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An Integrated Process from Design to Facilities Solutions

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Introduction

Closer links between design, construction and asset maintenance have been on our agenda for years in order to provide better facilities solutions seen in a lifecycle perspective. At the same time we have experienced the practical problems in achieving our goals of closer links and a more integrated process, due to different business perspectives and not cost effective information- and decision-support systems.
Several factors indicate that we are able to improve this situation in coming years. The requirements from the public sector and partly private investors regarding lifecycle planning, the changes in the old-fashioned building process towards more integrated solutions and internet-based information and communication solutions, - are three main factors giving us perspectives of a more integrated process from design to facilities management.

Requirements for lifecycle planning

In general the building owner and the facility manager aim to have a good and functional building, seen from a life long perspective with respect to costs, time, quality and environment. Most of the participants in the design and construction process and the facilities managers will agree upon these general goals for facilities.

Going solely from a common general understanding, it turns out that we can not succeed with a fully lifecycle planning. Often we end up with conflicting interests between the long term and short term perspective regarding:

- A lifecycle based solution mostly leads to a higher investment cost. We have had methods of lifecycle cost planning for years, but mostly decisions are based on the investment cost.
- The actors in design and construction do not have the knowledge about lifecycle planning, or they do not want to give priority to what is happening after their work is done.
- The actors in FM does not have the knowledge or attitude to go into a creative design and construction process, where the focus should be on building and facilities as dynamic objects over the lifetime.
- The whole lifecycle planning process are to complex and involving to many participants, so our existing systems for information and communications today are not suitable for a total planning perspective.

Are we seeing improvements and solutions that might create another future? Yes, I would argue that there are changes and improvements in a small scale and solutions that might create another future.

Regarding the physical part of buildings and facilities, the lifecycle planning is changing in a positive way based on four major factors:

- Stricter requirements to design lifetime set from clients (public and private) to designers and builders. Example: The design lifetime for the new library building in Alexandria, Egypt is 200 years. Architect Snøhetta, Norway.
- The environmental focus on the building and property industry, setting requirements to lifecycle analysis of environmental impact (energy, ecology, waste, health) in both a local and global perspective. These requirements are implemented in national and international laws and regulations for the construction and FM industry. In industrialized countries you also find that good environmental solutions are cost effective due to high cost for energy and getting rid of waste. Example: Pilestredet Park in Oslo, Norway where they are going to transform a large old hospital area downtown into a green urban area for living and offices.
- The development of betters methods and tools for lifecycle planning and design. A number of large research projects have been going on in Norway, as in other European countries and globally, in recent years on the subjects lifecycle planning and management. Recent work at NTNU is documented in dr.ing thesis [Wigenstad 2000], [Andresen 2000] and in a number of research reports. The research is moving from fundamental system analysis to more applied and practical solutions implemented in design guidelines for specific areas. We also see changes and improvements in standards and building codes. Example: We have in Norway a new revised standard NS 3454 for lifecycle costing.
- The changes and reorganization of the building process with a stronger focus on integration and communication between all the different actors in planning, design, construction to FM. These issues will be discussed in the following, even if a total integration from design to FM is still in the early stages.

Reorganizing the Building Process

Our experience in reorganizing the building process are based on the project "SiB – The Integrated Building Process" carried out by a joint Norwegian consortium from the industry together with the NTNU 1996 – 1999. The project had the overall goals to increase productivity in the building process, and to contribute to the market development through better value for clients and users of facilities. To fulfil these goals we focused on two major areas for improvements:

- Reorganizing the building process by improving design management, production planning and logistics applying to all kinds of products, services and information. An important part has been organizational development focusing on team building, leadership and enterprise modeling.
- Development of new information structures for building specification and development of networks (WEB) for the exchange of data (drawings, reports etc.) between participants in a specific project, and for communication between industry and public authorities.

The development of information technology and the business process re-engineering in the building sector are changing the way we organize a building project [Gray 1996], [Lahdenpera 1995]. The traditional way of organizing the building process with specific phases, tasks and participants are fading away as new enterprises and more flexible processes are becoming more dominant. Smaller companies are merging into larger companies which integrates both design, construction and facilities management.

This is driven from two positions; one where the traditional contractor expands into selling a total package (design, production and management) like in a BOOT - contract (build, own, operate and transfer). Another trend is more owner and consultant driven development, where the planners and designers (architects and consultants) are refining their product and focus on planning, concept and early design.

A major result in the SIB-project is that we managed to implement low cost IT-solutions (standard WEB applications from the Internet) that give better handling of information and communication in

the building process. To create a shared understanding of the parts and the relationships of the building process we have used enterprise modeling. Enterprise models are images, which emphasize certain aspects of the organization or project that we agree, are important. These models are used to develop a common frame of reference, a common platform for communication, and a common way to navigate in information.

Internet-based information and communication solutions

An integrated process from design to facilities solutions means integration of a number of different actors and a long list of activities and processes in a life-long perspective.
The problem is to link the processes and knowledge using lifecycle cost planning methods and lifecycle information and communication systems.

The web-technology has given us new opportunities in this area, by giving easy access to systems and common databases for all participants in the overall building process, irrespective of time and distance. We are here still in the paradigm shift, seeing just the start of the new solutions and possibilities.

In the SiB-project [Haugen 2000] we established in 1997 our first web-based project server used in a full-scale construction project, linking the architect, the consultants, the owner, the contractor and the public authorities together using one database for drawings and documents. The solution was based on low-cost standard hardware and software applications from the Internet, creating a fully integrated solution through the Internet. The research and development project was successful, and led to the establishment of a new company, ProsjektNett as, which are a service provider today for a number of construction projects. Our situation is not unique; we see the same development in other countries.

We also see that other typical FM software providers have started to use the Internet for their applications for operational and management tasks. And we see that organizations and network groups are using the Internet for common information, benchmarking, etc. So far though, we have not seen many web-based solutions capable of linking and integrating information in a lifecycle perspective from design to FM. Some software vendors will claim they manage this, but in general that will be not open and standardized solutions.

Fully integrated and open solutions rise a number of complex issues that both researchers and the industry have been struggling with for years. The ideas about fully integrated IT systems have been on the agenda at least since the 1960ies, and previously we have found that the fully integrated systems are not cost effective.

To establish a more integrated process based on web-technology, we have seen that there is a need for a new structure for organizing information from design to FM, and to work with better methods for visualization and communication in the lifecycle process.

A New Information Structure - BARBI

The AEC/FM industry requires a common terminology for use in structuring information in a computer interpretable form. This was stated by a meeting organized by ISO/TC 59/SC 13 in 1999 attended by representatives from:

- IAI International Alliance for Interoperability
- ICIS International Construction Information Society
- ISO International Organization for Standardization
- CIB W78 Information Technology

The Norwegian building standards organization, NBR, started in 1988 a study program on object library developments. Based on a survey of what had been done internationally, and focusing on the principles of product modeling, the different product models and the evolution which has been going on, it was decided to establish BARBI as a common reference library for facilities. The reference library will contain a complete overview (with unique ID´s) for all objects in buildings and constructions, from built objects to products and resources. In addition all entities and relations for the objects will be defined [Bakkmoen 1999], [Wright, T. 1999].

In a common reference library, all information will be classified or assigned and stored in the same way through all phases of the lifecycle of the facility. All actors in the building process and all computer tools should access the reference library, and all information will be recognized through the unique ID´s.

The work so far has shown that the use of the traditional classification tables and systems for organizing information in construction and FM does not cover the needs today. The classification tables have worked well in manual systems, but does not cover all kind of objects in facilities and they do not cover all the phases in the lifecycle. Typically there is a conflict regarding the need for information structures in design / construction and in the operation and maintenance phases.

To establish a reference library like BARBI represents a great challenge with respect to time and resources. The Norwegian building standards organization have decided to bring the work forward in co-operation with the Dutch organization STABU with their LexiCon and the BAS project. National Building Specification, UK together with Construction Specification Canada and Construction Information Systems, Australia has shown their interest in taking part in future work.

Visualization for Better Communication - 4D

4D CAD represents a tool for better communication for all participants (stakeholders) in the building process, from planning, design, and production to facilities management. Used as a tool for visualization in the early project stages you can decide on planning issues and relations to external stakeholders, and in modernization and maintenance you can evaluate different alternatives, plan temporary solutions for facilities and assist workers in typical maintenance activities.

4D = 3D + TIME. Today we create a 4D model by building up an object oriented 3D CAD model of the building / property, where the building elements (objects) in the 3D model are linked to activities defined in the activity / project plan. This generates a 4D model that simulates the development of the building project over time. Our work in this area started in 1998 with help from Professor Martin Fischer, Stanford University who has been a pioneer in this area.

We have during the last year tested different 4D applications developed in the US, but ended up with developing a 4D-application (APS) to ArchiCad, which is a CAD program commonly used by designers and planners in the Europe. Software vendor is Graphisoft, Hungary.
By linking the 3D model in ArchiCad to a time / schedule plan in MS project, we get a 4D model.

Together with Statsbygg, we have used the 4D-application in a large modernization and development project in Oslo. The project, *Pilestredet Park*, is the redevelopment of the large old state hospital area with a number of old buildings. Some old buildings are going to be demolished, some refurbished from hospital buildings into apartments and offices and a number of new buildings.

Pilestredet Park has a very strong focus on environmental issues, and there are strict requirements to demolition activities, transportation, new construction etc. This project demonstrates the use of 3D and 4D visualization in FM where we follow the physical resource trail – the property focus [Nutt 2000]. We see this example and the use of 4D as one part in achieving an integrated process from design to facilities solutions.

Final remarks

Our goal is to improve lifecycle planning and knowledge of facilities solutions in order to achieve an overall efficient optimum use of costs and resources. And we believe that a more integrated process from design to construction will give us more focus on lifecycle planning and knowledge.

To achieve a more integrated process we have to redefine the structure and traditional phases of the building process from design to FM. The new building process has to reflect the practice of concurrent engineering and a whole life perspective to buildings and constructions.

The web gives us the possibility to create a more integrated process based on better information and communication between all the different stakeholders.

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