative techniques for complying with the requirement. The first of these is the Elemental Method. In this, the building complies with Requirement L2 if each element of its envelope and each of its energy-consuming building services achieves its individual performance target. The method is conceptually the simplest but although there are some permitted trade-offs between certain performance targets, it offers the least flexibility in building design. The other two methods are intended to allow more flexibility, but are more complex to apply. They are the Whole-Building Method and the Carbon Emissions Calculation Method. These two approaches can be adopted for the design of office buildings. Under each of these approaches, the building will meet the requirement if the operation of its heating, ventilation, air conditioning and lighting systems emits no more carbon per year than a specified benchmark.

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
mechanical ventilation systems are installed, so that no more energy needs to be used than is reasonable in the circumstances; (f) limiting the heat gains by chilled water and refrigerant vessels and pipes and air ducts that serve air conditioning systems; (g) providing lighting systems that are energy-efficient; providing sufficient information with the relevant services so that the building can be operated and maintained in such a manner as to use no more energy than is reasonable in the circumstances.	<u>The Elemental Method</u> Measures to comply with L2(a) are particularly likely to influence building design in ways that affect the building envelope. The measures should: limit the heat loss through the building envelope through the use of insulation; limit heat gains in summer; and minimise unnecessary air infiltration through the building fabric. Compliance with L2(a) by the elemental method in effect demands that the heat loss through the building envelope does not exceed that which would have obtained if: • the building were constructed of building elements (walls, floors, roofs and roof lights, windows and doors etc.) having U-values no greater than those listed in the document; and • having window, door and roof light areas no greater than as specified; and • having no significant additional heat paths at the junctions and edges of the elements as a result of thermal bridges and gaps in the insulation (references are given for advice on detailing to achieve this). Designers have some flexibility in how this performance target can be met using trade-offs between actual U-values for different elements and trade-offs with window areas. However, there are overriding maximum elemental U-values for wall and roof elements along with certain other constraints, including that daylight levels are adequate. ADL2 provides extensive tables of U-values for all of the aforementioned elements, constructed and insulated in various ways. Where elements such as walls and roofs have repeated thermal bridges, methods of calculating their U-values are identified and some example calculations given. It is also possible to calculate an acceptable trade-off between the average U-value of the envelope and the efficiency of the heating system, provided that this does not effect the rate of carbon emissions. The document explains how this can be done. The document offers advice to avoid solar overheating (except where calculation shows this not to be a problem in the particular case). The measures described include the specification of appropriate glazing, shading and limiting the area of glazing as a fraction of wall area – the maximum being dependent upon orientation. A method is provided for calculating the solar heat load per unit floor area under standard conditions and the document recommends that this should not exceed 25 W per m^2. The calculation shows the dependency of the heat loading on the use of internal blinds and different types of glazing (e.g. low e; reflective; absorptive). Concerning air infiltration through the envelope, the document sets a target average leakage rate of no more than $10m^3$ per hour per m^2 (of total building envelope) at an internal overpressure of 50Pa. It offers only an outline of how the building can be built to achieve this although references are given for more detailed advice on particular building types. Criteria for acceptable efficiency of heating plant are given and there is guidance on designing heating systems and their controls that make efficient use of energy. Standards are given for insulating pipes, ducts and vessels. ADL2 sets criteria for acceptable (building-averaged) efficiency in electric lighting and shows how this can be calculated for building types including offices. Advice is given on the provision of controls to enable the unnecessary use of artificial lighting to be minimised. Criteria are given for the minimum acceptable efficiency of air conditioning systems or mechanical ventilation systems, if these are to be installed in office buildings. The criteria are given as a "Carbon Performance Rating" and the document provides the procedure for its calculation. <u>Whole-Building Method</u>. This method has been developed as the Whole-Office Carbon Performance Rating Method as described in BRE Digest No. 457. The building will meet the requirement if the combined carbon emissions of its building services do not exceed limits expressed as kg Carbon per m^2 per year. The acceptance vary with building type and

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
	whether new or refurbished. Despite the greater flexibility, there remain some overriding maxima on envelope U-values and strictures to avoid unnecessary thermal bridges and gaps in insulation, as given for the Elemental method. <u>The Carbon Emissions Calculation Method</u> This is essentially similar to the Whole-Building method but the design should emit no more carbon than would a notional building of the same shape and size but designed to comply with the Elemental Method. **Work on existing buildings:** It may be noted that the level of provision (for example the degree of insulation of walls) needed to meet Requirement L2 when working on existing buildings will depend upon the circumstances and may not be as described above.
Access and facilities for disabled people **M1 Interpretation** In this Part "disabled people" means people who have - (a) an impairment which limits their ability to walk or which requires them to use a wheelchair for mobility, or (b) impaired hearing or sight. **M2 Access and use** Reasonable provision shall be made for disabled people to gain access to and to use the building. **M3Sanitary conveniences** (1) Reasonable provision shall be made in the entrance storey of a dwelling for sanitary conveniences, or where the entrance storey contains no habitable rooms, reasonable provision for sanitary conveniences shall be made in either the entrance storey or principal storey. (2) In this paragraph "entrance storey" means the storey which contains the principal entrance to the dwelling, and "principal storey" means the storey nearest to the entrance storey which contains a habitable room, or if there are two such storeys equally near, either such storey. (3) If sanitary conveniences are provided in any building which is not a dwelling, reasonable provision shall be made for disabled people. **M4 Audience or spectator seating** If the building contains audience or spectator seating, reasonable provision shall be made to accommodate disabled people.	Some of these requirements have a limited application to dwellings and within the supporting Approved Document ADM, the guidance is separated into that which does and that which does not apply to dwellings. The summary that follows is for non-domestic buildings. ADM provides guidance on designing for adequate access to buildings and into them. It deals with aspects of pedestrian approaches, such as their ramps, steps and handrails and the need to ensure these routes are negotiable by those with impaired vision. There is guidance on the selection of types and sizes of doors and on lobby dimensions. The issue of mobility within buildings is likewise addressed, with guidance on the design of doorways, including their size and on the use of vision panels. There are recommendations for internal lobby and corridor designs. There is guidance in connection with vertical circulation in buildings, in particular the provision and design of passenger lifts and stairs suitable for disabled use. To facilitate the use of buildings, there are recommendations specific to the design of hotel bedrooms, changing rooms and washing facilities and so that catering facilities can be used without assistance. A particular recommendation in ADM is that there should be aids to communication in certain locations using, for example, loop-induction or infra-red transmission systems. Sanitary arrangements are described, covering the design of facilities and their disposition within buildings. There is advice on what provisions for wheelchair users in theatres, sports stadia etc. would meet the requirements.
Glazing – safety in relation to impact, opening and cleaning **N1 Protection against impact**Glazing, with which people are likely to come into contact whilst moving in or about the building, shall – (a) if broken on impact, break in a way which is unlikely to cause injury; or (b) resist impact without breaking; or (c) be shielded or protected from impact	*Requirement N1 Protection against impact* The guidance describes locations (defined in terms of height relative to finished floor level in internal and external walls, partitions and doors) where glazing panels are regarded as posing their greatest risk. It recommends measures to reduce the risk in these circumstances by: • selecting glazing materials that break safely; or • using material that is inherently strong, or installing it in small panels; or • physically guarding glazing, such as with grilles and appropriate specifications are given in each case.
N2 Manifestation of glazing Transparent glazing, with which people are likely to come into contact while moving in or about the building, shall incorporate features which make it apparent	*Requirement N2 Manifestation of glazing* Manifestation, or marking, of glazing is required in critical areas where people moving in or around a building might not see an area of glazing and might collide with it.

Schedule 1 of Building Regulations 2000 - requirements	Explanatory note
	Examples of critical areas are fully glazed doors, and internal or external glazed walls. Manifestation can take the form of etched patterns or transfers applied to the glass at the normal sight level of those using the building.
N3 Safe opening and closing of windows etc. Windows, skylights and ventilators which can be opened by people in or about the building shall be so constructed or equipped that they may be opened, closed or adjusted safely.	*Requirement 3 Safe opening and closing of windows etc.* Provisions to ensure that controls for window opening can be safely reached and measures to prevent persons falling out of upper floor windows are described.
N4 Safe access for cleaning windows etc. Provision shall be made for any windows, skylights or translucent walls, ceilings or roofs to be safely accessible for cleaning	*Requirement 4 Safe access for cleaning windows etc.* Measures are described to give access to both sides of glazing for cleaning, where otherwise it could not safely be reached from the ground or other safe surface. Recommendations are to install windows of design (e.g. reversible) and size (criteria given) that enable all surfaces to be reached from within the building or provide various provisions to facilitate safe access from outside by ladders, walkways, cradles etc.
AD to support regulation 7 **Materials and workmanship** Building work shall be carried out - (a) with adequate and proper materials which (i) are appropriate for the circumstances in which they are used; (ii) are adequately mixed or prepared; and (iii) which are applied, used or fixed so as adequately to perform the functions for which they are designed; and (b) in a workmanlike manner. .	The main point of this AD is that compliance can be met by the use of proper materials of a suitable nature and quality in relation to their intended use. Workmanship should ensure that materials are adequately mixed or prepared, and applied, used or fixed so as to perform the intended functions. The AD gives details of how to demonstrate the fitness of materials. There is also reference to the environmental impact of building work and suggests consideration of the use of recycled and recyclable materials – subject to such materials not having an adverse implication on the health and safety standards of the building work. It refers to short-lived materials. The main issue here is that if materials that have a life shorter than the expected life of the whole building or building system are to be used they must be readily accessible for inspection, maintenance and replacement. This has an overriding proviso that the consequences of failure should not risk the health and safety of persons in and around the building. Materials that are likely to be affected by moisture can be used if they are protected from any likely damage from moisture and/or condensation. It notes that the performance some materials may be affected by certain environmental conditions. They can be used providing it can be shown that the residual properties are adequate for the intended function for the life of the building.

The Construction (Design and Management) (CDM) Regulations 1994

The CDM Regulations are aimed at improving the overall management and co-ordination of the health, safety and welfare of those involved throughout all stages of a construction project to reduce the large number of serious and fatal accidents and cases of ill health which happen every year in the construction industry. It also aims at improving the health and safety of those who need to look after the building

The CDM Regulations apply to most construction projects and all demolition. However, there are a number of situations where the Regulations do not apply. These include:

- construction work other than demolition that does not last longer than 30 days and does not involve more than four people;
- construction work for a domestic client,
- construction work carried out inside offices and shops or similar premises without interrupting the normal activities in the premises and without separating the construction activities from the other activities;
- the maintenance or removal of insulation on pipes, boilers or other parts of heating or water systems.

The CDM Regulations place duties on all those who can contribute to the health and safety of a construction project. Duties are placed upon clients, designers and contractors and the Regulations create a new duty holder - the planning supervisor. They also introduce new documents - health and safety plans and the health and safety file.

The role of the designer in construction safety

Designers are organisations or individuals carrying out design work for a construction project, including temporary works design. Under the Regulation, the term designer includes architects, engineers, quantity surveyors, chartered surveyors, technicians, specifiers, principal contractors and specialist contractors. Design includes drawings, design details, specifications and bills of quantity.

Designers play a key role within the construction project in ensuring that the health and safety of those who are to construct, maintain or repair a structure or building are considered during the design process. They have to consider the potential effect of their designs on the health and safety of those carrying out the construction work and others affected by the work. This means there will be a need to assess the risks of the design which can reasonably be foreseen. In the main, this will include risks to those persons building, maintaining or repairing the structure as well as those who might be affected by this work.

To ensure that risks to health and safety are fully considered, a risk assessment should be carried out to:

- identify the significant health and safety hazards likely to be associated with the design and how it may be constructed and maintained;
- consider the risk from the hazards which arise as a result of the design being incorporated into the project.

The design should be altered to avoid the risk, or where this is not reasonably practicable, reduce it to an acceptable and manageable level.

Conclusions

The United Kingdom Government develops and maintains a series of Building Regulations which are predicated on a performance basis. The regulations set minimum allowable standards in specific areas including:

- Health and Safety;
- Conservation of Fuel and Power; and
- Provision of access for disabled people.

The regulations are continually updated under the guidance of the Building Regulations Advisory Committee with the consequence that the minimum allowable standards are continually being raised.

The United Kingdom Building Regulations have been developed to emphasise the importance of overall performance targets, but they are still applied using deemed-to-satisfy solutions. While these are only intended to be examples, the reality of building control and monitoring is such that innovative alternatives to the published deemed-to-satisfy solutions are often rejected.

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Appendices

APPENDICES

Terminology

Selected Key Concepts and Terms related to Performance-Based Building (PBB)

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This update as of 2005-10-01

Posted at the ICF Website and hot-linked to the CIB PeBBu Website

These terms focus more specifically on the terms related to Statements of Requirements (SoR)

The text below includes a short overview of the PBB Conceptual Framework and some of the key concepts and terms used in relation to the preparation of Statements of Requirements (SOR). These apply particularly when using a PBB approach. When an explicit, measurable, distinction is made between the requirements of the users (demand) and the capability of the service or product, including Buildings, Facilities and other Constructed Assets (supply), to meet those requirements, Demand and Supply can be compared and the "gap" or "fit" between the two can be ascertained.

This can be summarized in the following manner: Functionality <-- Suitability -->Serviceability

The Performance Concept is Simple

After many discussions, the consensus within PeBBu is that the simplest, most useful, and clearest definition is contained in CIB Report #64:

> "The ***Performance*** approach is [..] the practice of thinking and working in terms of **ends** rather than means." (Gibson 1982, p4) [emphasis added]
>
> "It is concerned with **what** a building or a building product **is required to do**, and **not** with **prescribing how** it is to be constructed." (Gibson 1982, p4) [emphasis added]

The second sentence quoted above provides the focus of the Performance Based approach for the building and construction industry sector. Gibson explains further that:

> "In some parts of the building materials industry, performance specifications are known as "**end result**" specifications, while prescriptive specifications are known as "**recipe**" specifications. (Gibson, 1982, p4 footnote)

Performance Based Building (PBB) focuses on the target performance required for the business processes and the needs of the users. It is about defining the requirements and fitness for purpose of a building, constructed asset or facility, or a building product, or a service, right from the outset.

How does the prescriptive approach differ?

A prescriptive approach "describes **means** as opposed to ends, and [is] concerned with type and quality of materials, method of construction, workmanship, etc". (Gibson 1982).

The Nordic Model as a Point of Departure

The search for a different set of methods and tools to complement the traditional prescriptive ones has been taking place in many countries, in the public and private sectors, as well in the regulatory realm.

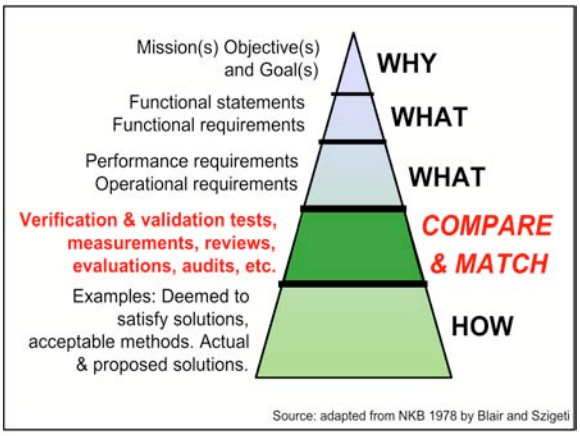

Figure 1. Adapted from the Nordic Model

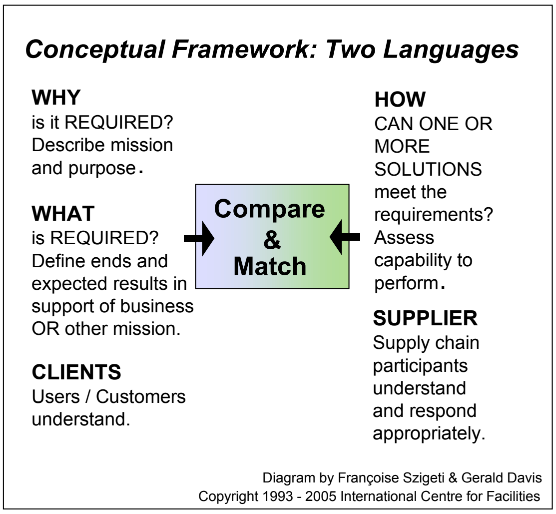

Figure 2. WHY + WHAT and HOW – Two languages
(Source: Szigeti, et al. 2005, p108)

Two Key Characteristics of the Performance Concept

Two key characteristics of the Performance concept are (1) the use of **two languages**, one for the demand for the performance and the other for the supply of the performance and (2) the need for **validation and verification of results** against performance targets.

Two languages -- The Performance concept requires two languages. On the one hand, there is a requirement (demand) and, on the other hand, there is a capability to meet that demand and perform as required (supply). The language of the client is needed on the demand side and the language of the provider is needed on the supply side. These are different and it is important to recognize this fundamental difference. (Figure 2)

It is not all one or the other

Using a Performance Based approach does not preclude the use of prescriptive specifications when the use of such specifications is more effective, efficient, faster, or less costly. When that is the case, it is useful to remember that prescription, whether in codes, standards, or specifications, is implicitly based on past performance, prior experience, observation, tests or study. Indeed, Gibson states:

> "In principle, all prescriptive specifications or design details for general use, [...] should state the level of performance expected to be achieved, where this can be confidently predicted from experiment, calculation or feedback from use. This can help provide continuity and consistency between design decisions taken at different stages of a project, and should also reinforce caution about making untested changes to established details or products, which can have a disastrous effect on their performance." (Gibson 1982, p4)

There is not yet enough experience with the Performance Based Building approach to do this consistently. Therefore, it is not likely that a facility will be planned, procured, delivered, maintained, renovated and used

using solely Performance Based documents at each step of the way, down to the procurement of products and materials.
Prescriptive specifications continue to be useful in many situations. Prescriptive codes, regulations and specifications are rooted in the experience of what has worked in the past—they are the expression of the performance embedded in the chosen solution and of the knowledge and experience of those who use them. PBB is part of a continuum. **It is not either performance or prescription**. Blending the two is often having the best o both worlds.

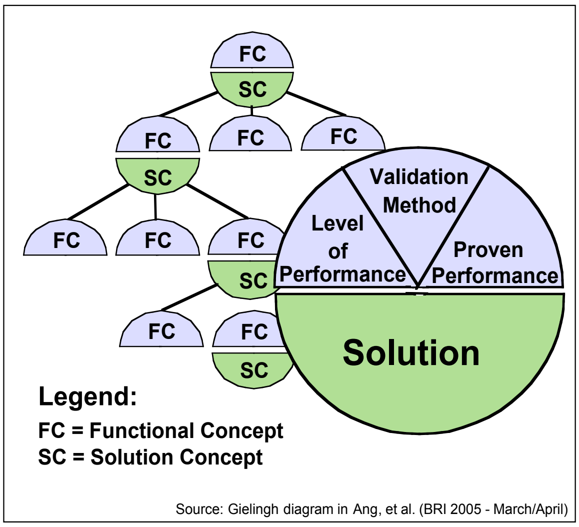

Figure 3. Adapted from The Hamburger Model

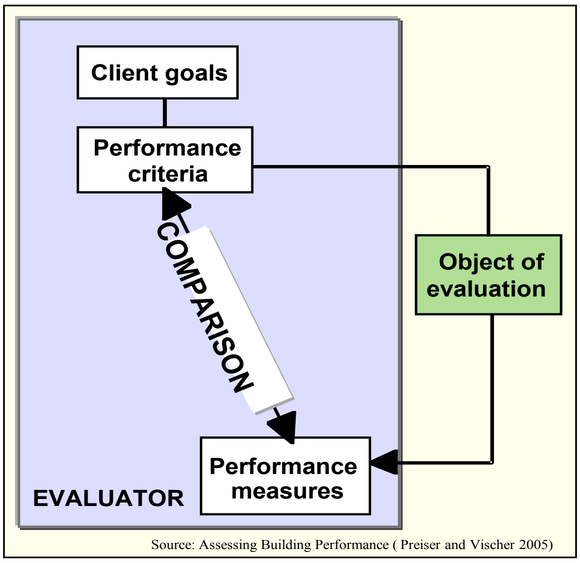

Figure 4. Basic feedback system

Conceptually, the dialog between client and supplier can also be expressed as two halves of a "hamburger bun", with the statement of the requirement in functional or performance language (FC) matched to a solution (SC). (Figure 3)

Evaluation, validation and verification: Tests, measurements, reviews, audits, etc.
Clients say, "At the end of the day, we need to be able to verify that what we get, at move in and over the life cycle of the facility, is what we asked for and paid for" (Hammond 2005). Evaluations and reviews as part of design, construction, commissioning, POEs, and benchmarking, need to refer back to explicit statements of requirements, otherwise they are based on perceptions, intuitions and guesswork. So, whether or not a "pure" performance approach is used, there is a need for making requirements more explicit and linking those requirements to the objectives for the project. Altogether, an evaluative stance is therefore useful throughout the Life Cycle of constructed assets. (Figure 4)

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Definitions of Performance and related terms

Performance (PBB approach) is the practice of thinking and working in terms of ends rather than means. It is concerned with what a building or building product is required to do and not with prescribing how it is to be constructed. (CIB Publication 64, 1982)

> NOTE: This definition has been agreed upon by consensus within the PeBBu members as the basis for understanding what PBB is about and as the foundation for all related definitions and concepts.

Performance is defined in ISO 15686 as "a qualitative level of a critical property at any point of time considered". It is also defined as "the desired characteristic, behavior or property of a building, system or component."

Performance (of a building) is the ensemble of clearly identifiable qualitative and quantitative characteristics of a building which make it possible to assess its ability to perform the different functions for which it was designed. In other words, it means the conditions that make a building suitable for its intended use. (Technical Building Code of Spain).

Performance (of a facility) is the behavior in service of a facility for a specified use.
(ISO/TC 59/SC3 Document N474: Performance standards in buildings – levels of functional requirements and levels of serviceability – Part 1: Principles)

Performance (in use) is the qualitative level of a critical property at any point of time considered (ISO/FDIS 15686 – 1:2000(E), 3.3.3)

Performance (brief): Client's design requirements for a building expressed in terms that do not limit the designer's choose of style, materials and methods. (PeBBu 2003)

Performance (requirements): These outline a suitable level of performance which must be met by building materials, components, design factors, and construction methods in order for a building to meet the relevant functional statements and, in turn, the relevant objectives. Requirements for a building or part of the building over its design life for a specific use expressed in terms that focus on the outcome rather than the input do not limit the choice of style, materials and methods and include pre-determined means of assessing this outcome.

> An example of a performance requirement in a building code is: A room or space must be of a height that does not unduly interfere with its intended function. (Guide to the Building Code of Australia 1996)

Performance (specification): Statement that defines the required performance of a building material, element, sub-system or system in a contract document. (ICF 2002)

Performance (standard): Standard that defines the required performance of a building material, element, subsystem or system. (ASTM E632)

Key related concepts

Fitness for Purpose: "Warranty of Fitness for Purpose" and "Fitness for Purpose" are concepts that have meaning within the ISO 9000 Guidelines, and also in terms of due diligence as understood in legal terms. There is an implied warranty that the supplier will deliver a product that is fit for the intended purpose defined by the buyer, or included explicitly and implicitly in a Statement of Requirements (SOR). This applies in particular to acquiring constructed assets by an integrated process such as design-build.

Functional Statement: A Functional Statement is a short statement of the **functional requirements** such as those included in the ASTM Standards for Whole Building Functionality and Serviceability at the front of each Aspect section, or that performance codes are including to describe what each objective, or sub-objective, is addressing.

Statement of Requirements: The term Statement of Requirement (SOR) is gaining currency, as applied to the definition of the requirement of the customer for any procurement. It is the comprehensive document that consolidates all requirements for a procurement and states the functional requirements from a performance / results stance. It is contrasted to a prescriptive / specification type of documentation.

Related concepts and terms include Statement of Need, Functional Statement, and Functional Program (or Brief) at several milestones in the project delivery for a building or facility. Several terms are used to identify the program prepared at these milestones, such as: organizational, strategic, planning, fit-out, furniture, and operational.

An SOR usually includes the following: Description of "user group/organization", Time/Schedule, Cost/Budget, Location, Quantity and Demographics, Levels of Functionality Requirements and matching Serviceability (equivalent indicators of capability), Technical Performance Statements, and other relevant information.

Statements of Requirements provide:
-- Requirements of occupants, organizations and other stakeholders,
-- the means to match / compar to
-- Physical Condition, Service Life, Security, and other aspects of the Performance of Buildings, Facilities and other Constructed Assets

> See Figure 1 in Meacham, B., Tubbs, B., Bergeron, D., and Szigeti, F., Performance System Model – A Framework for Describing the Totality of Building Performance, in *Proceeding of the 4th International Conference on Performance-Based Codes and Fire Safety Design Methods* (FSDM & SFPE), 2002.
>
> See also: SFPE (Society of Fire Protection Engineers) in collaboration with CIB W14, *Compendium of Objectives, Functional Requirements and Performance Criteria from Performance-Based Codes,* Washington, DC, USA, 2000.
>
> See also: ASTM (American Society for Testing and Materials), *ASTM Standards on Whole Building Functionality and Serviceability*, 2nd Printing, ASTM, West Conshohocken, PA, USA, 2000.

Key related terms

best use, *n* —most appropriate use of a facility, taking its serviceability and other factors into consideration. (Excerpt from draft update for ASTM Standard for Facility Management related terms -- E1480)

best match, *n* —most appropriate facility, compared to the stated requirements, taking all factors into consideration. (Excerpt from draft update for ASTM Standard for Facility Management related terms -- E1480)

DISCUSSION:
Process: Comparing functionality and serviceability levels. Analysis of the gaps between Functionality and Serviceability Profiles -- Adding costing information and other appropriate information -- Making trade-offs. - Making the final "informed" decision.
Result: Decision to buy, lease, keep, refit, renovate, re-use, up-grade, or dispose of owned or leased asset, to provide the facility best suited to the given requirements.

facility function, *n* —purpose or activity for which a facility is designed, used, or required to be used. (Excerpt from draft update for ASTM Standard for Facility Management related terms -- E1480)

functionality, *n* — being suitable for a particular use or function, ASTM E1480-92 (98)

facility performance, *n* —behaviour in service of a facility for a specified use. (Excerpt from draft update for ASTM Standard for Facility Management related terms -- E1480)

DISCUSSION:

The scope of this performance is of the facility as a system including its subsystems, components and materials, and their interactions such as acoustical, hydro-thermal, and economic, and the relative importance of each performance requirement.

facility serviceability, *n* —capability of a facility to provide the range of performances for which it is used or required to be used, over time, ASTM E1480-92 (98) -- proposed revision 2006

functional suitability, *n* —degree of match between the functionality requirement of a specific user and the serviceability of the facility being considered. (Excerpt from draft update for ASTM Standard for Facility Management related terms -- E1480)

See also "fitness for purpose".

facility suitability, *n* – the degree of "fit" between requirement and asset, considering (a) the functionality requirement compared to the serviceability rating, and (b) the requirement for service life and condition compared to the expected service life. (Excerpt from draft update for ASTM Standard for Facility Management related terms -- E1480)

facility durability, *n* —capability of a facility to maintain serviceability for a specified duration. (Excerpt from draft update for ASTM Standard for Facility Management related terms -- E1480)

List of Terms related to
Functionality, Suitability, Serviceability and Service Life

To accomplish the aims, objectives, goals, and targets of society, groups, and individuals, there is a trend to use a "performance approach" to define levels of expected results, describe levels that indicate that the service or product would provide the required results at the same level, and measure actual results. The terms below reflect this dialog between Demand and Supply in a consistent way.

Demand Uses - Needs – Requirements – Wants – Wishes	**Supply** Products, Services
Users Occupants – Facility Managers / Building Managers -- Portfolio Managers – Visitors Other stakeholders, such as investors, insurers, municipalities, code officials, etc.	**Constructed and other Assets** Facilities – Properties – Buildings – Building systems, components, products and materials Infrastructure assets, such as bridges, highways, municipal waste systems, etc. Materiel Other logistic support
Define / State / Set	Provide / Assess / Rate / Evaluate
Inputs	Outputs
Objectives, Ends, results, outcomes	Means, solutions
Functional statement	Performance statement
Statement of Requirements (SOR)	Explicit and implicit performance
Functional element	Physical Feature
Bundle of required functional elements	Combination of physical features
Functionality	Serviceability
Functional Performance	Technical Performance
Functionality Requirement Scales	Serviceability Rating Scales
User Functional Requirement	Asset / Facility capability
Functionality Profile	Serviceability Profile
Functionality Requirement Profile	Serviceability Rating Profile
Bundle of Functions	Combination of Features
Description of Functional element	Indicators of Capability
Demand for Functionality	Supply of Serviceability
Demand for Service Life	Estimated Service Life
Level of Functionality (0 and 1-9)	Level of Serviceability (0 and 1-9)
Level of Demand (0 and 1-9)	Level of Service (0 and 1-9)
Functional Requirement Technical Requirement Operational Requirement Criteria	Measure(s) Verification Test method Indicator, etc.

Notes:

1.In Building Condition Reports (BCR) or Facility Assessment Reports (FAR), if "functionality" is referred to, it is often a category of technical deficiency, which addresses the operative capabilities of a building component or system, not the user's requirements to be satisfied by the facility as it would be defined in the *ASTM Standards on Whole Building Functionality and Serviceability*.

2.These terms are compatible with the Performance System Model proposed by the Inter-jurisdictional Regulatory Collaboration Committee (IRCC) and with the terms used in the CIB Report 64.

Key Words

Who -- Actor / Role

____agents
____builders
____buyers
____contractors
____developers
____designers
____landlords
____owners-occupiers
____occupants
____providers
____stakeholders
____suppliers
____tenants
____users, such as passengers, patients, students, etc.
____visitors
____other (add)

When -- Stage / Phase

____ 00 portfolio and asset management
____0 strategic planning
____1 project initiation
____2 feasibility study / definition
____3 design
____4 construction
____5 commissioning / hand-over, including POE
____6 operation and maintenance
____7 use
____8 disposition / deconstruction
____other (add)

What

____building objects
____building elements
____building work
____buildings
____built environments
____components
____constructed assets
____constructions
____facilities
____infrastructure
____materials
____products
____properties
____real property
____structure
____systems
____other (add)

Performance related

____acceptable solutions
____aim
____aggregation
____agreements
____aspects
____attributes
____behavior in use
____briefs (documents)
____building performance
____characteristics
____criteria
____criticality
____demand
____dis-aggregation
____effectiveness
____efficiency
____fitness-for-purpose
____fitness
____functional elements
____functional programs
____functional requirements
____functional statements
____functionality
____functions
____goals
____granularity
____indicators of performance
____indicators of capability
____in-service performance
____levels
____levels of precision
____levels of required functionality
____levels of serviceability
____life cycle
____life cycle costs
____life cycle management
____mission critical
____mission dependency index
____objectives
____parameters
____performance
____performance based
____physical features
____program (document)
____prescription
____prescriptive
____programming
____quality
____qualitative requirements
____quantity
____quantitative requirements
____requirements
____serviceability
____serviceable
____service life
____statement of requirements
____suitability
____supply
____supply chain
____targets
____technical requirements
____user requirements
____other (add)

Verification

____assessments
____audits
____benchmarks
____benchmarking
____certification
____comparisons
____evaluations
____evaluation methods
____matching method
____performance measurements
____performance test protocols
____ratings
____tests
____test methods

___other (add)

Glossary

Glossary of Abbreviations, Acronyms and Initialisms
Prepared by Francoise Szigeti (ICF), Dr. Josephine Prior (BRE) and Kathryn Bourke (formerly with the BRE)

NOTE: This work has been internally funded by ICF and BRE.
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Abbreviation, Acronym, or Initialism Meaning

4ps	Public Private Partnership Programme (UK)
4RE's	Retrieve, Reuse, Revise, Retain
AAA	Alberta Association of Architects
ABCB	Australian Building Codes Board
ABP	Asset Business Plan
ABSW	Algemeen Bestek voor de sociale woningbouw General Standard (technical prescriptions) for social (subsidized by government) residential housing.
AC	Attestation of conformity
AC	Agrément Certificate This is the general European system for certification of products.
ACA	The Association of Consultant Architects (UK)
ACCA	The Association of Chartered Certified Accountants (UK)
ACE	Architects Council of Europe
ACE	Association of Consulting Engineers (UK)
ACES	The Association of Chief Estates Surveyors and Property Managers in Local Government (UK)
ACI	Asset Condition Index
AD	Approved Document (to the Building Regulations (UK)
ADA	The Americans with Disabilities Act. Ensures access to public accommodation for the handicapped. (USA)
ADAAG	ADA Accessibility Guidelines (USA)
ADEME	Agence de l'Environnement et de la Maîtrise de l'Énergie (FR)
ADP	Aéroports de Paris (FR)
AE	annual equivalent
AEC	Architecture, Engineering and Construction

AEI	Architectural Engineering Institute of the American Society of Civil Engineers (USA)
AfDB	The African Development Bank Group
AFNOR	Association Française de Normalisation (FR)
AFVF	French Association of Life Value Analysis (FR)
AGC	Associated General Contractors of America (USA)
AHP	Analytical Hierarchy Process
AI	Artificial Intelligence
AIA	American Institute of Architects
AICVF	Association des Ingénieurs en Climatique, Ventilation et Froid (FR)
AIE	Agence Internationale de l'Ënergie
AIJ	Architectural Institute of Japan
AIM	Alternative Investment Market
AIMCC	Association des Industries de Matériaux, Composants et Ëquipements pour la Construction (FR)
AISC	American Institute of Steel Construction
AM	Asset Management
AMP	Asset Management Plan
AMPRI	BOMA Indonesia
ANACI	Associazionne Nazionale Amministratori Condominiali e Immobiliari (Italy)
ANSI	American National Standards Institute
AO	Alternative Officing. A term for how, when and where people work.
AOD	Associated Owners and Developers (USA)
APCC	Australian Procurement and Construction Council
APCC	Associacao Portuguesa de Centrols Comerciais (Portuguese Council of Shopping Centres)
APMS	Asset performance measurement system
APPA	Association of Higher Education Facilities Officers (formerly Association of Physical Plant Administration) (USA)
approx.	approximately
APWA	American Public Works Association (USA)
AQC	Agence Qualité Construction (FR)
ARCOM	Association of Researchers in Construction Management (UK)
ARLA	The Association of Residential Letting Agents (UK)
ARSEG	Association des Responsables de Services Généraux. (The French Association of Facility Management) (FR)

ASCE	American Society of Civil Engineers
AsDB	Asian Development Group
ASEE	American Society for Engineering Education
ASF	anti-shatter film
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers (USA)
ASID	American Society of Interior Designers
ASIPA	Asociacion de Inmobiliarias con Patrimonio en Alquiler (Association of Spanish Property Companies) (Spain)
ASL	Architectural System Level
ASLA	American Society of Landscape Architects
ASP	Application Service Provider
ASTM	ASTM International, Inc., formerly American Society for Testing and Materials,Inc.
ASTM E06	ASTM Committee on Performance of Building Construction
ATG	Belgian Technical Approval
ATM	Automated Teller Machine
AUI	Asset Utilization Index
Aus-PeBBu	Australian Performance Based Building Network
AWS	Alternative Work Strategies
BAFO	Best and Final Offers
B2B	business to business
BALI	British Association of Landscape Industries (UK)
BARBi	Reference library for the Norwegian Building and Construction Industry
BBA	British Board of Agrément
BBRI	Belgian Building Research Institute (same as CSTC) (Brussels - Belgium)
BCA	Building Code of Australia
BCA	Building Control Authority (UK) The building control authority (BCA) is charged by central government to ensure within its areas that any building works are constructed in a safe, healthy manner and are also provided with adequate access for the disabled, and have provision for energy conservation.
BCA	Building and Construction Authority (Singapore)
BCCA	Belgian Construction Certification Association (operated by BBRI and SECO)
BCCI	Building Component Condition Index
BCE	Building and Construction Engineering (division of CSIRO - AUS)

BCI	Building Condition Index (derived from SCI)
BCIS	Building Costs Information System
BCO	British Council of Offices
BCR	Building Condition Report
BCR	Benefit-cost ratio (See also CBR)
BCSC	British Council of Shopping Centres
BDA	Building Design Advisor
Be	Collaborating for the Built Environment (Combined Design Build Foundation and Reading Construction Forum)
BEMS	Building Energy Management Systems
Bn	Billion
BENOR	Proof of conformity to performance specs re CPD 6 essential requirements (Belgium)
BEPAC	Building Environmental Performance Club U.K.
BGA	Building Government Agency (The Netherlands) (See also RGD)
BIAT	British Institute of Architectural Technologists (UK)
BIFM	British Institute for Facilities Management (UK)
BIFM	Bouw Fysich Informatie Model (Building Physics Information Model) (See Also BIM and FIM)
BIFMA	Business and Institutional Furniture Manufacturer's Association
BIM	Building Information Model (See Also FIM)
BIN	Belgian Institute for Normalization
BIUAS	Building in-use assessment system. Designed to assess seven key dimensions of employee experience of total work environment.
BLIS	Building Lifecycle Information/Interoperable Software project
BMAR	Backlog of Maintenance and Repair
BMF	Builders Merchants Federation (UK)
BMI	Building and Maintenance Information (a service of the RICS Building Cost Information Service Ltd.) (UK)
BMS	Building Management System
BN	Briefing Note (Ireland, PPP)
BOCA	Building Code of Southern Congress, now replaced by United States Unified Codes
BOD	biochemical oxygen demand
BOMA	Building Owners and Managers Association (USA)
BOMA International	Building Owners and Managers Association (International)

BOOT	Build Operate Own Transfer (a UK procurement method)
BOSTI	Buffalo Organization for Social and Technological Innovation
BOT	Build Operate Transfer (a UK procurement method)
BPA	Business Process Analysis
BPE	Building Performance Evaluation
BPEO	Best Practical Environmental Option
BPF	British Property Federation
BPI	Business Process Improvement
BPRU	(former) Building Performance Research Unit - was a division of BRE (UK)
BQA	Building Quality Assessment for Offices
BQF	British Quality Foundation (promoting business excellence)
BRANZ	Building Research Association of New Zealand
BRE	Building Research Establishment (UK)
BREEAM	Building Research Establishment Environmental Assessment Method (UK)
BRI	Building Related Illness. A medically identifiable disease with symptoms lasting an extended period. 1976 Philadelphia American Legion conv.
BRI	Building Research Institute (Tsukaba, Japan)
BRI	Building Research and Information (Journal) (UK)
BS	British Standard
BSA	Building Societies Association (UK)
BSBP	Building Services Best Practice
BSC	balance scorecard
BSI	British Standards Institute
BSJ	Building Services Journal (official Journal of CIBSE) (UK)
BSL	Building System Level
BSRIA	Building Services Research and Information Association (UK)
BTI	Building Technology Inc.
BUS	Building Use Studies (UK)
BTW	By the way
Butgb	Belgian Union for Technical Approval
BZ	bravo-zulu = well done
CABA	Continental Automated Building Association (North America)
CABE	Commission for Architecture in the Built Environment (UK)

CABS	Centre for Ageing and Biographical Studies
CAD	Computer Aided Drafting or Design
CAFIM	Computer Aided Facilities Information Management Systems
CAFMS	Computer Aided Facilities Management Systems
CAFM	Computer Aided Facility Management
CAFOM	Computer Aided Facilities Operational Management Systems
CAMS	Capital Asset Management System
CAPEB	Confédération de l'Artisanat et des Petites Entreprises du Bâtiment (FR)
CARM	Computer Aided Requirements Management
CAS	Condition Assessment Surveys
CASCO	Conformity Assessment Committee of ISO
CAT5	Computer Cable (colloquiallism)
CBA	Cost-benefit analysis
CBD	Case Based Design
CBD	Central Business District
CBDA	Case Based Design Assistant
CBE	Centre for the Built Environment (Glasgow) a joint venture between University of Strathclyde and Glasgow Caledonian University
CBI	Confederation of British Industry, The
CBO	Certified Building Official (USA)
CBPP	Construction Best Practice Programme (UK)
CBPR	AIA Centre for Building Performance and Regulations
CBR	Case-Based Reasoning
CBR	Cost Benefit Ratio (See also BCR)
CC	Construction Confederation (UK)
CCA	Canadian Construction Association
CCB	Construction Criteria Base (part of the Whole Building Design Guide (NIBS)
CCC	Confederation of Construction Clients
CD	Committee Draft (ISO)
CD-RW	Compact disk that is read and write capable
CD	Computer Disk (CD-ROM)
CD	Construction Documents (working drawings and specification) AIA
CDB	Caribbean Development Bank
CDM	Conceptual Data Model

CDM	Construction Design & Management Regulations UK (health and safety)
CDROM	Compact Disk Read Only Memory
CE	Constructing Excellence (UK merger of Construction Best Practice Programme and Rethinking Construction)
CE	Constructing Excellence (UK) combines Rethinking Construction, Housing Forum, LGTF, M4I
CEAB	Confederation Europeen des Administrateurs de Biens (European Confederation of Property Managers) (Beligium) part of CEPI
CEBE	Centre International d'Etudes de la Gestion des Bâtiments et Equipments (Canada)
CEBR	Centre for Economics and Business Research
CEC	Commission of the European Communities
CECODHAS	Comite Européen de Coordination de L'Habitat Social (Belgium)
CEED	Centre for Economic and Environmental Development (UK)
CEI-BOIS	European Confederation of Woodworking Industries
CEM	College of Estate Management (UK)
CEN	Comité européen de normalisation
CENELEC	European Committee for Electro technical Standardisation
CEO	Chief Executive Officer
CEPI	Conseil Europeen des Professions Immobilieres (European Real Estate Council) (Belgium)
CEPMC	Council of European Producers of Materials for Construction
CERF	Civil Engineering Research Foundation (USA)
CERL	Construction Engineering Research Laboratory (of the US Army) (SEE Also ERDC)
CES	Centre for Energy Studies, Indian Institute of Technology (New Delhi, India)
CFC	Chlorofluorocarbon
CFD	Computational Fluid Dynamics
CFI	Court of First Instance
CFM	Certified Facility Manager
CFO	Chief Financial Officer
CGTF	Central Government Task Force – Property and construction best practice development centre
CHD	Coronary Heart Disease
CHP	Combined Heat and Power
CI	Condition Index
CI	Construction Industry

CIB	Conseil International du Bâtiment (FR)
CIB	International Council for Research and Innovation in Building and Construction (ENG)
CIB	Construction Industry Board (UK)
CIB - TG	Task Group of the CIB
CIB - W	Working Group of the CIB
CIBA	Continental Intelligent Buildings Association
CIBdf	CIB development foundation
CIBSE	Chartered Institution of Building Services Engineers (UK)
CIC	Construction Industry Council (UK)
CICA	Confederation of International Contractors' Associations
CICSC	Construction Industry Council Standing Committee (UK)
CIFM	Computer Integrated Facility Management
CII	Construction Industry Institute (USA)
CIO	Chief Information Officer
CIOB	Chartered Institute of Building (UK)
CIPFA	Chartered Institute of Public Finance and Accounting (UK)
CIPS	Chartered Institute of Purchasing and Supply (UK)
CIRIA	Construction Industry Research and Information Association (UK)
CIRT	Construction Industry Round Table (USA)
CITA	Construction Information Technology Alliance
CITB	Construction Industry Training Board (UK)
CITC	Community Investment Tax Credit
CLG	Construction Liaison Group
CLI	Calling Line Identification
CML	Council of Mortgage Lenders (UK)
CMMS	Computerised Maintenance Management Systems
CMS	Content Management System
C-MU	Carnegie-Mellon University
CNMIS	Comité National du Matériel d'Incendie et de Sécurité (FR)
CNBR	Collaborative network for building researchers (International - Based in Australia at RMIT)
CNR-ICITE	Istituto Centrale per l'Industrializzazione e la Tecnologia Edilzia del Consiglio Nazionale delle Recherche (Milan, Italy)
COB	Close of Business (of a given day)
COD	Chemical Oxygen Demand

COL	Common Object Library
COM	Computer Output Microfilm
CONFEDILIZIA	Confederazione Italiana della Proprieta Edilizia (Italy)
COO	Chief Operating Officer
COPROP	The Association of Chief Corporate Property Officers in Local Government (UK)
CoreNet	Corporate Real Estate Network (combined NACORE and IDRC) (USA)
CPA	Chartered Professional Accountant
CPA	Construction Products Association
CPA	Critical Path Analysis
CPAIS	Corporate Property Information System
CPM	Critical Path Method
CPD	Construction Products Directive (European)
CPD	Continuing Professional Development (UK professional training scheme)
CPN	Construction Productivity Network (UK)
CPV	Common Procurement Vocabulary, developed by EC in all European languages
CPU	Central Processing Unit (computing)
CR	Case Retriever
CRCC	Co-operative Research Centre for Construction (Australia)
CRD	Central Reprographic Department
CRE	Corporate Real Estate
CREF	Centre for Real Estate Investment and Finance (Finland)
CREPAH	Conseil Recherche Étude pour la Planification et l'Amélioration de l'Habitât (FR)
CRI	Colour Rendering Index. The process by which light manufacturers rate fixtures. CRI refers to the color shift an object undergoes when illuminated by a light source. Natural sunlight provides a CRI of 100 (on a scale of 1 to 100)
CRI	The Carpet and Rug Institute (USA)
CRISP	Construction and City Related Sustainability Indicators (an EU FP5 Thematic Network)
CRISP	Construction Research and Innovation Strategy Panel (UK)
CRM	Customer Relations Management
CRM	Customer Relationship Management
CRM	Corporate Resource Management
CRS	Case Retrieval System
CRT	Cathode Ray Tube
CRT	Construction Round Table (UK, disbanded June 2001)

CRV	current replacement value
CSCE	Canadian Society of Civil Engineers
CSD	Case Studies Data Base
CSF	Critical Success Factors
CSI	Construction Specifications Institute (Canada)
CSIR	Building and Construction Technology (South Africa)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CSLA	Canadian Society of Landscape Architects
CSP	Constraint Satisfaction Problems
CSTB	Centre Scientifique et Technique du Bâtiment (FR)
CSTC	Centre Scientifique de la Construction (Belgian Building Research Institute in Brussels)
CTBA	Centre Technique du Bois et de l'Ameublement (FR)
CTD	Cumulative Trauma Disorders
CTE	Spanish Building Code (SP).
CTS	Carpal Tunnel Syndrome
CUAP	Common understanding of assessment procedure
CURT	Construction Users Round Table (USA)
CWC	Collaborative Working Centre (UK) (See also *Be*)

D&B	Design and Build (construction procurement method)
DAEI	Direction des Affaires Économiques et Internationales (FR)
DAFAG	Direction des Affaires Financières de l'Administration Générale (FR)
DAIS	Department of Administrative and Information Services (Government of South Australia)
dBA	Decibels A-weighting sound pressure level
DBIA	Design-Build Institute of America
DBF	Design Build Foundation (UK) Now part of "Be". (See also *Be* - Built Environment)
DBFO	Design - Build - Finance - Operate
DBFM-O	Design - Build - Finance - Manage and Operate
DBMC	Durability of Building Materials and Components
DBMC-10	International Conference on Durability of Building Materials and Components (10th - April 2005, Lyon, France)
DBMS	Database Management Systems
DBUR	Danish Building and Urban Research, the national building research institute in Denmark
DCF	Discounted Cash Flow

DD	Design Drawings (preliminary, schematic, and design development drawings) (AIA)
DDE	Direction Départementale de l'Ëquipement (FR)
DDI	Direct Dial In
DDSS	Design Decision Support System
DEBS	Design Economics for Building Services in Offices
DECT	Digital Enhanced Cordless Telephone
DEEP	Design Excellence Evaluation Process (UK Ministry of Defence)
DEFRA	Department of Environment, Food and Rural Affairs (UK)
DEG	Data Exchange Group
DETR	UK Government Department for Environment Transport and the Regions (disbanded 2001)
DFBM	Design Finance Build and Maintain, a performance based construction procurement method used in UK
DFBMO	Design, Finance, Build, Maintain and Operate, a performance based construction procurement method used in UK
DfEE	UK Government Department for Education and Employment
DGUHC	Direction Générale de l'Urbanisme, de l'Habitat et de la Construction (Plan Urbanisme, Construction, Architecture) Ministère de l'Equipement, des Transports et du Logement (FR)
DIAG.	the Directive Implementation Advisory Group (EPBD)
DIN	Deutsches Institut für Normung e.V.
DIP	Document Image Processing
DIT	Dublin Institute of Technology
DIY	Do It Yourself
DM	Deferred Maintenance
DQI	Design Quality Index / Indicator (a UK assessment tool for evaluating design quality)
DRC	Depreciated Replacement Cost
DSL	Design service life
DSS	Decision Support System
DST	Decision Support Tool
DTI	Department of Trade and Industry (UK)
DVDROM	Digital Versatile Disk Read Only Memory
dwg	drawing

E&B	Environment & Behavior
EB	Eurocer-Building
EB	External Benefit
EBC	European Builders Confederation
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EC	European Communities
EC	Energy consumption
ECA	European Centre for Accessibility
ECA	Electrical Contractors' Association (UK)
ECB	European Central Bank
ECCE	European Council of Civil Engineers
ECCREDI	European Council for Construction Research Development and Innovation
ECDG	European Commission Directorate General
ECI	European Construction Institute
ECJ	European Court of Justice
eCORE	eCore Software Solutions Inc (USA) (software and networking experts)
E-CORE	European Construction Research Network
ECOTECT	Commercial Design and Analysis (software package written by architects, for architects)
EDI	Electronic Data Interchange
EDM	EXPRESS Data Manager
EDM	Electronic Data / Document Management
EDRA	Environmental Design Research Association (USA)
EEA	European Economic Area
EEC	European Economic Community
EEPD	European Energy Performance Directive (EU) (See also EPBD)
EFBWW	European Federation of Building and Woodworkers
eFIG	European Federation of Interior Landscape Groups
E-FM	the Internet and Facilities Management
EFRO	Funding program for coal mining sites
EFMA	European Facilities Management Association
EFTA	European Free Trade Association
e.g.	for example
EI	Environmental Impact

EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIBG	European Intelligent Buildings Group
EIIM	Electronic Information and Image Management
ELI	Employer Liability Insurance
ELO	European Landowners' Organization
ELV	End of Life Vehicle
EMAS	Eco Audit Management Scheme (UK)
EMF	Electromagnetic Fields
EMI	Institute for Quality Control and Innovation in Building (Budapest, Hungary)
EMLV	European Mortgage Lending Value
EMP	Enterprise Management Plan
EMP	Environmental Master Plan. Identifies existing environmental issues and areas of both compliance and non-compliance. Identifies energy-saving opportunities; and evaluates building systems, the physical plant and operating parameters.
EMS	Energy Management System
EMS	Engineered Management Systems
EMS	Environmental Management System
EN	European Norm / Standard
EN	European Normalization
ENBRI	European Network of Building Research Institutes
ENHR	European Network for Housing Research
EOTA	European Organization for Technical Approvals
EOTA	European Organization for Technical Assessment
EOTC	European Oganization for Conformity Assessment
EPA	Environmental Protection Agency (USA)
EPA90	Environmental Protection Act 1990 (UK)
EPACT	Energy Policy Act of 1992 (USA)
EPAG	European Property Agents Group (Groupment Europeen des Agents Immobiliers) part of CEPI
EPB	Environmental Performance of Buildings
EPBD	the Energy Performance of Buildings Directive (EU) (See also DIAG and EPD)
EPD	Energy Performance Directive (EU) (See also DIAG, EEPD, EPBD)
EPM	Enterprise Planning and Management

EPM	Environmental Planning and Management
EPF	European Property Federation
EPIC	Electronic Product Information Coordination
e-PIMS	Electronic Property Information Mapping System (UK Government)
EPRA	European Public Real Estate Association
EQF	Element Quantity Ratio Factor
EQT	Leading private equity company N. Europe, with industrial strategy. Offices, Stockholm, Copenhagen, Helsinki, Munich owns TAC
ER	Essential Requirements
ERDC-CERL	Engineering Research & Development Centre - Construction Engineering Research Laboratory (of the US Army) (USA)
ERES	European Real Estate Society
ERI	Environmental Risk Index
ERM	Enterprise Resource Management
ERP	Enterprise Resource Planning
ESRI	GIS and mapping software
ESCO	Energy Saving Companies
ESL	estimated service life
ESLC	Estimated Service Life of a Component. A function of the RSLC and a number of factors relating to design, workmanship etc.
ETA	European Technical Approval
ETAG	European Technical Approval Guideline
ETLA	Research Institute of the Finnish Economy
ETSI	European Telecommunications Standards Institute
EU	European Union
EU FP(x)	European Union Framework Programme (number x)
EUEB	European Union Ecolabelling Board
EUR	Element Unit Rate
EVCA	European Private Equity and Venture Capital Association (promotes private investment to investors, policy, industry)
EVS	European Valuation Standards
EXPRESS STEP	ISO Standard (Standard for Exchange of Product Model Data) (See also STEP)
excl	exclusive
EZ	Enterprise zone

EZP	Enterprise Zone Program Operated by the Virgin Islands Development Authority to encourage investment in dilapidated structures and businesses in the Enterprise Zone (EZ).
FAC	Federation of Arab Contractors
FacQual	Facilities Quality Benchmarking Program
FAECOM	Finance, Architecture, Engineering, Construction, Operation & Maintenance (integrated technology for built environment)
FAR	Facility Assessment Report
FAR	Federal Acquisition Regulation (US Government)
FAR	Floor Area Ratio
FAST	Function Analysis Systems Technique
FBE	Foundation for the Built Environment (UK) owns BRE
FBNet	Fit Buildings Network
FBS	Function Behaviour Structure
FCI	Facilities Condition Index
FCI	Forum for Construction Industry (Ireland) Work on tendering processes, client guidance.
FCSC	Finnish Council of Shopping Centres
FCR	Facility Condition Report
FE	Further Education (UK)
FEE	Federation des Experts Comptables (European Federation of Accountants) (Belgium) represents accountants in Europe
FEHRL	Forum of European National Highways Research Laboratories
FEIC	European International Federation of Construction
FEMA	Federal Emergency Management Agency (USA)
FETA	Federation of Environmental Trade Associations (UK) Represents interests of heating industry.
FFB	Fédération Française du Bâtiment (FR)
FFC	Federal Facilities Council, National Academy of Sciences (USA)
FFE	Furnishings, Fixtures and Equipment
FFI	Fitness for Industry
FHE	Further and Higher Education (UK)
FIABCI	International Real Estate Federation (Paris, France) (Network open to all professionals involved with the property industry)

FIAPP	Fully Integrated & Automated Project Processes
FIATECH	Fully Integrated & Automated Technology Applications (USA) (Consortium, research integrating IT, automation & communications)
FIC/NIBS	Facilities Information Council of NIBS (USA)
FIDIC	International Federation of Consulting Engineers
FIEC	Federation de l'Industrie Europeenne de Construction (Brussels, Belgium)
FIIC	Federacion Interamericana de la Industria de la Construccion
FIM	Facility Information Model
FIMS	Facilities Information Management System
FiSIAQ	Finnish Society of Indoor Air Quality and Climate (have developed a classification for indoor environment including IAQ, temperature etc.)
FM	Facility Management
Fm	Factor Method
FMAA	Facilities Management Association of Australia
FMEA	Failure Mode Effect Analysis
FMECA	Failure Mode Effect and Criticality Analysis
FMJ	Facility Management Journal
FMN	Facility Management Nederland
FMOC/NIBS	Facility Management and Operations Committee of NIBS/FIC (USA)
FMP	Facility Management Professional.
FMS	Facility Management Simulation. A game introducing students to the field of Facilities Management.
FNPC	Fédération Nationale des Promoteurs Constructeurs (FR)
FORMAS	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
FPC	Factory Production Control
FPD	Flat Panel Display
FPE	Fire Protection Engineer
FRPC	Federal Real Property Council (US Federal group of senior execs)
FREF	Finnish Real Estate Federation
FRI	Full Repairing and Insuring
FRR	Facilities Revitalization Rate
FRV	Functional Replacement Value. The estimate of a building's space replacement.
FSDM	Fire Safety Design Methods (USA)
FSI	Farmer Sustainability Index

FSM	Facilities Sustainment Model
FTE	Full Time Equivalent
FTP	File Transfer Protocol (computing)
FUSCCA	Federation of United States and Canadian Contractors Associations
FYI	For Your Information
GAO	Government Accountability Office, US Federal Government (formerly General Accounting Office)
GARM	General AEC Reference Model (Australia)
GATT	General Agreement on Trade & Tariffs (world-wide)
GBA	Government Buildings Agency (The Netherlands) (See also RGD and VROM)
GCCP	former Government Construction Client Panel (UK) Now part of OGC
GDP	Gross Domestic Product (UK economics)
GDR	Group Decision Room
GDS	Group Decision Support
GEA	Gross External Area
GGU	Glasgow Caledonian University (UK, Scotland)
GHG	Greenhouse Gas [emissions]
GIA (UK)	Gross Internal Area
GIFA (UK)	Gross Internal Floor Area
GIFAS	Groupement de l'Industrie Française Aéronautique et Spatiale (FR)
GIS	Geographic Information System (mapping)
GML	Geography Mark-up Language
GN	Guidance Note
GNP	Gross National Product (UK economics)
GOA	Gross Outside Area
GPRA	Government Performance and Results Act of 1993
GPRS	General Packet Radio Service
GPS	Global Positioning System
GPT	Green Transport Plan
GRI	Global Real Estate Institute (New York and London offices) Mutual exchange between principals in real estate + related industries.
GSA	United States General Services Administration
GSF	gross square feet

gsm	grams per square meter
GT	Georgia Tech University (USA)
HAPM	Housing Association Property Mutual / Manual (UK) Company providing risk reduction and insurance.
HAZOP	Hazard and Operability Study
H&S	Health & Safety
H&SS	Health and Safety System
HB	Healthy Buildings
HCFC	Hydrochlorofluorocarbon
HDD	Hard Disk Drive
HDL	High Density Lipoprotein
HE	Higher Education (UK)
HEDQF	Higher Education Design Quality Forum (UK)
HEPA	High Efficiency Particulate Air Filters
HID	High Intensity Discharge. Fast becoming one of the most widely used types of industrial and commercial lighting.
HLM	Habitation à Loyer Modéré (FR)
HMC&E	Her Majesty's Customs and Excise
HOPE	Health Optimization Protocol for Energy Efficient Buildings – European research project run by TNO
HPD	Hearing Protection Device
HQ	Headquarters
HQE	Haute Qualité Environementale (FR)
HQE	Haute qualite environmental - a French certification environment tool
HR	Human Resources Group / Branch / Department in an organization
HSL	Human System Level
HVAC	Heating Ventilation and Air Conditioning
i	Interest earned by I Euro (or other currency) in one year at a given rate of interest percent ®
IAB	Irish Agreement Board
IaDB	Inter-American Development Bank
IAF	International Accreditation Forum (ISO)

IAI	International Alliance for Interoperability
IAP	Indoor Air Pollution
IAPS	International Association for People-Environment Studies (UK)
IAQ	Indoor Air Quality
IBC	International Building Code (single code document for the USA)
IBD	Formerly the Institute of Business Designers (now part of IIDA)
IBI	Formerly the Intelligent Buildings Institute (now defunct)
IBMS	Integrated Building Management System
IBN	Belgian Institute for Normalization
IBPE	International Building Performance Evaluation (network)
IBPSA	International Building Performance Simulation Association
IBRI	Icelandic Building Research Institute
ICBO	International Council/Conference of Building Officials (Uniform Building Code)
ICC	International Code Council (US -- Administers the IBC)
ICC	International Chamber of Commerce
ICCPM	International Conference on Construction Project Management
ICE	Institute of Civil Engineers (UK)
ICEC	International Cost Engineering Council
ICF	Informed / Intelligent Client Function
ICF	International Centre for Facilities (Canada)
ICIS	International Construction Information Society
ICT	Information and Communication Technology
ID	Identification Number
ID	Interpretative Document of the Construction Products Directive (CPD)
IDEA	the **I**mprovement **DE**velopment **A**gency (UK)
IDEFo	Integration Definition for Function Modeling
ID-IQ	Indefinite Delivery - Indefinite Quantity
IDQLI	Indefinite Delivery Quantity Line Item. Composed of small separate trade specific contracts instead of blanket contract.
IDRC	International Development Research Council (now combined with NACORE to form CoreNet)
IE	Energy Performance Regulations
i.e.	that is (id est)
IEA	International Energy Agency

IED	Improvised Explosive device
IEMA	Institute of Environmental Managers and Assessors
IEQ	Indoor Environmental Quality
IESNA	Illuminating Engineering Society of America
IET	Instituto de Ciencias de la Construcción Eduardo Torroja (Construction Science Institute Eduardo Torroja)
IFA WPCA	International Federation of Asia and Western Pacific Contractors' Association
IFCs	Industry Foundation Classes (IAI)
IFD	International Framework for Dictionaries
IFMA	International Facilities Management Association (USA)
IGLC	International Group for Lean Construction
IIDA	International Interior Design Association
IIEC	International Institute for Energy Conservation (USA)
iiSBE	International Initiative for Sustainable Built Environment
IHT	Inheritance Tax
ILO	International Labour Office
ILSA	Integrated Lighting System Assistant
IMBM	Institute of Maintenance and Building Management (UK)
IMC	International Mechanical Code (USA)
IMF	International Monetary Fund
IMT	Information Measurement Theory
inc.	inclusive
Inc.	Incorporated (corporate legal status)
INREV	European Association for Investors in Non-Listed Real Estate Vehicles (institutional investors, fund managers, investment banks)
INVESTIMMO	EU project on Maintenance, Retrofitting and Refurbishment programme
IOBC	Institute of Building Control (UK)
IP	Internet Protocol
IPC	International Plumbing Code (USA)
IPC	Integrated Pollution Control (UK)
IPF	Institute of Public Finance (UK)
IPFMA	Irish Property and Facilities Management Association (subsidiary of Services Organisations)
IRCC	Institute for Research in Construction - Canada

IRCC	Inter-jurisdictional Regulatory Collaboration Committee (International membership of national Code setting organizations)
IREM	Institute for Real Estate Management (USA)
IRM	Independent Resource Mechanism
IRR	Installations Readiness Report
IRR	Internal Rate of Return
ISDN	Integrated Services Digital Network (USA)
ISIAQ	International Society of Indoor Air Quality and Climate
ISO	International Standardization Organisation
ISO/TC 59	International Organization for Standardization Technical Committee 59 – Building Construction
ISO/TC 176	International Organization for Standardization Technical Committee 176 – Quality Management and Quality Assurance
ISOP	Invitation to Submit Outline Proposals
ISP	Internet Service Provider
IStructE	Institution of Structural Engineers (UK)
IT	Information Technology
ITB	Building Research Institute (Poland)
ITBC	Information Technology and Business Continuity
ITC	Istituto per le Tecnologie della Costruzioni (Milan, Italy)
ITC	Istituto Trentino di Cultura (Trento, Italy)
ITN	Invitation to Negotiate
ITS	Information Technology System
ITT	Invitation to Tender (See also RFP)
IVM	Institut de la Ville en Mouvement (FR)
IVM	Institute of Value Management
IVSC	International Valuation Standards Committee (non-government org, member United Nations; harmonise and promote valuation standards)
JAABE	Journal of Asian Architecture and Building Engineering
JCCS	Japan Construction Classification System
JFM	Journal of Facility Management (UK)
JFMA	Japan Facility Management Association
JIT	Just-in-time

JPCF	Journal of Performance of Constructed Facilities
JTEVA	Journal of Testing and Evaluation
JV	Joint Venture
K/k	thousands
KBMA	Korea Building Management Association
KBS	Knowledge Based System
Kbsps	Kilobytes per second
KC	Knight Cornell factor
KER	Key Estate Ratio (UK)
KPI	Key Performance Indicator (Measure - Analyse - Improve - Control)
KTI	Finnish Institute of Real Estate Economics (independent university-linked research institute)
KVA	Kilovolts per annum
kWh	kilo Watt hours
LAN	Local Area Network
LBG	Learning Building Group (UK)
LBNL	Lawrence Berkeley Lab
LCA	Life Cycle Analysis
LCA	Life Cycle Assessment
LCC	Life Cycle Costs or Life Cycle Costing
LCD	Liquid Crystal Display
LCI	Lean Construction Institute
LCIA	Life Cycle Impact Assessment
LCM	Life Cycle Management
LCR	Land Condition Report
LDI	Low Density Lipoprotein
LEAD	Leadership for Environment and Development (USA) (a global network of people and organizations committed to sustainable development)
LEC	Local Enterprise Companies
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design (USA) (environmental rating system)
LEP	Light emitting polymers

LexiCon	Dictionary structure created by STABU - The Dutch foundation responsible for the main standard in the Building Industry
LGA	Local Government Association (UK)
LGFA	Local Government Finance Act (UK)
LGTF	Local Government Task Force (UK)
LNE	Laboratoire National d'Essais (FR)
LOGS	Logistics
LPCB	Loss Prevention Certification Body (UK, insurer, part of BRE Certification)
Ltd.	Limited (corporate legal status)
LUX	Unit of illumination = I lumen / sq/m or .0929 ft candles
m	metre(s)
M	million
M&E	Mechanical and Engineering
Mb	Megabytes
MBR	Model Based Reasoning
Mbs	Megabytes per second
mBOMB	Model Based Operations and Maintenance of Buildings
MCA	Multi-Criteria Analysis
MCDA	Multi Criteria Decision Analysis enables a decision, taking account of conflicting management objectives
MDI	Mission Dependency Index
MEAT	Most Economically Advantageous Tender
Mhz	Mega hertz (unit of frequency)
MEP	Mechanical Electrical Plumbing
MEP	Member of the European Parliament
METL	Ministère de l'Equipement, des Transports et du Logement
MFD	Multi-functional Devices
MIIP	Municipal Infrastructure Investment Planning
MIDEM	**M**arché **I**nternational du **D**isque et de la **M**usique
MIMOSA	**M**achinery **I**nformation **M**anagement **O**pen **S**ystems **A**lliance
MIPIM	**M**arché **I**nternational des **P**rofessionels de l'**IM**mobilier
MIS	Management information systems
MLIT	Ministry of Land, Infrastructure & Transport

MLV	Mortgage Lending Value
MMC	Modern Methods of Construction (UK)
MMI	Man-Machine Interface
MOA	Memorandum of Agreement
MOP	Memory Organization Pattern
MOPS	Measured - Observed - Perceived - Simulated (POE performance measures)
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheets
MTA	Mid-Term Assessment (EU term for review half-way through a project)
MWD	Ministry of Works and Development (New Zealand)
NACORE	National Association of Corporate Real Estate Executives (now combined with IDRC forming CoreNet)
NAFTA	North American Free Trade Agreement
NAIR	National Arrangements for Incidents involving Radioactivity
NAPA	National Academy of Public Administration (USA)
NAR	National Association of Realtors (USA)
NAS	Newly Associated States (of Europe) (13 join CIB from Bulgaria, Czech Rep., Lithuania, Poland, Slovenia and Slovakia)
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NBC	National Building Code (BOCA, International, U.S.A)
NBI	Norwegian Building Research+B286 Institute
NBN	National Belgian Standard
NBRI	National Building Research Institute (Israel)
NBS	National Building Standards (UK)
NBS	National Bureau of Standards (now known as NIST) (USA)
NCCTP	Network of Construction Collaboration Technology Providers (UK)
NCIDQ	National Council for Interior Design Qualification (USA)
NCS	National CAD Standard (USA)
NCSBCS	National Conference of States on Building Codes and Standards (USA)
NDP	National Development Programme (Ireland) improvement of National Infrastructure
NEC	National Electrical Code (USA)
NECA	National Electrical Contractors Association (USA)

NEHRP	National Earthquake Hazards Reduction Programme (USA)
NEN	Norm (or standard) (The Netherlands)
NES	National Evaluation Service (USA)
NFPA	National Fire Protection Agency (USA)
nga	net grant-equivalent
NGO	Non Governmental Organization
NIA	Net Internal Area (UK)
NIBS	National Institute for Building Sciences (USA)
NIH	National Institutes of Health (USA)
NIH	Not Invented Here
NIOSH	National Institute for Occupational Safety and Health (USA)
NIST	National Institute of Standards and Technology (formally NBS) (USA)
NKB	Nordic Committee on Building Regulations (formulated the Nordic Model of conceptual approach to performance codes)
NLA	Net Lettable Area (UK)
NNDRM	National Non-Domestic Rating Multiplier (UK)
NOA	Net Occupiable Area (UK)
NOPA	New Office Promotion Association. Japanese trade organization sponsored by US Ministry of International trade and industry
NORAD	North American Air Defense (Treaty)
NPBA	National Pre-fabricated Building Association (UK)
NPV	Net Present Value
NRA	Net Rental Area (UK)
NRC	Noise Reduction Coefficient
NRCC-IRC	National Research Council of Canada - Institute for Research in Construction
NSERC	National Science and Engineering Research Council of Canada
NUA	Net Useable Area
NUS	National University of Singapore
NZBC	New Zealand Building Code
NZIA	New Zealand Institute of Architects
O&M	Operations and Maintenance
OA	Office Automation
OB	Optimism Bias

oBIX	Open Building Information Xchange
OCCS	Overall Construction Classification System, now known as Omni Construction Classification System (see also JCCS) - IAI/CSI Committee
OCR	Optical Character Reader
OCSD	Oxford Center for Sustainable Development
ODBMS	Object Database Management Systems
OECD	The Organisation for Economic Co-operation and Development
OFSTED	UK Office for Standards in Education
OGC	Office of Government Commerce (UK)
OGC	Open Geospatial Consortium
OH and P	Overheads and Profits
OIS	Optical Information System
OJ	Official Journal
OJEC	(Supplement to) the Official Journal of the European Communities
OJEU	As OJEC above
OL	Organizational Learning
OM	Organizational Memory
OMB	Office of Management and Budget (USA)
OMNICLASS	Classification developed by the IAI/CSI OCCS committee (SEE also OCCS)
OMSI	Operation and Maintenance System Information
ONS	Office for National Statistics (UK)
OPAC	Public Office of Concerted Development
OPN	Office Productivity Network (UK)
OPS	Operations
OPS	Office of Pipeline Safety (USA)
OSCRE	Open Standards Consortium for Real Estate
OSHA	Occupational Safety and Health Administration (USA)
OSP	Off-Site Production

pa	per annum
P&RTC	Physical and Recreational Training Centre
PABX	Private Automatic Branch Exchange
PA	Performance Assessment
PAM	Performance Assessment Method

PAMPeR	Portfolio and Asset Management Performance Requirements (IAI project)
PAMPeR/ED	Early Design Phase of PAMPeR project
PAPER	People and Physical Environment Research (Australasia) (cited in Kernohan et al participatory evaluation)
PB	Performance Based approach
PBB	Performance Based Buildings Concept
PBBCS	Performance Based Building Codes and Standards
PBD	Performance Based Design
PBX	Private Branch Exchange. A sophisticated digital computer linking the corporation to the public switched telephone network.
PC	Personal Computer
PCIB	Performance Concept In Building
PCSCB	President's Commission to Study Capital Budgeting (USA)
PCRD	Programme Cadre de Recherche Développement (de la Communauté européenne)
PDA	Personal Digital Assistant products. Hand held devices combining features of personal computer, electronic notepad etc.
PDAA	Penn Design Alumni Association
PDE	Product Data Exchange
PDF	Extension for Acrobat file format
PDF	Probability Density Function
PDT	Product Data Technology
PE	Professional Engineer
PeBBu	Performance Based Buildings Network
PeBBuCo	Performance Based Buildings, Compendium of Statements of Requirement
Perp	Perpetuity
PERT	Program Evaluation Review Technique
PEST	**P**olitical, **E**conomic. **S**ociological. and **T**echnological
PFI	Private Finance Initiative (UK)
PIA	Professional Interest Area (of American Institute of Architects)
PIP	Product Introduction Package
PI	Performance Indicator
PII	Professional Indemnity Insurance
PLEA	Passive and Low Energy Architecture International
PLI	Public Liability Insurance

PLM	Product Life Cycle Management
PM	Product Modelling
PMS	Product Model Server
PM4D	Product Model 4D
PMI	Project Management Institute (USA)
PMV	Predicted Mean Vote
POE	Post Occupancy Evaluation
PPD	Percentage of People Dissatisfied
PPD	Predicted Percentage of Dis-satisfied
PPE	Personal Protective Equipment
PPG	Planning Policy Guidance (UK)
ppm	Parts per Million
PPM	Planned Preventive Management
PPP	Public Private Partnership (UK)
PPP	Purchasing Power Parity
PPS	Belgian Public Private Co-operation (similar to pfi and ppp in the UK)
PPS	Predicted Percentage of Satisfied
PPT	Power Point software
PQQ	Pre-Qualification Questionnaire
PR	Public Relations
PROBE	Post Occupancy Review of Buildings and their Engineering (UK study 1995-2002)
PRV	Plant Replacement Value
PRV	Present Replacement Value
PSIB	Process and Systems Innovation Programme for the Building Industry – a large scale programme aimed at industry change (Netherlands)
PSM	Performance System Model
PSS	Product Service Systems
PSTN	Public Switched Telephone Network
PTM	Performance Test Methods (which simulate Performance in use - from CIB Report 64)
PTPT	Point-to-Point-Tunnelling (protocol)
PWGSC	Public Works and Government Services Canada
PWS	Performance Work Statement
QA	Quality Assurance

QBS	Quality Based Selection
QC	Quality Control
QFD	Quality Function Deployment. A methodology that interprets, ranks needs, details future requirements and provides focused plan. (UK)
QMF	Quality Managed Facilities
QMP	Quality Management Principles
QMS	Quality Mark Scheme (UK) Scheme to combat cowboy builders.
QMS	Quality Management System
QWL	Quality of Working Life
R	Rate of Interest = the amount earned by 100 (currency) in one year
R&A	Renovations/Repairs and Alterations
R&D	Research and Development
RAKLI	Finnish Association of Building Owners and Construction Clients
RDA	Regional Development Agency (UK)
Regs	Regulations
REIT	Real Estate Investment Trust
REN	Real Estate Norm (The Netherlands)
Reval	Revaluation
RFP	Request for Proposals, or Invitation to Tender
RFQ	Request for Qualification
RGD	Rijksgebowendienst - Dutch Government Buildings Agency - See also GBA, VROM
RIBA	Royal Institute of British Architects
RIC	Risk Identification and Control Mapping - RIC Maps
RICS	Royal Institute of Chartered Surveyors (UK)
RILEM	International Union of Laboratories and Experts in Construction Materials, Systems and Structures
RILEM	Reunion Internationale des Laboratories d'Essais et de recherche sur les Materiaux et les Constructions
RoI	Return on Investment
RM	Requirements Management
RM	Risk Management
RMIT	Royal Melbourne Institute of Technology
RMS	Repetitive Motion Syndromes

RR	Recapitalization Rate
RSA	Regional Selective Assistance (UK)
RSI	Repetitive Strain Injury
RSL	Remaining Service Life
RSLC	Reference Service Life of a Component
RTC	Resolution Trust Corporation. A US federal agency charged with disposing of all the real estate assets of troubled financial institutions
RTD	Research and Technical Development
RV	Rateable Value
SABLE	Simple Access to Building Lifecycle Exchange
SAM	Strategic Assessment Model
SAMIS	Strategic Asset Management Information System (Australia)
SAP	Standard Accounting Practice
SAP	Standard Assessment Procedure (Energy prediction calculation for compliance with Building Regulations UK)
SAPOA	South Africa Property Owners Association
SBC	Standard Building Code (a "model code" -- U.S.)
SBCCI	Southern Building Code Congress International - Standard Building Code (USA)
SBI	Danish Building and Urban Research Institute (see DBUR above)
SBP	Strategic Business Plan
SBPPE	Strategic Building Performance Planning and Evaluation
SBR	Foundation for Building Research, Rotterdam, Netherlands Ir. Koss Johanes
SBS	Sick Building Syndrome
SCALA	Society of Chief Architects of Local Authorities (UK)
SCC	Standing Committee for Construction of the European Communities
SCI	System Condition Index (derived from BCCI)
SCRI	Salford Centre for Research and Innovation
SDRT	Stamp Duty Reserve Tax (UK)
SECO	State Secretariat for Economic Affairs (Switzerland)
SEP	Supplier Evaluation Process
SEPA	Scottish Environmental Protection Agency
SEPTRA	Service d'Etudes Techniques des Routes et Autoroutes (FR)
SFB	Strategic Facilities Brief

SfB	Swedish Classification system, of which NI/SfB and CI/SFB are Netherlands and UK translations
SFP	Strategic Facility Plan. An active framework to help understand the future requirements for the facility.
SFP	Strategic Facilities Planning
SFPE	Society of Fire Professional Engineers
SGML	Standard Generalized Mark-up Language
SHRM	Society for Human Resource Management (UK)
SI	Sustainability Index
SIA	Security Industry Authority (UK)
SII	Standardization Institute of Israel
SIPA	Scandinavian International Property Association (represents largest most important property investors in Nordic property markets)
SKr	Swedish Krona
SL	service life
SLA	Service Level Agreement
SLB	Service Level Brief
SLC	Service Level Commitment
SLM	System Life Cycle Management
SLP	Service Life Planning
SMDS	Switched Multi-rate Data Service
SME	Structural Mechanical Electrical
SMM	Standard Method of Measurement
SoR	Statement of Requirements
SoTA	State of The Art (CIB PeBBu Project)
SPC	Statistical Process Control. Uses simple statistical techniques to determine if a process is in control and meeting its upper and lower limits.
SPF	Swedish Property Federation
SPICE	Structured Process Improvement Tool for Construction
SPR	Statement of Performance Requirements
SPRM	Supplier Performance and Relationship Management
SPRW	Syndicat des Proprietaires ruraux en Region Wallone (Belgium)
SPV	Special Purpose Vehicle
sq	square

sq ft	square foot
SQL	Structured Query Language
SR	Sustainment Rate
SSAP	Statement of Standard Accounting Practice
SSBAIF	Service Spécial des Bases Aériennes d'Ile-de-France (FR)
ST	Socio-Technical
STABU	Standaard Bestek Utiliteitsbouw
ST&M®	Serviceability, Tools & Methods® (Canada)
STC	Sound Transmission Coefficient
STEP	**St**andard for the **E**xchange of **P**roduct model data
SUDS	Sustainable Drainage Systems (UK)
SUI	Space Utilization Index
SUP	Sustainable Urban Planning
SWOT	**S**trengths - **W**eaknesses - **O**pportunities - **T**hreats
TAG	Technical Advisory Group -- ISO related Group in member countries
TC	Technical Committee at ISO, CIB-PeBBu, ASTM, etc.
TC	Thermal Comfort
TCO	Total Cost of Ownership
TEGoVA	The European Group of Valuers' Associations (aim to set harmonised standards of valuation and appraisal practice) (Belgium)
TFM	Today's Facility Manager (magazine) (USA)
TFM	Total Facilities Management
TFT	Thin Film Transistor
TG	Task Group (ASTM, CIB)
TGD	Technical Guidance Document (Ireland)
TIA	Teachers in Architecture (UK)
TIN	Technical Information Notes (part of Belgian Building Regulations)
TIP	Technological Implementation Plan (EU)
TNO	Building and Construction Research (The Netherlands)
TOC	Table of Contents
TOC	Total Ownership Cost
TQM	Total Quality Management
TRADA	Timber Research and Development Association (UK)

TUS	Time Utilization Studies
TV	Television
Tx	Thanks
UBAtc	Belgian Union for Technical Approval
UBC	Uniform Building Code (a "model" code)
UBR	Uniform Business Rate
UBT	Usable Buildings Trust
UEAtc	Union Européene pour l'agrément technique
UEPC	European Union of Developers and House Builders
UFGS	Unified Federal Guide Specifications (USA)
UICB	International Union of Building Centres
UK	United Kingdom
ULI	Urban Land Institute (objective information on urban planning, growth and development, educational and research institute) (USA)
ULI Europe	Urban Land Institute - Committed to bring timely and informative programmes to whole development community in Europe (Belgium)
UMIST	University of Manchester Institute of Science and Technology (UK)
UML	Unified Modeling Language
UMTS	Universal Mobile Telephone Service
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFOHLM	Union Nationale des Fédération d'Organismes HLM (FR)
UNI	Italian National Standards body - Ente Nazionale Italiano di Unificazione UNIFORMAT II NIST publication NISTR 6389, Elemental Classification for Building Systems (Standardized as ASTM E1557-05) (USA)
UNSFA	Union Nationale des Syndicats Français d'Architectes (FR)
UoS	University of Strathclyde (UK, Scotland)
UPC	L'Union Professionnelle du Credit (Belgium)
UPS	Uninterrupted Power Supply
USA	United States of America
USCG	United States Coast Guard
USGBC	United States Green Building Council

USPI-NL	Uitgebreid Samenwekingsverband Procesindustrie, Nederland (Netherlands)
UWWTD	Urban Waste Water Treatment Directive (European)
VAT	Value Added Tax
VAV	Variable Air Volume (air conditioning unit)
VE	Value Engineering
VE	Virtual Enterprise
VDT	Visual Display Terminal
VDU	Visual Display Unit
VHM	Flemish Society for Social Housing (Belgium)
VHM	Vlaamse H uisvestingsmaatschappij (Belgium)
VM	Value Management
VM	Virtual Model
VOC	Volatile Organic Compounds. Indoor air pollutants.
VOIP	Voice Over Internet Protocol
VPN	Virtual Private Network
VR	Virtual Reality
VROM	Dutch Ministry of Housing, Spatial Planning and the Environment
VTT	Technical Research Centre of Finland
VUW	Victoria University of Wellington (New Zealand)
W	Working Commission (CIB)
WAN	Wide Area Network
WAP	Wireless Application Protocol
WB	The World Bank Group
WBS	Work Breakdown Structure
WBDG	Whole Building Design Guide at NIBS (USA)
WC/wc	Water Closet
WD	Working Draft (ISO)
WDV	Written Down Value
WFTAO	World Federation of Technical Assessment Organizations
WG	Work Group (ISO)
WLC	Whole Life Costing
WLCF	Whole Life Cost Forum (UK)

WLCM	Whole Life Cycle Management
WLP	Work Life Performance
WLV	Whole Life Value
WORM	Write Once Read Many
WPL	workplace Parking Levy (UK)
WTO	World Trade Organization
XML	e**X**tensible Mark-up **L**anguage
YP	Year's purchase
ZAG	Slovenian National Building and Civil Engineering Institute

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