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**Formal and informal computer mediated communication
within design teams for complex building projects**

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In this paper the information environment of design teams is discussed because of the use of Internet based Project websites (PWS) to improve the information exchange within design teams. Because design teams heavenly depend on informal information exchange and PWS is a tool for formalising information exchange the question is how a PWS can be used effectively within deign environments. To get a more holistic view on the information environment of design teams Davenport's model for Information ecology is used (Davenport, 1997). The design organisation of DGW&T of the Ministry of Defense in the Netherlands is described by using the different aspects of information ecology. Finally informal information exchange processes within DGW&T are discussed as well as possibilities for improvement of information handling.

Keywords: Information ecology, formal- and informal information exchange, Projectwebsites, communication tools.

Project web sites, being protected part of the internet to be used as virtual and dynamic project information databases, might enhance the performance of design teams of complex building projects because of its powerful features for computer mediated communication: speed of design information exchange, overview, transparency, version control as well as easiness of use and keeping track to ownership of design information.
However, it isn't clear how this new tool should be implemented and used in a fickle information environment like a design team for a complex building project, in which a lot more communication tools as well are methods are used. Also this kind of tool might formalise the communication within these design teams too much, might be threatening because of 'big brother effects' and for both reasons might easily kill the creative, cyclic design process.
Design processes for complex building projects are cyclic processes in which communication is essential for the progress of the development of the design. This progress is heavily depending on the information exchange between design partners. In this respect, architectural design processes of these design teams can be described as design information handling processes between participating design partners in unique, project-based environments (Reymen, 2000). Design information handling within this context can be defined as all activities, facilities and processes concerning the generation, transmission, receiving, publication, storing, as well as the retrieval of design information, formal as well as informal.

The most available and most common methods and tools used for communication within design teams are: 1/ face to face meetings; 2/ informal meetings; 3/ formal meetings; 4/ discussions; 5/ mail; 6/ telephone; 7/ fax; 8/ email; 9/ desk top and groupware tools. The new, high potential and promising ICT tool for enhancing information handling: the PWS might become the essential part of the above listed means of communication and perhaps be used instead of other means of communication.

Based on the characteristics of communication within design teams:
   a) the high level of communication (De Vries, 1996, Nederveen, 2000);
   b) the desire to communicate by all means of communication as well as
   c) to communicate informal (Sproul & Kiesler, 1998, Donker, 1999 , Wiegeraad, 2000);
formal and informal communication will be discussed in this paper against the background of computer mediated communication through a-synchronic electronic systems. A-synchronic electronic systems seems to be adapted within design teams very quickly by users instead of synchronic systems.

Formal and informal design communication

Formalising specific communication channels within design teams might kill partly the creative design process or just fail to function and being bypassed by other informal communication channels.
To improve the information exchange within architectural design teams, procedures about communication behaviour of the team should be better established at the start as well as defined within protocols for the use of specific channels for formal information exchange as well as for informal communication. The hypothesis is raised that if channels for informal communication will not be taken into consideration and are not informal enough, formal established communication channels might easily fail to function also. Changing channels of communication need time to get acquainted to by the users and will temporarily decrease flows of information through that channels.
In that respect it is as important to keep informal communication channels open as well as to prescribe formal channels for communication.
This is especially important during the changes made in the information environment because of the uncertainty during changes in organisations.
Without informal communication these changes will not be successful (Ouchi, 1980; Stohl and Redding, 1987, Sproull & Kiesler 1998). As soon as the team members experiences the benefits of the features of the new channels of information exchange (for instance the use of a project web site to publish design information for purposes of the design team) they will be more willing to change their communication behaviour.

Exploring research is going on to investigate 1/ generation of information, 2/ information exchange, and 3/ publishing of information within the environment of design teams of DGW&T, the design and engineering services of the Ministry of Defence in the Netherlands, with a total of 1200 employees and 21 offices spread over the country. These three main information processes show the main information handling within design teams for complex building projects.
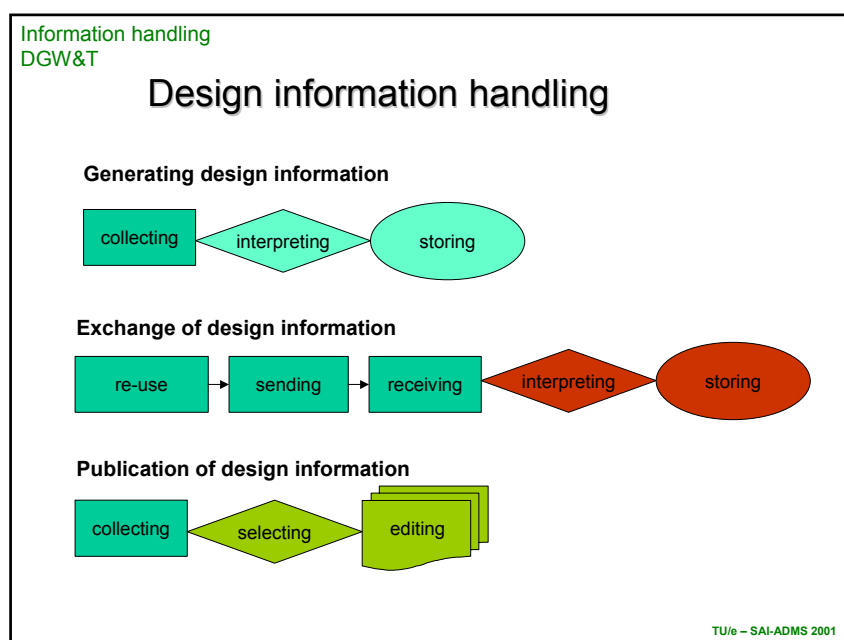
DGW&T is interested to use PWS, for the assembling of in all the design object information during the design process to improve design processes in terms of performance:
time (throughput time), quality (less double, redundant and outdated information, version and status control); organisation (as many parallel information processes as possible) as well as costs of failures. Because in this way important design object as well as process information (meta data) is captured within the system also this also benefits another target, which is: feedback on design process history (Wiegeraad, 1998) as well as re-use of design information in other projects.

For the design / project teams of DGW&T this means a change to computer mediated communication in which the PWS has to become the central electronic information exchange tool to be used.

The information ecology of design teams of DGW&T

Because of the complexity of the knowledge structure, which exists on all levels in design teams for complex building projects within DGW&T, the Information ecology approach of Davenport (Davenport, 1997), partly based on Mckinsey's well-known 7-S model, is adapted (den Otter & Prins 2000) to analyse the information environment. In this approach Information ecology is considered as the interaction between information organisms and their environment. An information organism is defined as any human group that is organised for a specific purpose, for instance an architectural design team (levey, 1999). In this holistic view an information environment can be described in terms of: Information architecture, strategy, process, staff, politics and behaviour as well as culture and information systems.
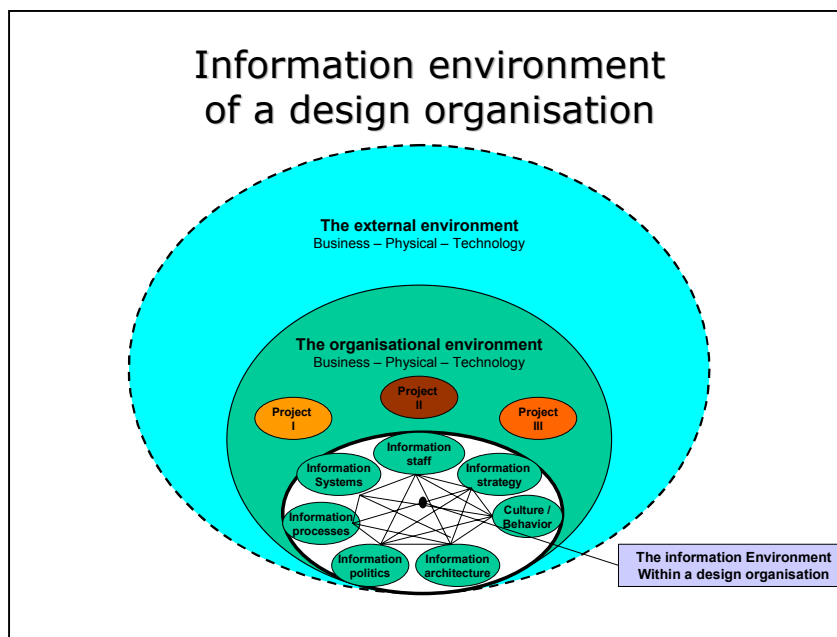
Information strategy
Information strategy within design teams of DGW&T matches the approach of a more or less static process of setting an organizational direction around the questions 'what do we want to do with information within this project ' and 'how can we do this efficiently?'. Due to these characteristics, on the project level Information strategy is formulated by the project manager of DGW&T.

Strategic information management within DGW&T isn't a well addressed issue yet, however due to several business studies done by graduate students of the TU/e, ADMS, special workgroups made plans for implementation of: output documents as well as Integrated object design and re-use of design information. Within the coming years these plans will be implemented within the design environment within all the regional offices. Because of the temporary nature of building projects and the different projects running concurrently, it appears to be hard, to develop project based information strategies. Also it has to be remarked that design fees are so much under pressure that regularly there aren't enough financial means to address this process function within projects.

Information politics
The formal, hierarchically way in which design teams of DGW&T are organised, and the way internal, formal, information processes are designed and managed, have to fit. This critical component involves the power information provides, and the governance responsibilities for its management and use.

While design information strategy within DGW&T is developed poorly, the same can be stated for explicit information politics. For instance the roles of general business management, project leadership, and project execution are often diffused among the employees. Within the context of architectural design there are very few procedures developed to digitally store design information. So with the exception of formal information, (like technical product data from suppliers), very little organizational knowledge is made explicit.

Within multidisciplinary design teams for complex building projects, information policies generally are not explicitly made fully clear. On the other hand it has to be remarked that a design firm's success is strongly depending on the understanding of the implicit information politics in it's surrounding. It appears there is often role diffusion between participants. For instance identification of the role of the design leader and the position of the design management function in regard to the project management. Also the positions of the design and design specialist partners involved and the architecture for the project bound information processes and systems have to be identified clearly. Because of the co-ordination task of the architect in fact no information can formally be added to a project's knowledge base without his formal approval. On the other hand the architect hasn't the formal authority and also has too less domain specific knowledge to judge the content.

Information behaviour and culture
Information behaviour has to deal with the skills, habits and backgrounds of design participants of DGW&T. It concerns information sharing, information overload and how to handle multiple meanings. Within DGW&T design participants: designers, design specialists as well as engineers, are regarded as knowledge and information workers. Often personal and organizational knowledge to a certain extend is shielded from others in the project environment, while this is what is actually their personal value added to the design. This inhibits true collaboration. So the level of information sharing is rather corrupted by psychological factors bound to the characteristics of professional behaviour. Within design teams of DGW&T as well as in the regional offices, a collective, coherent and consistent project knowledge base is of essential importance to improve the performance of design teams. Specifically on the level of technical design specifications, the sharing of design information as well as status and version control is very important

Information staff
This component isn't defined as a separate function within design teams of DGW&T. Information staff is only identified as technology experts who are familiar with hard- and software issues. Within design organizations, given the volume in staff, information managers can hardly be found, also because of the general lack of information strategies and politics.
When CAD systems were implemented within the regional offices of DGW&T, ICT managers were employed to implement and maintain hard and software but not to develop information strategies. Due to the functional and technical complexity of the designs of DGW&T as well as the project constraints, the information handling within design teams is becoming more and more complex. For these reasons the need for specialised information staff within a regional office to facilitate the design teams is rising.

Information processes
This component determines the main formal- and informal information processes for the generating- , exchange- en publishing of information. Within the field of architectural design formal professional procedures for information exchange are not well defined.
Concerning the design process, there is the upcoming field of architectural design management, which tries to model the process for handling its complexity and managing architectural quality.
Because of the lack of information strategy as well as the nature of the design process also on this aspect less formal procedures exist within design organizations. This is also due to the reluctance of designers and engineers of DGW&T to almost every kind of modelling in terms of design methods and systems as well as in terms of managerial activities applied to the design process.
There is a growing need for formalized design procedures since design projects are becoming more and more complex. This is especially needed for the management of changes in design information.

Information architecture

The central function of information architecture is to match information needs with information resources. Up till now there are no formal standard procedures, rules or methods for the design of the information architecture within the design organizations of DGW&T, it is more or less an implicit grown structure, different per region as well as different per design office.

Information needs of employees are often diffuse, in terms of the tacit knowledge needed, strongly project based, and partly something a designer has to generate himself as part of the design task. As far as the more formal information like technical product data from suppliers, standard contracts, rules, laws and so on are concerned, DGW&T is developing an intranet based information structure which also will be used for distributing external mail.

Because of the growing load of generic as well as project specific information, information architecture is becoming necessary. Information architecture will be integrated within project knowledge bases of design teams per regional office of DGW&T. Per region, separate design offices will be united soon.

Information systems

Information systems as defined in the 7S-model concern all hardware and software tools as well as procedures and protocols, used to process object as well as process information. This also includes daily mail, agenda, and reception functions.

Within DGW&T's regional offices a variety of information systems is used apart from the CAD-system. Different software for building specification is used also. The connectivity and integration between all these systems and the information they generate is lacking.

Informal information exchange DGW&T

Based on the results of the first analyses design teams within DGW&T now are heavenly depending on informal information exchange between colleagues in the organisation and the majority like to stick to the existing information culture. Most of the design specialists in the area of quantity surveying however like to have a change to computer mediated communication and linkage between information systems for object information to quantity and cost information systems.

As the figure on page 5 shows, design partners in design teams of DGW&T are collecting information through colleagues by informal information exchange in the corridor, offices or at coffee and tea breaks. Books, magazines as well as Internet sites score very low. Collecting information through colleagues has a social function.

Putting a Project web site in place will not easily change this information behaviour. Instead of predicting to use the new tool in a formal way a step-by-step approach by means of an information plan defined by the design team itself would be far better. A possible solution might be to use email as an informal channel for information exchange and a PWS for formal information exchange. In that way computer mediated exchange might be enhanced in a smooth way instead of predicting the formal use of a PWS. A PWS is more formal then email because information put in it has to be explained for status as well as version. Besides this, the team has to decide in what way the different tools should be used within the team.

Not all members of the team have the same skills in the use of ICT tools, have different opinion about the use of the tools, and also their habits for communication.
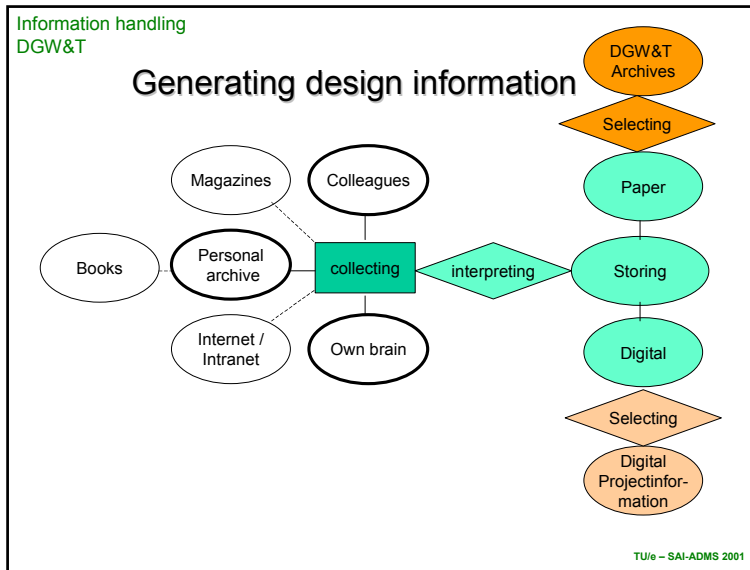
As is known: the strength of the chain is in its links. So it might be better to start on a lower level of using a PWS, for instance only for approved design information instead of information in use. When the team members experience the benefits of the system they will more or less spontaneously use the system in a better way.

Conclusions and recommendations

Regarding the aspects for information handling improvement on one hand the technical functionality of PWS's can be effective to solve problems concerning design object information aspects as well as speeding up the process of information handling. On the other hand team aspects and especially differences in information behaviour of design partners in complex projects can easily enhance the information chaos in which the PWs can't be active anymore.

Within the digital design team, digital design information exchange, storage and publication will have a most dominant position. Due to the nature of digital information handling the collaborating design partners have to become more pro-active and inter-active in the design process. Much more design information becomes explicit then has ever been before.

This might be the introduction to a paradigm shift in design organizations while more and more design and design management will be interpreted in terms of integral, inter organisational, information handling. If this paradigm shift doesn't occur, a lot of the promises PWS's offer for the improvement of the architectural design process will not be gained.
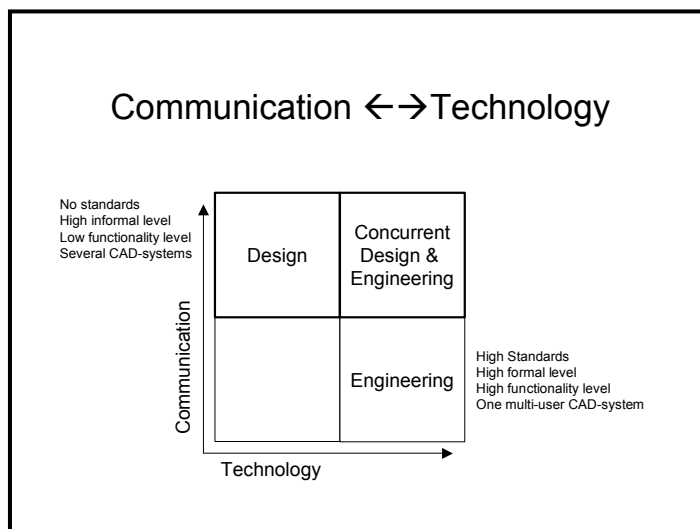
Concurrent design possibilities will be made much more explicit when the design team acts pro-active and technical design information is available for the actual builders.

In fact architects will need more multi-media skills to prosecute their profession. Instead of verbal and written information, more digital information in sketches, images, schemes and documents has to be available as well as accessible for all design team members. The digital design team will be more vulnerable then before, working with digital tools in the collaborating design process, more or less depending on the tools used and being depended on the bandwidth of the network provider.

The meta-data of the design process might be used for improvement of the process and for acquiring generalized design process knowledge. So the process might start more or less in a chaotic way and improves to a structured process by using the recorded meta-data of the electronic information exchange process.

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