CIB W106 Geographical Information Systems – Work Period Report

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ABSTRACT
In the building and construction sector all features are location based. The world of geographic information and application orientation is moving extremely fast, thus challenging the building sector to facilitate and implement this new technology and applications. In order to deal with these issues CIB in 1996 established the task group CIB/TG20-GIS. Based on the report CIB 256 from this group and its recommendations, CIB in 2000 established the working commission CIB W106 "Geographical Information Systems", with the overall objectives to provide an international platform for R&D of GIS applications for the built environment, and to promote and encourage the use of GIS in the building sector. The W106 has members from 14 countries/organisations and will present its final report for work period 2001-04 due for the 10DBMC conference in 2005.

The work is divided into the following four Tasks: TG1- GIS-requirements and availability of geographic standards-, -data and infra -structures, TG2- GIS-based analysis and modelling of flow and distribution of materials in the built environment, TG3- Spatial dynamic modelling for Simulation of the interaction between the natural and the built environment, TG4- GIS in Education and Info sources. Objectives and work programme for each of these tasks are given and illustrated with examples, taken from state –of-the-art reports on the use of GIS elaborated by the participating countries/organisations.

With the rapid development of IFC based standards for digital object oriented models of building products there is a huge need for property sets, such as environmental exposure data, reference service life, service life models, factor distributions, LCA and LCC data, which can be linked directly to the building elements. The significant drive within the AEC/IFC to provide for relevant location based data (GIS) via IFC format will be a major facilitator for access to relevant durability data on the specific building site.

It is concluded that time is ripe for a broad implementation of GIS based applications in the building sector. Hence, it is recommended that the work programme of W106 for the coming working period includes a focus on support for an IFC based fully integrated design and planning process for the built environment, as well as a close link to the European based R&D frameworks for integrated life cycle management of the built environment.

KEYWORDS
Service Life, Geographical Information Systems, Spatial Data Infra-structures, Environmental characterisation

1 INTRODUCTION

In the building and construction sector all features are location-based and spatially-referenced. The world of geographic information systems (GIS) and its application in industry are moving extremely fast, thus challenging the building and construction sectors to facilitate the implementation of this new technology and the associated applications.

In order to deal with this issue, in 1996 CIB established the task group CIB/TG20 on GIS. Based on the first report from this group, [CIB 256 2000], CIB established the working commission CIB W106 "Geographical Information Systems" with the overall objectives to provide an international platform for R&D of GIS applications for the built environment and to promote and encourage the use of GIS in the building sector. Currently, CIB W106 has members from 14 countries/organisations. The progress report to the CIB World Congress in 2004 in Toronto contained overall objectives and operating strategy, as well as a summary of the National reports [Haagenrud et al, 2004]. These were based upon draft reports produced by Australia, Canada, France, Italy, Japan, Norway, and Sweden up to the W106 meeting in Milan in June, 2003. CIB W106 will present its final report for the work period 2001-04 at the 10DBMC conference in 2005.

The work in W106 is divided into the following four Task Groups:

- TG1- GIS-requirements and availability of geographic standards, data and infrastructures,
- TG2- GIS-based analysis and modelling of flow and distribution of materials in the built environment,
- TG3- Spatial dynamic modelling for simulation of the interaction between the natural and the built environment,
- TG4- GIS in education and information sources.

The objectives and work programme for each of these Task Groups are illustrated with examples taken from state-of-the-art reports on the use of GIS elaborated by the participating countries/organisations. This is available at www.cibworld.nl.

2 TG1: GIS-REQUIREMENTS AND AVAILABILITY OF GEOGRAPHIC STANDARDS, DATA AND INFRASTRUCTURE

2.1 Motivation

The world of geographic information and its application in industry is moving extremely fast, as shown by the business plan of ISO/TC211 on geographic Information/geomatics (www.isotc211.org). This is challenging the building sector to facilitate and implement this new technology and its applications.

For more than 10 years, countries and regions have tried to define and implement the concept of a spatial data infrastructure (SDI). Over the last few years, these activities have been structured in a more homogeneous way, one specific implementation is the work of the Global Spatial Data Infrastructure (SDSI) initiative [Norwegian Mapping, 2003].

The Building sector, via the IFG[1] initiative, has recently started to present their requirements to the GIS community. [Wix et al, 2005].

2.1 Objectives

The objective of TG1 is to:

- increase the understanding and usage of geographic information;
- promote the exploitation of efficient, effective, and economic use of digital geographic information, and
- contribute to a unified approach to addressing global performance requirements.

2.2 Overview of Activities concerning Spatial Data Infrastructure (SDI)

[1] Ifc for GIS. GIS workgroup in IAI. http://www.iai.no/ifg/

2.2.1 Standardisation ISO/TC211

The mandate for ISO/TC211 is to develop an integrated set of standards for digital geographic information concerning objects or phenomena that are directly or indirectly associated with a location relative to earth (www.isotc211.org). These standards specify geographic information, methods, tools and services for data management (including definition and description) or deal with acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations.

The standards development work shall link to appropriate standards for information technology and data wherever possible, and shall provide a framework for the development of sector-specific software applications using geographic data.

Many national and international agencies are actively engaged in the work of ISO/TC 211. These include national standardization bodies (27 member countries), the OpenGIS Consortium (OGC)-(www.opengeospatial.org), international professional bodies, UN agencies, and sectoral bodies.

2.2.2 EU project INSPIRE

The European Commission launched an initiative to establish a European spatial data infrastructure in 2001. This initiative is called INSPIRE- Infrastructure for Spatial Information in Europe (eu-geoportal.jrc.it/gos). The initiative aims at making available relevant, harmonized and quality geographic information for the purpose of formulating, implementing, monitoring and evaluating EU environmental policy making. At a later stage, the initiative will be broadened to other sector policy areas such as transport and agriculture, and shall eventually culminate in the establishment of a multi-sector spatial data –infrastructure. INSPIRE recognizes ISO standards as a foundation for its work.

An initial survey of web sites and literature on National Spatial Data Infrastructures (NSDI) was conducted for 32 countries (15 EU Member States, 10 Accession Countries, 3 Candidate Countries, 3 EFTA countries and 3 non-European countries). This information was compiled for 29 of the 32 countries with the help of national GI- and SDI-experts, including a series of important recommendations for the implementation of INSPIRE. Furthermore, a detailed country report with a description of the state of practice of SDI is available for all 32 countries [Orshoven 2003].

From this wealth of compiled information, the report concluded that operational NSDIs made up of the integrated components as identified in the Global Spatial Data Infrastructure Cookbook (GSDI www.gsdi.org/pubs.html) do not exist in Europe. However, various components of NSDIs are definitely in place or being developed. This happens almost exclusively in the public sector sphere of every studied European country. Driving forces are modernization of government, modernization of National Mapping Authorities (NMA) or similar institutions, creation or modernization of cadastres, programmes related to the promotion of e-government and information society, shortcomings in disaster prevention and management, and the need to enhance and make more cost-efficient administrations.

In 18 of the 32 countries, including all Scandinavian countries and most Accession Countries, a 'National Data Producer (NDP)' (that is, the NMA or a similar agency -Cadastre or Land Survey Agency), is taking the lead to: (1) coordinate its traditional geodetic and mapping activities with other data producers, and (2) interact with the major user groups of spatial data in order to better meet their needs (to a variable extent across countries but definitely most advanced in the Scandinavian countries). In this way, the agency fulfils an already existing, traditional mandate of coordination or takes up a more recent formal mandate. In both cases, the awareness raising by international initiatives such as GSDI and INSPIRE have had great influence, although the term 'SDI' is not always used.

The W106 Final Report will contain more detailed reports on the SDI work in each country

A major milestone was reached for the use of geographical information in Europe when the INSPIRE Proposal for a Directive was adopted by the Commission in July 2004 [CEC 2004]. This is a first step in a co-decision procedure that should lead to the formal adoption of the INSPIRE Directive, which then must be implemented in every EU Member State. The INSPIRE Proposal will also be used as a starting point for the practical preparations of the future implementation of the INSPIRE Directive.

2.3 The IFC/IFD/IFG initiative

With the rapid development of IFC (Industry Foundation Classes) based standards for digital object oriented models of buildings/products, the vision of the Norwegian Building Authorities [Wix et al, 2005]. This initiative is attempting to make the planning, design, construction, commissioning and operations of the built environment more efficient and Internet-based. Key to this development of IFCs is the integration of GIS information with AEC/FM (Architectural and Engineering Construction/Facility Management) information about the individual buildings and constructions. For example, for a building in the planning phase, information can be obtained from the land registry to provide data about location, neighbouring lots, property data, utility services, demographics, zoning, risk factors. This integration is illustrated in Figure 1.

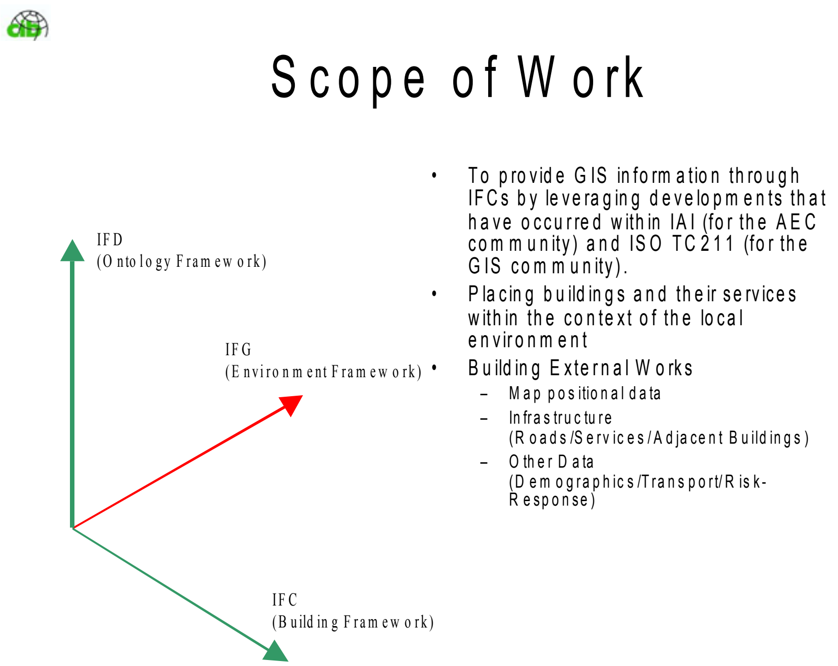

Figure 1 IFC-IFD[2]-IFG concept

An IAI based project was recently launched for developing the concept of using the IFC model as the specification for the exchange of limited but meaningful information between GIS and CAD systems [Wix et al, 2005]. The aim of the project is to use entities that are already established within the Coordination and Code Checking views of IFC 2x so as to be able to reuse the tools, techniques and capabilities already developed by vendors from the AEC/FM community .

This standardisation project was recently finalised and its implications are described and illustrated with examples in the proceedings of this conference [Wix et al, 2005]. In general, both the AEC/FM and GIS worlds share the concept of the provision of lifecycle based information and have similar approaches to portfolio and capital project development, design processes, costing and cost management, asset management, durability, maintenance, and other factors.

AEC and GIS share a common interest in systems development for purposes of distribution systems, as described later in this paper in subsection 4.2.2. Whilst GIS is currently being used in utility systems (roads, bridges, buried utilities, land planning) within regional infrastructure systems, as opposed to the local distribution mechanisms applied in AEC/FM, the approaches for data modelling and implementation are remarkably similar.

[2] IFD - International Framwork for Dictionaries, ISO/DIS 12006-3. http://www.icis.org/tc59sc13wg6

3 TG2: GIS-BASED ANALYSIS AND MODELLING OF FLOW AND DISTRIBUTION 0F MATERIALS IN THE BUILT ENVIRONMENT

3.1 Motivation

The building and construction sector is a major consumer of materials and energy resources. In the industrialized world, the construction sector is estimated to account for some 40% of the total energy consumption. In addition, construction itself produces approximately 40% of all man-made waste. The transport of building materials to the construction site is also energy-intensive and contributes to the burden on the traffic system.

Therefore, the development of GIS-based techniques for the modelling of the amount, distribution and flow of materials in the built environment is, in this perspective, a priority area.

3.2 Objectives

The objective of TG2 is to:

- promote the exploitation of geographic information technology as a tool to model the amount, distribution and flow of building materials, and
- explore the material data availability and data sharing possibilities for an efficient, effective, and economic use of digital geographic information for modelling and mapping materials (amounts, distribution, flow) on various geographic scales.

3.2 Case Study Review

France addressed "The use of GIS as a tool for waste management", in their national progress report for TG2 [Lair 2003]. The report presented the main European and French regulations concerning waste classification and transportation, especially the management of construction and demolition wastes. It also included a national plan for waste management. The implementation of this national plan would be strongly facilitated by the extensive use of GIS in the construction community.

More examples and national reviews will be included in the W106 Final Report .

4 TG3: GIS-SPATIAL DYNAMIC MODELLING OF THE INTERACTION BETWEEN THE NATURAL AND THE BUILT ENVIRONMENT

4.1 Motivation

Interaction of the environment with infrastructure is a complex process, involving a range of environment factors whose impact is very sensitive to spatial position and form. [Jernberg et al 2004, Sjöström et al 2005]. This is both the case with the infrastructure's reaction to severe events (flooding, cyclones, earthquakes, etc.) as well as to long term exposure to the "normal" environment. GIS offers a tool that can integrate the data and models on the critical factors within the natural environment and the resulting response of the built environment to these natural events. The IFC/IFD/IFG initiative and resulting standards for information exchange between the CAD and the GIS world will facilitate a paradigm shift, and permit common access to wide variety of geographically sensitive information. This information can range from climate and pollutant information to landscape or hydrological data. In many parts of the world, GIS-based air quality surveillance and planning systems that include modelling tools down to the micro-level, are being used to provide information on the exposure environment causing degradation and other damages [Jernberg et al, 2004].

4.1 Objectives

The objective of TG3 is to:

- promote the exploitation of the geographic information technology as a tool to model the degradation environment to buildings and infrastructure;
- explore the availability of environmental data and data sharing possibilities for an efficient, effective, and economic use of digital geographic information for modelling and mapping the degradation environment on various geographic levels, and
- contribute to a unified approach to characterize the exposure of the built environment.

4.2 Case Study Review

4.2.1 Australia

The Australian progress report provided a good description and extensive examples of the use of GIS within the TG 3 field of work as presented in the Toronto report [Haagenrud et al, 2004].

> *"While geographic information systems are widely used in Australia in assisting land-use planning and management [Trinidad and Marquez, 1998], they are also of increasing use in managing risk to infrastructure [Trinidad and Cole, 2000] and in transport design [Marquez et al, 2001]. In most cases they are used primarily for information storage and retrieval, however, in some cases their capacity to integrate data and to make decisions based on this integrated data is being used in commercial settings".*

In the research arena, a much greater emphasis is placed on active use of GIS not only to integrate diverse data sources but also to transform data though manipulation within the GIS system [Trinidad, 1999]. In particular, significant advances to model the interaction between natural and man made environments have occurred over the last few years. This work has been based, in part, on the particular advantages of geographic information systems and on the ability of computer models to incorporate an intensity and breadth of data not possible in the experimental or engineering models previously applied. Consider the example of the prediction of corrosion in a marine environment as defined in a series of papers by Cole et al, [2003a-c, ,2004] A schematic diagram of the types of information being combined is shown in Figure 2.

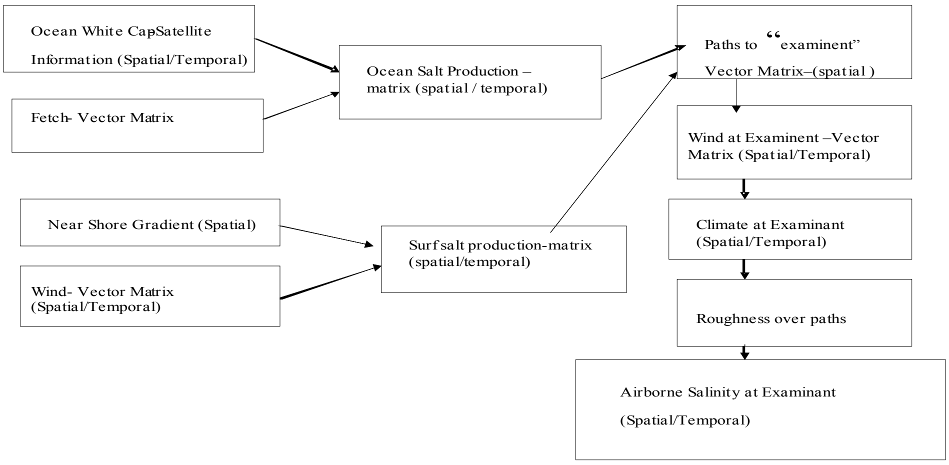

Figure 2 Schematic Diagram of Information Flow for Prediction of Airborne Salinity

This research highlights issues relating to data form, such as:

- the production of marine aerosols is derived from knowledge of the ocean white cap activity (spatial and temporal data) and the fetch (vector);
- surf salt production as derived from knowledge of fetch, near shore seabed gradient (spatial data) and wind speed and direction data (vector), and
- in determining the airborne salinity at inland points it is necessary to define paths (vectors) to the inland points, wind (vector) and climate (spatial and temporal data) at the inland point and the roughness of the terrain (spatial data) along the paths from the examinant to coast points.

The analysis indicates some of the capabilities required for modelling interactions between the natural and man made objects. Models need to be able to:

- manipulate and combine data of different forms, vectors, scalar and temporal;
- derive spatial data (particularly fetch and path vectors), and
- process temporal data with significantly varying time scales (from 3 hourly to seasonal data)

Such capability is readily managed by GIS systems but very difficult to construct in non-spatial systems. In particular, the manipulation of vector data and linking these data to temporal data required to link the wind, fetch and land form on salt production and transport would be impossible in conventional (non-GIS) frameworks.

4.2.2 Municipal infrastructure

Municipalities are *now* collecting a considerable amount of digital data, while also possessing a considerable amount of paperware. The alphabet soup of input technologies described by Vanier (2004b) such as CAD, SCADA, AVL, RWIS, CAS, GIS, and PDAs provide almost unmanageable amounts for heterogeneous data with little framework to integrate these data.

In a position paper for the W78 workshop in Toronto, Vanier [2004] posed the following problematic: how do infrastructure managers assist society to ensure that the existing and future infrastructure can be sustained? That is, how can this industry be sustainable? He answered and postulated that " this can only be done with the aid of ICT, and data integration is the key."

.As evidenced by the recent survey on the state of asset management in Canada (Vanier and Rahman, 2004), decision support tools are not readily available to infrastructure managers and decision makers. One of the reasons could be the lack of data standards and protocols to allow these tools to co-exist and to interoperate. In many instances the data are not dynamic and it's difficult to change input data and hence the output results (i.e. "what if" scenario).

Following a detailed survey of state of the art, challenges and opportunities, Vanier concluded the following:

> *"Municipalities are facing unprecedented challenges due to the increasing number of aging infrastructure assets combined with declining maintenance budgets. Leveraging the use of information technology, in general, and of GIS and asset management systems, in particular, to improve the efficiency and effectiveness of asset management work processes is considered as a crucial strategy to address these challenges."*

5 TG4: EDUCATION ON GEOGRAPHICAL INFORMATION SYSTEMS AND INFORMATION SOURCES

5. 1 Motivation

Graduate study courses often are unaware of the strategic importance of GI application in the construction industry, and especially today, when sustainability issues are rising for architectural and engineering design. In architecture and civil engineering undergraduate courses in most curricula around the world, the topics of GI and GIS are considered a matter for geographers, thus leaving the construction sector trailing behind in the adoption of this technology.

The target of the built environment assessment techniques is to supply both methodologies and effective management techniques to support decisions in all different phases of the design process seen as analysis, planning, design specification, management, exploitation and control chain of the built asset It may be applied to public and private assets, the infrastructures sector and also for management of the cultural heritage. Apart from the planning and design of the object itself, it comprises several other aspects like the environmental ones as well the socio-economic variables and the cultural variables that characterises a specific project site, see also subsection 2.3, Figure 1.

5. 2 Objectives

The objective of TG4 is to develop:

- education requirements for GIS use by architects and engineers;

- a glossary representing the common language among the GIS- and the construction community;
- courses presenting GIS as a technology within the architectural and engineering design process;
- a list of the info sources of free spatial data sets location accumulated across Europe.
- pilot education interoperable applications (e.g. for distance learning);
- an Internet discussion list to gather participants subscription and comments in real time, and
- a broad participation within European initiatives and programmes, especially the Marie Curie Programme.[3]

5. 3 Case Study Review
One example of courses aimed to develop both the cultural aspects of GI impact on the design process as well as the technical aspect of GIS use is the pilot course titled "Assessment techniques for Built Environment" (www.dpmpe.unifi.it/histocity/esposito/mae_courses.html) started in 2000 at the Faculty of Architecture of the University of Florence. The course's aim is to teach advanced techniques needed to integrate GIS technologies in the design process [Esposito, 2003].

7 CONCLUSIONS

The world of geographic information is moving extremely fast. It is driven by rapidly-emerging NSDIs in almost all countries and regions, as well as by the rapidly-developing infrastructure for telecommunication. This severely challenges the building sector to facilitate and implement this new technology and its applications within its sphere of influence.

The significant drive within the AEC/FM and IFC community to provide for relevant location-based data (GIS) via IFC format will be a major facilitator to access relevant property data sets, such as environmental exposure data, reference service life, service life models, factor distributions, life cycle analysis (LCA) and life cycle costing (LCC) data, which can also be linked directly to construction elements in the digital building model.

It is concluded that time is ripe for a broad implementation of GIS-based applications in the construction sector. As a start, it is recommended that the work programme of W106 for the coming working period includes a focus on support for an IFC based fully integrated design and planning process for the built environment, as well as a close link to the European based R&D frameworks for integrated life cycle management of the built environment.

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[3] It must be recognized that the activities of TG4 are part of an EU sponsored project.

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