

## **4. Improvement of the Design Process**

### **By Integrated Information Management and the Use of Computer Mediated Communication**

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#### **Keywords**

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#### **4.1 Abstract**

In this paper the changes in information handling within architectural design teams are explored as well as the attempts to improve information exchange processes within architectural design teams. The proposal for defining a model for integrated information management is worked out with the use of computer mediated communication.

#### **4.2 Characteristics of information-handling in architectural design processes**

Within temporary, project based organisations as well as permanent, small, medium sized or big organisations, the handling of information should be as important as the organisation of the team and the management of it to produce results. Handling of information concerns the generation-, transmission-, publishing-, receiving-, storing- and retrieval of information of an organisation verbal as well as non-verbal, synchronic or a-synchronic (Den Otter and Prins 2000). Within temporary project based organisations for technical complex building projects information exchange is of growing importance because of the following reasons:

- 1) Technical complexity as well as volume of these projects is growing.
- 2) Time pressure is growing for reasons of organisational as well as real estate concerns of the client.
- 3) More and different organisations are participating in the project.
- 4) Design teams for designing the artefact are growing because of the higher technical demands and the higher quality demands.

##### **4.2.1 Design processes**

Design processes in these kinds of projects are especially important concerning information handling because in the design the needs and expectations of the Client (The Client's brief) are translated into sketches, images, drawings and schemes. Designers use this kind of information exchange together with verbal information exchange (Donker 1999) to represent the volumes, masses and materials of the building they design.

Architectural design processes are creative, multidisciplinary, iterative processes, consisting of structured sequences of activities, directed to solve complex, ill-structured architectural problems.

Design is a reflective continuous whirling process in which 1) interpretation, 2) generation, 3) comparison of 4) design choices is important:

- 1) Interpretation: What's the shape of the problem? A definition of the problem.
- 2) Generation: What are the alternative solutions? A range of alternative solutions.
- 3) Comparison: What makes them different? A set of comparisons and preferences.
- 4) Choice: Where do we go from here? A decision about policy and action.

On the other hand the building that is designed and represented by drawings, images, sketches, schemes and documents has to be realized by building contractors, sub-contractors and suppliers. The design information produced for the participants mentioned above has a totally different focus and purpose. That is why in the design phase all the information and knowledge to realize the building in the most economic way should be available.

Design teams for technical complex building and design projects mostly consists of different designers coming from different organisations with different ways of handling information. Design teams are growing because of higher quality demands of the design for the building produced by the team. A lot of design specialists come into the team as van Loon (1998) stated. Design processes are whirling processes and consists of problem finding as well as problem solving processes (Rutten and Trum 2000, Friedl 2000) in which information handling between the design partners within the team is essential to produce the solutions for the design as formulated in the Client's brief. Participating designers and design organisations are highly depending on the exchange of each other's information to design their own solutions to the Clients brief (Heintz 1999). In most design processes, several design organisations with specialized knowledge are hired by the client for the development of the design; architectural designers and specialist designers for structural design and engineering, building physics, installations HVAC, facility planner, ICT, building cost adviser and others.

#### ***4.2.2 Design teams***

The configuration of the design team for a Building & Construction project is mostly as unique as each Building & Construction project is. The information handling process within such a team is primarily a whirling information exchange process between the participating designers about the artefact to design. Sketches, images, drawings and schemes are key information carriers for the handling of design information. The information handling between the architectural design team and the Client's organisation mostly is an important aspect of a decision taking process as well as a negotiation process with several stakeholders in different settings. The designers have to convince the client that the design they produced is the best solution to his needs and demands as formulated in the Client's brief.

For the purpose of this research an architectural design process for a technical complex building is seen as an information exchange process, processing multi disciplinary design information: object information as well as process information.

The information handling within design teams is complex and difficult due to reasons mentioned above. The different partners in the design team do have, apart from that, different information needs. Those needs can roughly be separated in the information needs of the client and the stakeholders and the information needs within the design team that generates the design. When building contractors are participating in the team up to date technical construction- as well as construction experience information exchange becomes available for

the team. This is especially important in fast-track projects in which there is a great time pressure on the design team to work as concurrent as possible (Den Otter and Prins 2000). The information needs of the client and stakeholders are focused to choices made in the design. The focus of the information needs within design teams is to get the right information of the client and his organisation and to exchange the generated design information between the design partners as efficient as possible to keep progress in the design process.

#### **4.2.3 Information media**

All the time new media for information exchange are entering the market. But the old media (books, paper mail, newspapers) don't disappear (Davenport 1997). Continuous developments in ICT are strongly influencing the way processes in the building industry give new dimensions to the notions: information and communication. Recent developments in the building industry lead to the need for ICT implementations on project level. However implementations of ICT- tools are implemented market driven per organisation instead of in the temporary project organisation.

Recently, web-based ICT tools: "Project websites or Data web houses (DWH)" entered the market. These kinds of tools can open the door to interactive, digital information, extranet environment for a collaborating team of design organisations in a building project. This digital environment looks ideal to use also within the design information environment because of the transparency, the openness, the collaborative, the safety and the dissemination aspects of such an information system.

- Transparency makes it possible that everybody has a clear site of the complete flow or flood of information and the changes in design.
- Openness makes it possible that everybody has access to all the information needed for designing.
- Collaboration makes it possible that the tool increases the collaboration in working together on the same object, see the progress of the design and the missing parts as well as the changes made.
- Safety makes it possible to put information in the DWH that can be traced at all times, protects the owner and protects the information by digital keys.
- Dissemination makes it possible to use specific information earlier in all parts of the designed object.

However, effectiveness of ICT-tools and efficiency of information flows and processes depend only for a part on the tools and the systems themselves, as we all know! In the Netherlands, and not only in this small country design teams and organisations are still facing major problems with their CAD-systems in regard to effectiveness and efficiency, and the exchange of information, the libraries and the codes for elements.

Design organisations; architectural offices as well as adviser's organisations, still aren't used to work usually in their projects with 3D-CAD systems for design work as we expected so many years ago! They are working mostly in 2D with all lot of different systems. They produce different stored and coded information, in different formats, and work only some-times in 3D.

Davenport (1997) writes about this subject: "Better computers and communications networks do not inevitably lead to better information environments". It involves people working in organisations: "Human factors are the keys"! The following statement could be added to these lines, specifically for architectural design teams in the Netherlands: "There are as much information systems as there are architectural design organisations".

For the above reasons this paper is specifically focusing to people working in the design information environment, working with all kinds of information systems in design teams and design organisations, digital as well as non-digital. That is why the main question about this subject is: What do we know about the design information environment, this specific information landscape with sketches, drawings and images as key information carrier?

Other questions following are: What do we know about the information behaviour and the information culture in the design office and the design team? How is the information environment managed and controlled? Who is responsible for it?

#### ***4.2.4 Information landscape***

Davenport writes about the changes in the information environment, behaviour and culture in all kind of business offices and business organisations. He writes about the information politics and the way we usually inform other people: verbal, by writing or digital. However Davenport doesn't write about or did research in the permanent, design organisations as well as in the temporary, multi-disciplinary, design teams in the building industry.

Verbal information has the highest percentage for chief executives and managers. Designers inform other people by sketches, images and drawings and, most of the times, together with a verbal, explaining story. Designers information attitude were not investigated by Davenport.

It is important to get a clear view on the information landscape within design organisations as well as in the design teams to know what can be improved, the importance of it, and the chances of success for the aspects and matters that are intended.

### **4.3 Problems with information handling**

Because of the growing team, the growing pressure in time, the growing technical complexity as well as the volume of building projects the improvement of the management of information handling: information management is of great importance to get a better control and steering on the growing team, the growing etc. etc.

The use of computer mediated communication promises to solve a lot of these problems by the use of so called Data web houses.

#### ***4.3.1 Information handling***

Better control as well management of information handling in architectural design processes for the design of technical complex building projects is of great importance for the improvement of the performance of those processes. The need for this on the one hand arises from the growth of design teams for big complex building projects in which more different design organisations are participating (Heintz 1999) as well as designers with specialist knowledge (Van Loon 1998). The need on the other hand arises from the growth of the volume, the size and the technical complexity of big building projects. Together with the growing building volume and technical complexity the number of participating design organisations is rising (Heintz 1999). Van Loon (1998) writes about these designers: the number of involved specialists is rising faster than the number of architectural designers.

The information handling within design teams is complex and difficult due to reasons mentioned above, all the more because the different partners in the design team do have different information needs. Those needs can roughly be separated in the information needs of the client and the stakeholders and the information needs within the design team that generates the design.

The focus on the information needs of the client and stakeholders (Donker 1999) has to do with the choices made in the design. The focus on the information needs within the design

team is to get the right information of the client and his organisation and to exchange the generated design information between the design partners as efficient as possible to keep progress in the design process. Designers are depending strongly on the generation of information of the participating designers to develop their own part in the design (Heintz 1999). Parts of the architectural design often are designed simultaneously or concurrent under the influence of the growing time pressure on the design process.

#### ***4.3.2 Influences to information handling***

The information handling within the design team is influenced by a number of aspects: 1) The arrangement and control of the architectural design team (den Otter 1999), 2) Differences in the working methods concerning the exchange of information of architectural design organisations as well as designers themselves (Heintz 1999), 3) Changes in the suitable information-exchange media in which electronic media like Internet play an ever growing role.

#### ***Arrangement and control of the architectural design team (den Otter 1999)***

Architectural design teams for the design of complex Dutch building projects are mostly temporary, multi-disciplinary design teams with a client and several stakeholders within a project based environment. The arrangement of a design team is mostly as unique as a complex Dutch building project is. For architectural design often the client hires several design organisations with special knowledge: architectural designers, specialist designers and technical advisers. The selection of design partners often is based on the best economic offer instead of based on criteria for collaboration and teamwork. The control of the architectural design process is strongly focused to co-ordination of the design partners (Heintz 1999) and is depending to the way a project is managed by the client and/or the delegated client.

Within the project environment and the design team of a complex building project on the one hand the control of information is an important aspect as stated for instance in the PMI-BOK (1995) and on the other hand there is a certain, continuous desire to communication and information exchange as (Donker 1999) argues. There are big differences in the way designers exchange design information. A characteristic of designers is the inimitable way of working they have and visualize their design results in different ways (de Bruijn 1999), amongst others by means of sketches, three-dimensional images, collages of existing images and so on. Due to that aspect the information exchange between designers is multi-interpretable. That is why often face-to face communication is needed to prevent misunderstanding and mistakes in perception of the design. Within the context of advisers who are designers as well as the architectural designers are, also have to be included the technical engineers who translate the final design into the detailed design by choosing building products and materials that fits within the design.

#### ***Differences in the working methods concerning the exchange of information (Heintz 1999)***

The differences in working methods for exchange of information of design organisations arise from the differences in applied information systems within design organisations especially for CAD. These systems mostly need different working methods. As there are a lot of different CAD-systems in use in design organisations there are also a lot of different offices depending on application depending working methods.

#### ***Changes in the suitable information-exchange media***

Due to the appearance of the Internet as well as email communication tools the information exchange is strongly influenced. The speed as well as the a-synchronous character (transmitter

and receiver do not necessarily have to be in contact with each other at the same time) of this type of communication is of importance for the users. From the preliminary design phase visual readable information like sketches, images, drawings and schemes often are as important as verbal information.

The improvement of the handling of information within architectural design processes for technical complex building projects can lead to:

- 5) Decreasing of throughput time of the design process decreases the total project time.
- 6) Expectations as well as needs of the client and the users can be suited faster as well as better.
- 7) Accelerating concurrent design and concurrent engineering processes that causes earlier start of realization of the building.
- 8) Improvement of the overall quality of the product.
- 9) Decreasing cost of design failures caused by design changes.
- 10) Improvement of the output of electronic information exchange.
- 11) Magnifying the chances to collaboration and teamwork between the concerned parties in the process.

#### ***4.3.3 Implementation and application of ICT - tools***

To improve the efficiency of information-exchange processes for architectural design almost continuously, new, improved, as well as better ICT-tools are being implemented in design organisations (BNA 2000). The market of ICT-tools is rich in providing different tools with different possibilities as well as different prices. This makes it hard as an organisation to make the right choice so it is even harder and almost impossible to implement the right tools within a temporary design team that consists of different design organisations using different ICT-tools. This is a well-known phenomenon called island automation. Earlier attempts to buy the same tools for a specific purpose branche-wide within architectural design organisations failed (VCA 1984-1986) because organisations are used to make their own choices based on their own needs and budget. Usually they wait for the right time to implement the tools within the organisation when the organisation is ready for this.

Because of the described phenomenon, design organisations created their own information environments with working methods based on the possibilities of the ICT-tools, the knowledge and experience of the organisation as well as the supplier with the specific ICT-tools. The implementation and use is very less based on norms and rules defined by branches because up till now these norms and rules are not available branche-wide and didn't pass even the definition phase (B.A.S.). Only attempts to define rules within user-groups for specific ICT-tools were successful like the organisation "Geïntegreerd Bouwen" for the use of AutoCAD within design organisations. The use and implementation of different CAD-systems in design organisations in the past fifteen years is the best example of this fragmented implementation and caused new and other problems in the exchange of design information.

Because of these reasons it is reasonable to expect that the implementation of new communication tools within design teams to solve information exchange problems faces problems as well as causes new problems we are not aware of at the moment. On the contrary the implementation and application of these ICT-tools goes much faster than the implementation of other ICT-tool because this implementation is more or less market-driven. A lot of design organisations like to profile themselves with new Internet tools being an up to date high tech as well as dynamic firm ready for the job. The branche organisation of

architectural designers in the Netherlands: BNA expects that within one year time (in 2001) 70 to 80% of all the architectural firms will use Internet and email (BNA 2000).

The latest ICT-developments concern Internet-tools for the application of Extranet environments in which all the project documents can be stored, updated and used by all participants in the design team (so called Data web houses). However these tools are promising in terms of solving information exchange problems, the effect and profit of using these tools is highly depending to the organisation and control of the information environment in which this technology will be implemented (Den Otter en Prins 2000).

#### **4.3.4 Information environments**

An information environment can be defined as the total structure of implicit- and explicit information exchange processes permanent or temporary organisations uses to reach the defined targets of the organisation. Implicit information exchange processes are mostly verbal, person depending exchange processes without vast procedures. The information environment of an architectural design organisation can be defined as the total structure of information exchange processes this permanent organisation uses to achieve continuousness in the generation of designs for building projects.

The information environment of an architectural design team can be defined as the total structure of implicit and explicit information exchange processes this temporary organisation uses for the generation of a specific, client-oriented, architectural design as well as to realize this design within an approved budget.

The information environment of a design team depends on the configuration of the project and the participating organisations. The design, arrangement and control are depending on knowledge and opinion of the project organisation in:

- 1) The project information environment.
- 2) The information environments of the participating design organisations.
- 3) The views on the possibilities of information exchange.

There are differences as well as similarities in the targets of the architectural design team and those of the participants in the team.

One of the most important targets of a design organisation is to continue the organisation after a design is finished and realized to be able to design other projects. Generated knowledge of realized designs is important for application in future projects as Weggeman defines within his book "Knowledge Management" (1997). Re-use of generated design information, knowledge and experience out of realized designs as well as design processes.

The most important target of the design team is to generate the design in conformity with the requirements and expectations of the client and within the specifications of time, budget and quality as confirmed with the client. The interest of the organisation of the design team is focused on collaboration and information exchange within the team to deliver specific knowledge of the concerned design organisations in time at the right location for application in the design and to prevent failures due to new, outdated or changed information.

Information environments of design organisations differ from each other as described before. As an example the information environment concerning CAD information exchange will be described in this paragraph. This part of the information environment is different within design organisations because of the implementation of different structured CAD-systems with different possibilities in 3D as well as in 2D. This development in design offices has lead to a discipline as well as office focused organisation and control, which from the perspective of the information environment of the design team can be seen as a nasty form of island automation. The lack of general norms, appointments and references within the Dutch

building industry for the structuring, storage as well as exchange of information is an important reason why this development could take place. Already in 1994 branche-organisations (BAS 1994) finally took the initiative to define a rule-system Building Industry-wide. However, until now this system is still in the definition phase and is not implemented in the building industry or in design organisations.

#### 4.4 An information ecology model for the overall design process

To get a clear view on the information ecology of the design information landscape seven different components are distinguished: 1) Information architecture, 2) Information strategy, 3) Information systems, 4) Information processes, 5) Information management, 6) Information politics and 7) Information Culture / behaviour.

These seven components for the model are based on the components of the ecology model of Davenport (six components) as well as on the 7S model of McKinsey as well as own observations and experiences in the architectural design- and drawings environment (Information systems).

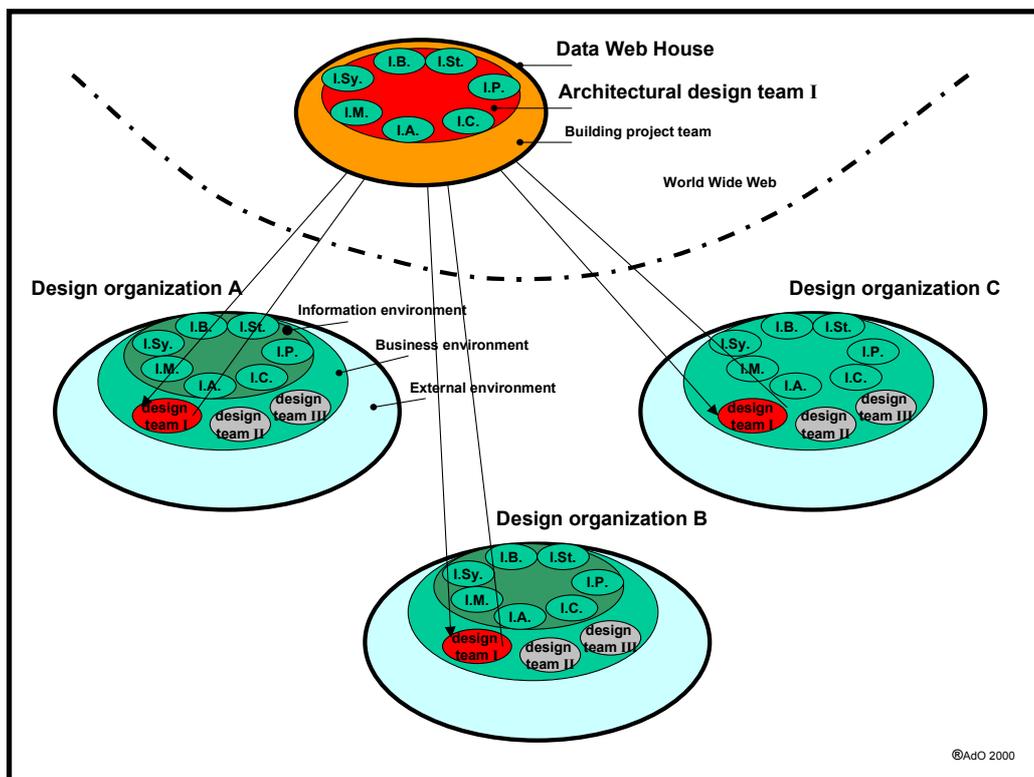


Figure 4.1: Components of design information landscape.

##### 4.4.1 Problems in the information exchange of architectural design processes

As stated by Den Otter and Prins (2000), important problems in information exchange processes within architectural design teams are caused by problems due to the design object, to the design team and by tools (ICT included). Design object aspects:

- 1) The complexity and the volume of building projects.
- 2) The growth of the volume of the design related information.
- 3) Changes and risks of mistakes in the design.

Team aspects are:

- 4) The growing time pressure of the design process.
- 5) The growing number as well as globalisation of design partners.
- 6) Differences in information handling of design partners.

ICT aspects are:

- 7) The number of applied electronic as well as non-electronic information systems
- 8) Double, incomplete and not updated information in different information systems as well as changes in information systems
- 9) The speed of technological changes.

As described in section 4.2, the information exchange is becoming more complex and difficult by the growth of the architectural design teams and the growing complexity and volume of building projects and besides that the application of different electronic information exchange tools and the lack of standardisation and norms for the procedures and exchange processes. For instance: There are standards and prescriptions for the design products that are delivered in specific design stadiums starting with the Client's brief, the Structural Design, the Conceptual Design, the Final Design and the Technical Design (NEN 2574). Design solutions have to be approved by the client, the users as well as the local authorities and concerned groups. But information processes, needed to communicate about design solutions or to exchange, integrate, compare information produced aren't standardized or even described. Chances to delays in the progress of the design are enlarged as well as the chances to mistakes and failures due to continuous chance-procedures in the developing design process.

#### **4.5 Research into improvement of information exchange processes**

In the recent past most efforts to cope with these developments were directed to setting up a prescription of a building as a collected assembly of information entities (object modeling). In the Netherlands for instance we have had BIM (with Idef technology) and COMBINE (with ISO-step technology) as the two major efforts. Apart from these attempts to improve information exchange also attempts were taken to model information exchange processes, based to object modelling theories: Electronic Data Interchange (EDI) and Product Data Interchange (PDI).

These attempts were successful within the Civil area as well as in mechanical installations but not in the Dutch building industry and in the design area. De Vries (1996) tried, by means of a vast protocol, to model the communication within the building process while Donker (1999) by means of a design language called Scaffold tries to improve the communication between all the stakeholders involved in the design and building process.

Bälter (1999) did comparable case studies to the use and application of email as information exchange system. He concluded amongst other things that apart from information-overload there is also communication-overload. He argued that it isn't only of importance what to exchange but also how and why. Email communication is positioned within a total framework of information exchange systems that an organisation uses as well make their choices out for her primary work process, depending on situation and circumstances.

As stated before the multi disciplinary architectural design team often has a fickle and unstable information environment. Davenport (1997) has done research to the improvement of information environments in business organisations and describes an approach for improvement by the holistic approach of 'Information Ecology' in which the human being is positioned centrally in an ever-changing information environment. Based on the 7S-model of McKinsey an "Information Ecology Model" is developed with three levels: the information

environment, the business environment and the external environment. Three aspects are dominant to the opinion of Davenport: 1) Information overload, 2) Information politics and 3) Multiple meanings.

This might be an interesting approach for the environment of design organisations however it is not applicable for temporary design team not directly. The project environment in which the information environment of the design team occurs is not defined in Davenports model. Den Otter and Prins have defined this in their article “Design management within the Digital design team” (Den Otter and Prins 2000), where they made a distinction between the following aspects:

- 1) Information strategy.
- 2) Information staff.
- 3) Information-architecture.
- 4) Information processes.
- 5) Information systems.
- 6) Information politics.
- 7) Information culture and behaviour.

#### **4.6 Conclusions**

The holistic attempts of object modelling as well as process modelling were not successful. That is why it can be stated that solutions have to be found within the management of the information handling of the design team as well as in the information management within the design organizations. For that reason the first exploring research by case studies (Yin 1994) about information handling finds differences as well as similarities in the information handling at workflow level as well as the management level (Gummesson 1991). The goal is to define the design parameters for the design of an Integrated Information Model to manage and control the information handling within the design process. By means of defining a classification system an insight view can be given to the information environments of the participating design organisations within the design team.

For the definition of the design parameters the next list of aspects is of concern:

- 1) The differences as well as the similarities in the information environments of the design partners.
- 2) The design of the architectural design management system and the level of self-control of the design partners.
- 3) The complexity of the design.
- 4) The application of the information systems for CAD and documents as well as the project management- and Internet tools.
- 5) The different information exchange systems.
- 6) The application of a Structure of rules (GB, VG-bouw or concept of the BAS).
- 7) The knowledge and experiences of the participants concerning the use of Computer Mediated Communication Communication (CMC).
- 8) The management and control of rights of ownership of information.
- 9) The information politics and information behaviour.
- 10) The technical information management (management of ICT-tools).

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