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**Beyond the Artefact and Techno-centricity:  
Towards Process-centric Understanding of  
Architecture - Alternative Facilitation Strategies  
and Proposals**

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## keywords

architecture process, information management, communication, interaction techniques, user-centricity, information (aesthetic) visualization

## abstract

The artefact and techno-centricity of the research into the architecture process needs to be counterbalanced by other approaches. An increasing amount of information is collected and used in the process, resulting in challenges related to information and knowledge management, as this research evidences through interviews with practicing architects. However, emerging technologies are expected to resolve many of the traditional challenges, opening up new avenues for research. This research suggests that among them novel techniques addressing how architects interact with project information, especially that indirectly related to the artefacts, and tools which better address the social nature of work, notably communication between participants, become a higher priority.

In the fields associated with the Human Computer Interaction generic solutions still frequently prevail, whereas it appears that specific alternative approaches would be particularly in demand for the dynamic and context dependent design process. This research identifies an opportunity for a process-centric and integrative approach for architectural practice and proposes an information management and communication software application, developed for the needs discovered in close collaboration with architects.

Departing from the architects' challenges, an information management software application, *Mneme*, was designed and developed until a working prototype. It proposes the use of visualizations as an interface to provide an overview of the process, facilitate project information retrieval and access, and visualize relationships between the pieces of information. Challenges with communication about visual content, such as images and 3D files, led to a development of a communication feature allowing discussions attached to any file format and searchable from a database.

Based on the architects testing the prototype and literature recognizing the subjective side of usability, this thesis argues that visualizations, even 3D visualizations, present potential as an interface for information management in the architecture process. The architects confirmed that *Mneme* allowed them to have a better project overview, to easier locate heterogeneous content, and provided context for the project information. Communication feature in *Mneme* was seen to offer a lot of potential in design projects where diverse file formats are typically used. Through empirical understanding of the challenges in the architecture process, and through testing the resulting software proposal, this thesis suggests promising directions for future research into the architecture and design process.



## palavras-chave

Processo em arquitetura, gestão da informação, comunicação, interação humano-computador, concepção centrada no utilizador, visualização (estética) da informação

## resumo

A investigação sobre o processo projectual em arquitetura, na maior das vezes, centra-se no artefacto ou na tecnologia, motivo pelo qual precisa de ser contrabalançado por outras abordagens. Há um aumento substancial da informação que é colectada e usada no processo projectual o que coloca desafios à gestão da informação e do conhecimento, como apresentado nesta investigação nos resultados das entrevistas efectuadas a uma seleção de arquitetos. Entretanto, as tecnologias emergentes são esperadas resolver muitos dos desafios tradicionais, abrindo novas áreas de investigação. Esta investigação sugere que entre essas novas técnicas, as que são dirigidas à forma como os arquitetos interagem com a informação no projeto, especialmente a que está indiretamente relacionada com os artefactos, assim como os instrumentos mais adequados para a natureza social do trabalho, nomeadamente a comunicação entre participantes, converteu-se numa grande prioridade.

Verificamos que nas áreas de conhecimento relacionadas com interação humano-computador prevalecem as soluções genéricas, embora sejam desejáveis soluções alternativas sensíveis ao contexto extremamente dinâmico em que se desenvolve o processo projectual. Esta investigação identifica uma oportunidade centrada no processo e na abordagem integradora da prática arquitectónica, e, propõe uma aplicação informática para a gestão da informação e da comunicação, desenvolvida para as necessidades descobertas, fruto de uma colaboração próxima com uma seleção de arquitetos.

Partindo dos desafios colocados pelos arquitetos, desenvolveu-se um protótipo de uma aplicação informática para a gestão da informação, *Mneme*. Este instrumento recorre ao uso de visualizações enquanto interface para dar uma visão global do processo projectual, facilita a busca e o acesso à informação, assim como permite uma visualização das relações entre peças de informação. Os desafios com a comunicação de conteúdos visuais, como as imagens e os ficheiros 3D, guiaram o desenvolvimento de uma nova possibilidade na comunicação, a qual permite associar as comunicações e as discussões anexas a qualquer ficheiro independentemente do seu formato, assim como, com a possibilidade de busca a partir de uma base de dados.

Fundamentada nos testes do protótipo com os arquitetos e nas publicações que reconhecem os aspectos subjetivos da usabilidade, esta tese discute e reivindica que as visualizações, mesmo as visualizações 3D, apresentam um potencial pouco explorado como um interface específico para a gestão da informação e da gestão do processo projectual em arquitetura. Arquitetos confirmaram que *Mneme* permitiu um visão global acrescida do processo projectual, permitiu localizar mais eficazmente conteúdo heterogêneo, assim como permitiu a visualização do contexto associado à informação. Os instrumentos de comunicação de *Mneme* foram percebidos como tendo um grande potencial nos projetos em design / arquitetura onde são tipicamente usados ficheiros tão diversos. Foi com recurso ao entendimento dos desafios do processo em arquitetura, assim como com os resultados dos testes com a aplicação informática proposta, que esta tese aponta para direções promissoras para futura investigação sobre o processo projectual em arquitetura e design.



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## GLOSSARY

agent (digital/software)	<i>"[So]ftware that acts like an assistant to a user of an interactive interface rather than simply as a tool. [...] Agent software can learn from interaction with the user, and proactively anticipate the user's needs"</i> (MIT Media Lab. 2013).
artefact-centric	In this research referring to research focusing on the designed artefact being worked on in the design process, such as a building.
big data	<i>"In information technology, big data is a collection of data sets so large and complex that it becomes difficult to process using on-hand database management tools or traditional data processing applications. The challenges include capture, curation, storage, search, sharing, analysis, and visualization"</i> (Wikipedia 2013). <i>"Data you leave behind as bread-crumbs as you move around"</i> (Edge 2012).
client-server architecture	<i>"Architecture of a computer network in which many clients (remote processors) request and receive service from a centralized server (host computer). Client computers provide an interface to allow a computer user to request services of the server and to display the results the server returns. Servers wait for requests to arrive from clients and then respond to them"</i> (Encyclopedia Britannica 2013).
Building Information Modelling	Intends software applications to construct a detailed digital model of a building allowing different parties and participants to work on the same model (see page 58-61)
design inclusive research	A methodology aiming to <i>"provide a sound theoretical foundation and a robust methodological approach for designerly inquiry to meet scientific rigor."</i> [It] <i>"opens up a possibility to blend systematically two domains of learning: research and design"</i> (Horvath 2007, 4-7).
Descriptive Coding	<i>"Descriptive Coding summarizes in a word or short phrase [...] the basic topic of a passage of qualitative data"</i> (Saldaña 2009, 70).

End-User Development	An approach in computer science allowing the users to customize, or program software applications.
horizontality vs. verticality in software	In this research verticality of software tools refers to their relatively closed and restricted nature, whereas a horizontal approach to software environments better information exchange between them not only from the technical point of view but also from the users point of view. i.e. beyond interoperability.
information visualization	<i>"[Develop effective visual metaphors to mapping abstract data"</i> (Card et al. 1999, see page 60). Information visualization is acquisition of insight from an image (Spence 2010).
information aesthetic visualization	<i>"[I]nformation visualization techniques that combine information visualization techniques with creative design."</i> (Lau and van de Moere 2007, 1)
Integrative approach	<i>"...integrate useful knowledge from the arts and sciences alike[.] Designers, are exploring concrete interactions of knowledge that will combine theory with practice for new productive purposes[.]"</i> (Buchanan 1992, 6)
In Vivo coding	<i>"[R]efers to a word or short phrase from the actual language found in the qualitative data record."</i> (Saldaña 2009, 74)
Likert scale	Unidimensional scaling method indicating responses along a range used in questionnaires and interviews.
process-centric	In this research refers to an approach looking at architecture or design process more holistically: including communication, social aspects and information indirectly related to the artefact in development.
semantic web	<i>"The Semantic Web is an extension of the existing World Wide Web. It provides a standardized way</i>

*of expressing the relationships between web pages, to allow machines to understand the meaning of hyperlinked information.” (Semantic Web 2013)*

synchronous vs. asynchronous

Synchronous is happening at precisely the same time while asynchronous is the opposite of synchronous.

## **ACRONYMS**

AEC	Architecture Engineering and Construction
DR	Design Rationale
EUD	End-User Development
HCI	Human Computer Interaction
BIM	Building Information Modeling
IPD	Integrated Project Delivery
CPU	Central Processing Unit







A personal and professional interest to study the design process together with findings already uncovered from the early interviews with designers and architects motivated this design inclusive research project (Horvath 2008). Further interviews with several practicing architects and literature made the specific focus increasingly clear. It became evident that research into the architecture process has been highly artefact and techno-centric with systems and tools focusing predominantly on issues such as building modelling, performance, simulation and analysis with particular interest, in recent years, on researching the challenges and opportunities of Building Information Modelling (Deamer and Bernstein 2010; Holzer 2011, 465; Rekola 2010, 265). However, as demonstrated by the interviews and evidenced through a review of the literature, other urgent challenges persist that demand attention. These include information and knowledge management, communication (Otter and Emmitt 2008, 121) and human factors (Shen et. al. 2010, 30), which form the core focus of this thesis. These challenges could be approached through different means, for instance through team and project management in architecture (Sebastian 2005). However, a close look into the above-mentioned challenges pointed towards an insufficient support in digital systems and tools, an area providing interesting opportunities for research and design.

Architecture projects are increasingly designed and executed in a distributed collaborative environment, driven towards digitalization of the process and the documentation. However, despite this tendency, the interviewed architects complained about insufficient project records, lack of project overview, and cumbersome and inadequate communication systems. In their complaints the architects were referring to information both directly and indirectly related to the artefact. These notions informed the overall approach of this thesis to understand architecture and the systems and tools related to it more holistically. Thus, the approach in this thesis can be called process-centric with a more horizontal view on the systems and tools. It seems that emerging technologies, namely the semantic web technologies (Shen et al. 2010, 2,13), may help resolve many traditional challenges related to information and knowledge management such as searching and retrieving information from different media (Grudin 2006, 1-2). At the same time other challenges become a higher priority, such as investigating appropriate means and interfaces for specific users and user groups to access the increasing amount of project related information.

Furthermore, the research revealed a greater need for specificity of methods and solutions. This is evidenced through the practitioner interviews and through criticism towards certain still prevalent generic and inappropriate methods and techniques in Human Computer Interaction (HCI) and Information Visualization, which do not sufficiently acknowledge

the importance of prior knowledge, aesthetics and subjective experience among others (Barkhuus and Rode 2007; Chen 2005, 12-16; Hassenzahl 2004; Karapanos 2010). Thus, the methods and solutions in this research project were considered and developed from the perspective of the architects and aimed to take into account their specific needs and abilities. As a research means and designed outcome this thesis introduces an information and communication software application *Mneme*. The novel features include the 3D visualization interface and communication feature designed for discussing about mainly visual, heterogeneous content. Findings from the interviews and testing the software prototype demonstrate the relevance of the overall approach of this thesis and indicate promising directions for further research.

The focus in Part I of the thesis, is on describing the problematic, objectives, the methodology and methods of this study.

Part II opens the research with a chapter aiming to concisely describe the nature of the architecture process. The chapter suggests that a more empirical understanding of the process is needed and thus discusses the process mainly through interviews with renowned architects and with experienced practicing architects. Further understanding of the architecture process is developed in the following chapter that discusses relevant aspects from different fields relating to systems and tools for architecture and design; including HCI, information visualization, architectural computing, and information and knowledge management. These two chapters are intended to formulate the basis and argumentation for the design inclusive part the thesis.

Part III describes the interview and design process in detail. From detailing the problem framing for the design proposal, to describing the chosen and developed interview methods and techniques, to design conception of the software application and the refinements of the proposal, towards the prototyping and collaborative efforts with a programmer. Part III arrives to the description, and the testing of the resulting interactive software prototype. The Part III ends with a synthesis of findings from the Part III and reflections on the implementation challenges and possibilities.

Part IV of the thesis presents the overall conclusions and contributions related of the thesis. It also discusses the contributions of the *Mneme* software proposal. The part IV further outlines both the limitations of the study, and discusses the suggested recommendations for future research into the architecture process, opening up alternative avenues for future research.





## RESEARCH QUESTIONS, OBJECTIVES, METHODOLOGY AND METHODS

### 2.1 Problem description and hypothesis

In this thesis the design process, more specifically the architectural design process, is the topic of research and design. The broader problematic revealed through practitioner interviews and literature is the prevailing artefact (the designed outcome)-, and techno-centricity of the research and development (Holzer 2011, 466; Rekola 2010, 265). This mainstream approach tends to overlook the overall view of the process, including social aspects, significant parts of relevant information, and concerns from the practitioners themselves (Deamer 2010, 19). This research suggests that what is called here the process-centric approach, combined with a user-centric and designerly integrative (Krippendorff 2004, Buchanan 1992, 6) approaches are useful to understand the problems from different levels (Conklin 2005, 4): from the level of the process and through the everyday challenges of the architects.

On a more detail level of the problematics, the artefact-, and techno-centricity has resulted in significant shortcomings in (software) tools for design. The tools are separated into tools dealing directly and indirectly with the artefacts. Due to this disconnection and overall verticality of the tools and systems, architects and designers appear to lack the overview and usable history of their projects, resulting in specific everyday challenges; the neglect of the content indirectly related to the artefacts and to the oversight of specific communication needs (of designers dealing with visual content and communication about heterogeneous content in distributed projects). Although many challenges traditionally pertinent to the tools may be resolved with certain emerging technologies, the urgent need to develop more appropriate systems and interfaces to deal with the increasing processual information remains.

Despite of the recent efforts and tendency towards networked and integrated practices, and tools that converge diverse content (Deamer, Bernstein 2010, Tombesi 2010, Krippendorff 2009, Aksamija and Iordanova 2011), the above-mentioned challenges still remain largely unrecognized and unresolved. Therefore, this research investigates and proposes domain specific content management and communication tools, and more appropriate interaction techniques, including the information (aesthetic) visualization. This research recognizes the need to understand the practice from 'within', the need to collaborate closely with the end-users (in this case practicing architects), and to investigate appropriate levels and types of user involvement.

### 2.2 Research objectives

The objectives of this thesis are intimately related to "*designerly integrative*" (Buchanan 1992, 6) way of working and combining several fields of knowledge. The research in this

thesis is divided into two parts, which can be called the theoretical (Part II) and the practical (Part III). Consequently, there are also two areas of research objectives.

First, through the literature; exploratory interviews with senior and project architects; and interviews with principals of architecture offices, contribute to a better understanding of the contemporary architecture process and changes that are taking place. This improved understanding constructs and introduces a process-centric approach. The main interest here is to understand challenges that architects with different experience levels currently face in their daily work and the type of challenges that are emerging due to the changes taking place in the architectural practice. These challenges are mainly described with the following target in mind: to create strategies and proposals to facilitate these challenges. Utilizing the knowledge of the current and transforming architecture practice, one of the objectives is improved understanding of tools and systems for the design process: where are they useful and where do they fall short.

Second, based on Part II of the thesis, create facilitation strategies and proposals, leading to designs and prototypes. The aim is to create the designs in close consultation with architects to achieve appropriate domain specific proposals. The aim is to implement a proposal or proposals, which can be tested with the architects. The objective of the testing is to present some generalizable results that can inform further research and provide some insights into improving tools and systems for architectural practice. Although the goal of this research project is to achieve domain specific results, the assumption is that some of the results may also prove useful for other design and project-based practices.

The specific objectives of this research can be summarized as:

- To introduce the process-centric (versus the currently more common artefact-centric) approach and how that can improve understanding of the practice and help create more appropriate facilitation strategies and proposals.
- By utilizing the 'process centric' and 'integrative' approaches, present facilitation strategies and proposals for architecture practice.
- Through close consultation with practicing architects present domain specific findings and solutions to improve systems, tools, and interfaces (visualizations) of tools for architecture practice.
- Present a proposal(s) of a novel tool(s) that by integrating and learning from the above mentioned notions is appropriate for the contemporary architecture practice by providing the needed overview and recognizes the need for more domain specific, dynamic and customizable (conversely to categorizing) tools.

## **2.3 Methodology and methods of study**

### **Methodology**

There is a long ongoing discussion about what design research is and how it should be conducted. For the overall framework of methodology for this research I have used mainly three references (Eckert 2003; Horvath 2008; Horvath 2007). Horvath's papers are a result of an extensive research into design methodologies and methods; both from design research



literature and promotion projects (117 of them), and therefore provide comprehensive references. Regarding the overall approach of this research, it is essential to mention that this is a design inclusive research thesis and the approach is therefore integrative, as explained by Buchanan.

***“Designers, are exploring concrete interactions of knowledge that will combine theory with practice for new productive purposes”***

(Buchanan 1992,6). Meaning, several fields of knowledge may be required and each one is addressed only to the extent that is crucial for the objectives of the project.

Eckert describes a framework how research can be carried out in big teams, but she also addresses the possibilities and limitations of a doctoral student.

*“Research in design, which should both advance knowledge and bring practical benefits to designers, is subject to tensions between conflicting needs and goals:*

- *between the need for valid, well-grounded research results, and the need for industry- supported research to have immediate practical applications;*
- *between the academic need to produce reportable results quickly from projects with limited resources, and the industrial need for powerful, reliable, validated tools and techniques;*
- *between the need for large research groups to exploit their resources to make major advances, and the need to allow isolated researchers to make effective contributions;*
- *between the need for students to achieve intellectual independence in their own research, and research leaders to achieve larger-scale, longer-term results;*
- *between the need for students to develop skills in different aspects of applied research and their need to focus to achieve results in a reasonable time. The crucial problem in applied design research is that achieving the usable results we aim for requires more effort than a single doctoral student can contribute or a single research grant will pay for.”* (Eckert 2003, 3)

These conflicting needs and goals mean reconciling between what is desired and what is possible within a PhD project. In the above list, although comprehensive, Eckert misses one aspect that became evident in this research, the issue of time and relevance. This research deals with the digital artefacts and architectural computing and therefore relevance of, in particular the design part, is short as technology and consequently the practice change rapidly. I suggest an added point to the list: tension between the time the results of the study are relevant and the time needed to conduct thorough research and design. These tensions need to be considered also regarding the multi-disciplinary nature of design research - when deciding on the one hand what is necessary for the theoretical grounding of the research from different fields and on the other, how far the design part of the PhD project is taken. Eckert also describes an eight-part spiral of applied research: *“Empirical*

*studies of design behavior; evaluation of empirical studies; development of theory and understanding it; evaluation of theory; development of tools and procedures; evaluation of tools; introduction of tools and procedures, dissemination; evaluation of dissemination.”* (Eckert 2003, 6) In her opinion a doctoral student can only adequately address two or three out of the eight aspects. This research mainly focuses on three, the *“empirical studies of design behaviour”, “the development of tools and procedures”* and *“evaluation of tools”*.

Where Eckert provides the framework for applied research and helps in understanding the possibilities and limitations, Horvath proposes and explains in detail an ontology of methodologies (in industrial design engineering): 1] research in design context, 2] design inclusive research and 3] practice-based design research (Horvath 2007,1).

Studies in the first methodology can be in short described as *“mono-disciplinary, their set-up corresponds to that of the ‘classical’ empirical approaches [...] experimental inquiries are conducted purposefully to get insights, or to achieve enhancement in various contexts, such as human behaviours and reflections, artefact qualities, and interactions and impacts on natural/artificial surroundings.”*

**The objective of the second, design inclusive research *“is to provide a sound theoretical foundation and a robust methodological approach for designerly inquiry to meet scientific rigor”. [It] supports analytic disciplinary and constructive operative design research by the involvement of various manifestations of design in research processes as research means, integrates knowledge of multiple source domains, and lends itself to multi-disciplinary insights, explanations and predictions, but can also generate knowledge, know how, and tools for problem solving.” [And] opens up the prospect to blend systematically two domains of learning: research and design.”***

The third methodology, practice-based research positions the practitioner as an observer, or a researcher. There are several views on how practice-based research should be defined. Some define it as *“research by design to describe a combination of research and design in which an evolving artefact is employed as a research means in the process”* (Horvath 2007, 4-8).

Research questions in this study originate from the practice of design and architecture; they are rather practical challenges designers and architects face in their work than theoretical questions. These challenges also more urgently demand more investigation on proposals and possible solutions than theoretical contribution. Design inclusive research methodology seemed the most appropriate, as it enables more scientific rigor and generalizability of solutions than practice-based research. The diagram by Horvath illustrates the main phases of design inclusive research (Fig. 1).

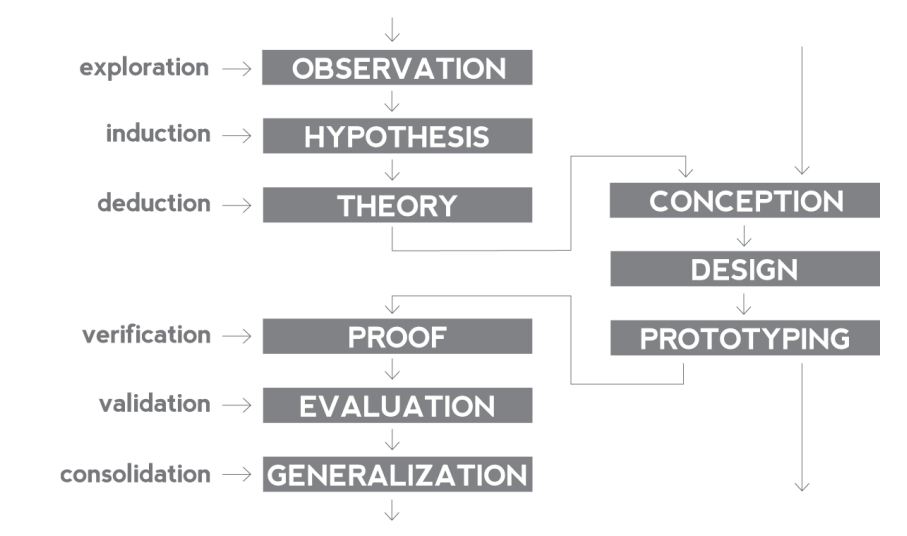


Figure 1. Major phases of design inclusive research.  
Derived from Horvath 2007, 6

### Methods of Study

The methods used in this study can be described as belonging within the broad framework of user-centred design. Since user-centred design includes a variety of methods and is rather general understanding that users are involved in some ways, the methods were informed more specifically by the field of Human Computer Interaction (HCI), Information Visualization and a selection of qualitative research methods. It is important to mention two main things that influenced the selection of methods. Firstly the methods needed to correspond with the goal of understanding the specific needs and opportunities in architecture. Thus, some interview methods and techniques were adapted or 'enhanced'. Secondly the methods were chosen to be appropriate for developing a software application proposal with a visualization interface.

User involvement could be described as 'light'. They were 'consulted about their needs, observed and participated in usability testing'. More intensive user involvement could entail user participation throughout the process as partners in design (Abrams et al. 2004), commonly referred to as participatory design. However, in designing digital systems,

**the downfall of user-centred design and participatory design are that the users are only involved during "design-time". Accommodating their "use-time" needs requires more active role from the users, commonly referred to as End User Development (EUD).**

(Fischer and Giaccardi 2006, 432). Although the resulting prototype could not incorporate this approach, this thesis acknowledges that in real implementation due to the dynamic nature of architecture process, any tool or system should be appropriately customizable. The "creative design actions" phase of the design inclusive research methodology (Horvath 2008,18) includes two roles for a single researcher: designer and researcher. This is in

line with the action research approach, which was chosen for the method of working and collaborating with the architects and designers. In this approach both the researcher and subjects are “*deliberate and contributing actors*” (Berg 1989, 96).

Regarding the software application proposal and in particular the visualization interface, the following categorization of Information Visualization methods by Plaisant informed the options and the overall scope of the interviews and testing the proposal with architects.

*“1: Controlled experiments comparing design elements. The studies in this category might compare specific widgets.*

***2: Usability evaluation of a tool. Those studies might provide feedback on the problems users encountered with a tool and show how designers went on to refine the design.***

*3: Controlled experiments comparing two or more tools. This is a common type of study. [...] Those studies usually try to compare a novel technique with the state of the art.*

*4: Case studies of tools in realistic settings. This is the least common type of studies, e.g. The advantage of case studies is that they report on users in their natural environment doing real tasks, demonstrating feasibility and in-context usefulness. The disadvantage is that they are time consuming to conduct, and results may not be replicable and generalizable.”(Plaisant 2004, 2)*

The points 2, 3 and 4 were considered as consistent with the objectives of this research. However, points 3 and 4 were not feasible due to time constraints and due to the early development stage of the software prototype. Thus, the most appropriate methods for this project fall within ‘*usability evaluation of a tool*’ category. Examples of this type of method include Graham et al. (2000), Kennedy et al. (2000) and more generally by Shneiderman et al. (2005). Although the methods in this thesis are informed by HCI and Information Visualization literature (including Card and Mackinlay 1997; Spence 2001; Shneiderman 1996; Shneiderman 2003), this research also led to some criticism of the mainstream methods and how usability should be understood. This refinement of the methods is further elaborated in the section 4.4.

### **Who and how many to interview?**

The decision on who and how many people should participate in the interviews and user testing was informed by several factors. For the ‘who’ the most important criteria were to select experienced architects with diverse background (countries where they were from and countries and offices they had worked at). As the problems expressed in the first interviews and based on my work experience were more related to and evident in bigger projects with large teams and several parties it was also important to select architects from bigger offices. Thus, an international group of architects with experience in several significant medium and large size offices (medium 20-49 employees, large 49-150 employees) were selected for the sample. The decision of ‘how many’ is a combination of literature recommendations and

constraints of the study. Graham et al. only used a few expert representatives, explaining this choice with mainly qualitative concerns of the study (Graham et al. 2000, 793). Overall the scope of their study has several similarities with this research. Shneiderman and Plaisant recommend identifying 3-5 diverse expert users (although in discussing '*multi-dimensional in-depth long-term case studies*' instead of earlier phase interviews and testing). However, they note that increasing the sample size will improve the reliability, validity and generalizability of the results (Shneiderman and Plaisant 2006). Isenberg et al. acknowledge the compromises that have to be made between sample sizes and how much data can be processed when using qualitative research methods (Isenberg et al. 2008, 3). Due to the limited time and resources available we could not include a large sample, but rather opted to select the sample, as explained above, to be diverse and experienced considering the problems we wanted to address. Overall 14 designers and architects were interviewed. Of the 14, four architects participated more intensively in the development and testing of the software prototype. I suggest some of the problems and needs they expressed can be generalized owing to their knowledgeable, engaged and insightful participation.

### **How and what to measure from the interviews and testing?**

How to conduct the interviews and user testing in software development includes a contentious choice: whether to measure effectiveness and efficiency (quantitative) or satisfaction (qualitative), or as discussed more in detail in the section 4.4 'pragmatic' or 'hedonic' aspects (Hassenzahl 2004, 320). In software development and user testing it is common to measure task completion times, error rates and learning time among other quantifiable results. User satisfaction on the other hand is measured through overall preference and attitudes towards the software and interface (Karapanos 2010, 12-13). Considering the objectives of this research and the development level of the prototype, measuring effectiveness and efficiency, such as task completion times, is too detailed of an approach. Also as the section 4.4 discusses, perhaps measuring the "*subjective side of usability*" should have a bigger emphasis than studies commonly acknowledge (Hassenzahl 2004, 321).

Thus, all of the interviews in this research were semi-structured allowing the interviewees to explain more freely how they felt about different issues and proposals and use their own terminology. The interviews attempted to understand both the functional aspects, and the appealingness of the proposal. The last user tests included also questions measured with a Likert scale, however the main emphasis was on the qualitative questions. Chapters 6 and 7 describe the interview and testing process and the analysis and findings in detail.

### **Coding and interpreting the interviews during the different phases of the software proposal development**

The following section clarifies the coding and interpretation process of the interviews, how they were conducted and why certain interpretations and choices were made.

First questions before beginning the interview process were: who and how many people to interview, how many times and what to record and how to interpret? Many of these questions are already answered in the above sections through finding appropriate research

methods that helped in determining sample size and sequence of work in a context of developing a software prototype. What the methods do not address completely is what to record and how to interpret the findings. In that qualitative research methods were consulted and used to an extent that seemed appropriately rigorous. Regarding what to record, I agree with the postmodern perspective that all reports are necessarily incomplete and partial, thus one has to determine what can be considered “*sufficient quality data*” (Saldaña 2009, 15) on project basis. In analysing the content, the approach was interpretative (Berg 1989, 266) from a point of view and due to the objectives of a designer. For a researcher working in an unfamiliar discipline, understanding the subjects, their terminology and environment can be challenging. Owing to my background in design and work experience in architecture I believe having had an advantage to filter out what were the really important issues in the practice and position the comments in a broader context of the discipline.

### **The interviews**

The first two sets of semi-structured interviews informed the problem framing and defining the solution space (see section 6.1). First set of interviews included designers from several disciplines and countries. They described their design process and challenges in the process. Most intriguing and urgent challenges seemed to be in architecture, the discipline in which I have also been involved in during the past years. Therefore, the second set of interviews focused on interviewing four architects from central and south of Europe with experience in medium and large-size offices. These second interviews were structured around tool groups and directions for new tool concepts. The tool groups and concepts were used to tease out more clearly the problems and needs in the practice and to define a possible solution space. These interviews were broader and the architects described a variety of problems. However, issues consistent with the gap in literature could be identified, which helped defining a solution space for the design proposal.

The problems and user needs were then translated into a design concept (see section 6.2). The process of translating the user needs into a concept is perhaps the most interpretative moment, where the design choices depend on the one hand on the interplay of the major codes (Saldaña 2009, 187) and on the other on the expertise, capabilities and objectives of the designer(s). I created two versions of the concept and discussed them with three architects. Two of the interviewed architects were the same as in the previous interviews and one was new to the project. The versions showed the main functions in a sequence of images, not yet interactively. Based on these interviews one version of the concept was selected for further development.

Within the overall concept the user needs needed to then be translated into functions of the software proposal. In order to create a testable prototype and get assistance and advice in refining software functionalities, a software programmer joined the project for seven months. Additionally two professors from computer science advised during the prototype development (see section 6.5). The design of the concept, prototype, visualizations, interface and main functionalities were my responsibilities as the principal researcher. At this stage we made improvements to the concept and in order to properly understand

and further validate the functions, I interviewed two of the architects again (see section 6.4). This time I used a combination of a video demo and a paper prototype, accompanied with transparent tracing paper. It seemed that most functions were present. However, additions and improvements were suggested. The coding approach loosely combined In Vivo and Descriptive Coding (Saldaña 2009, 70-74)

After the paper prototype we made further improvements and the programmer completed the implementation of the interactive prototype and I designed the visual encoding and interaction (see sections 6.3.1, 6.3.2). I tested the prototype with the four architects (see section 6.8). In the tests they first created a new project and used planning related features. After they used a simplified dummy project. In the dummy project the architects performed sets of tasks. After each set of tasks they were asked questions to rate the task (in five point Likert scale) and also elaborate freely on their experience. I also asked the architects to explain their impression and opinion on the visualization and elaborate on the appealingness of the prototype. A mixed approach of In Vivo and Descriptive Coding (Saldaña 2009, 70-74) was used to analyze the interviews.

The findings of the post-study are described in detail in the Chapters 7 and 8. They *“comprise verification, validation, and generalisation. The actions are orientated to: the verification of the hypotheses, the constructed theory and the outcome of the design processes, the internal validation of the research methods and the design methods, the external validation of the findings of the research, and the results of the artefact development, the consolidation of the results by matching them against the existing body of knowledge, and by generalising them towards other applications”* (Horvath 2008, 18). The above-mentioned actions for post-study in this research consisted of evaluating the interviews and user-testing methods and results, as well as findings regarding the design proposal. The design proposal was also evaluated reflecting its novelty and appropriateness to the architecture practice compared to existing systems and tools. Due to certain choices explained earlier in this section, such as to interview only experienced practicing architects, and limitation due to time and technology this thesis aims to present findings that can inform novel directions for further research. Figure 2 on the next page presents the process of this research project overlaid with the major phases of design inclusive research by Horvath.

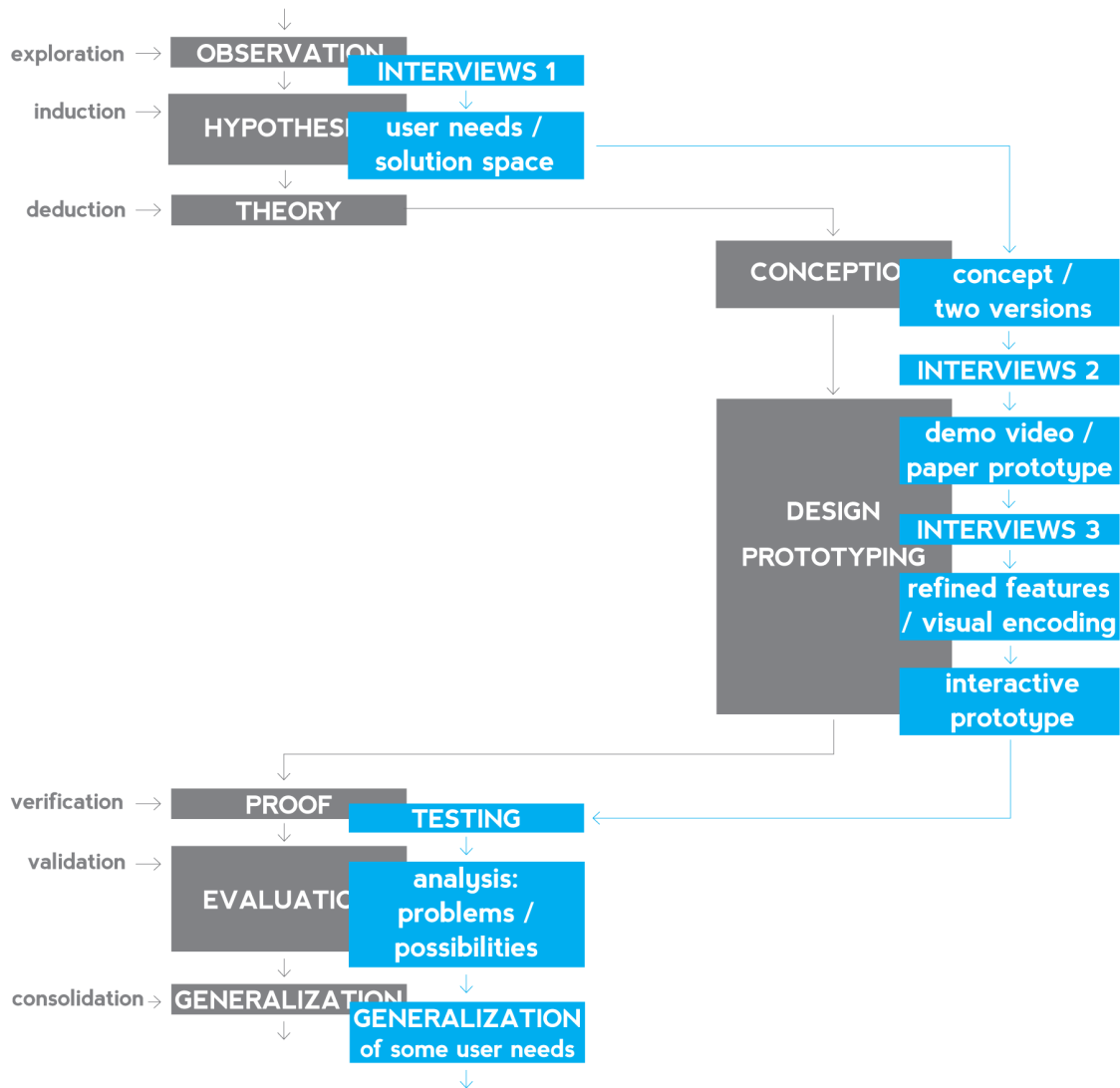


Figure 2. In grey major phases of design inclusive research. Derived from Horvath 2007, 6. In blue the interview sequence and software prototype development until user testing.







### 3.1 Changing architecture process

#### Discussions with architects; understanding challenges and discovering facilitation opportunities

*“It would be great if each of you would generate/be responsible for a permanent record of the process so that not every presentation becomes a desperate improvisation.” [1]*

The different sections in this chapter intend to concisely sketch the nature of the architecture process and present the main argument of this research project through interviews with internationally renowned architects and through insights from exploratory interviews with practicing senior and project architects from acknowledged offices. Incorporating knowledge from different fields supports this empirical work and is further substantiated in the following chapters. Whereas other parts of this thesis focus on explaining in greater detail certain fields of knowledge, or the interview and design process, this chapter takes a broader perspective and introduces the topics, issues and tendencies in the architecture process revealed during the research.

The architecture process can be in short described as a messy and terribly slow collaborative activity (Hawthorne 2010, 70), taking place in a rich context of interdependent factors. In order to understand the current architecture process and changes that are taking place, incorporating knowledge from different fields and interviewing architects with different levels of experience were crucial for this research. Through understanding the dynamic nature of context, increasing complexity and distributed creation and execution, this chapter arrives to a notion that architecture process needs to be understood as information produced and used within projects and that the current model of practice needs to be challenged and new facilitation strategies proposed. This research sees architecture from a process-centric view, conversely to the common artefact centric and techno-centric view: as information exchange in a network of parties – as a social and informational system.

[1] A note from Rem Koolhaas to all staff members. Shown at the OMA/Progress exhibition Barbican, London October 2011 - February 2012

## **The interviews**

In part, this chapter is informed by exploratory interviews, embedded in this design inclusive research project. These interviews with practicing project and senior architects from central and south of Europe and China represent internationally acknowledged offices. The interviews were done in several semi-structured sessions during this research project. This chapter also references renowned architects, interviewed specifically for this thesis: Ole Scheeren (Annex 1 and 5), Winy Maas (Annex 3 and 5), and Dietmar Eberle (Annex 2 and 5). These architects were chosen to represent different approaches to architectural design; from an approach influenced by the contemporary dynamic Asian context, to the Dutch conceptual design, and to the pragmatic and methodological Swiss approach. The interviews were semi-structured, focusing on understanding the approach and methods of each architect and office and in particular challenges they face in bigger projects. Interviews also aimed to uncover which tendencies are influencing architecture practice. All of the interviewed architects represent medium to large-size offices. Extra large offices (Kolleeny, Linn 1999) are not included in this research; thus, some concerns and findings discussed in this chapter may not apply in that category. Additional discussion with Ludger Hovestadt (Annex 4) enriches the view on the architecture process with his perspective on emerging technologies. This chapter of course has its limitations. As Cuff observes, there can be a difference between “*what architects say and what they do*” (1991, 7). Although having to do without an extensive immersion to several offices and architecture practice I believe that based on the interviews, literature and some inside knowledge about architecture practice this chapter is able to present interesting and useful findings.

### **3.1.1 Related (mainly empirical) research into the architecture process**

There appears to be significantly more publications about the design process in general, than about the architecture process. The few research publications about the architecture process are likely to mention the rarity of the subject matter. I will not go into the known references about the design process in general here, but will outline some specific references related to the architecture process, and some that have directly influenced this research.

The most comprehensive account and analysis of the architecture practice may still be *Architecture: The Story of Practice* by Cuff from 1991. It appears that Cuff's background both in social sciences and architecture allows her to capture many still essential elements of the architecture practice through in depth observation. She discusses many aspects of the practice: the roles of different level architects, architects' relationship with clients, the education of architects, the design problems, and different participants to the architecture projects, among other subjects. Although not very recent, her book is certainly a useful reference for understanding the practice. However, she does not attempt to provide solutions or strategies to challenges, and naturally cannot provide insights into many of the contemporary challenges. A much more recent (2009) publication by Yaneva, *Made by the Office for Metropolitan Architecture: An Ethnography of Design*, appears to share some similarities with Cuff's study. Unfortunately, it does not offer any more insights into the contemporary architecture process. Perhaps due to Yaneva's background as an

ethnographer, certain aspects of the process at OMA fascinate her. She thus focuses on detailed accounts and stories of what is going on in the office, mainly related to the use of physical models. PhD study by Sebastian (2007) bears resemblance to this study in some aspects. He aims to describe the characteristics and difficulties in increasingly complex architectural projects through interviews and case studies, however, through management of projects. Sebastian also recognizes that focus of the other studies is in the artefacts and that the description of the process is generally limited. The case studies emphasize social complexity and this is reflected in his proposed concept, “*managing-by-designing*” which focuses on “participative role of design management through creative teamwork” (Sebastian 2007, 93). Although more general, discussing both design and architecture, Lawson’s frequently cited book *What Designers Know* (2004) has influenced this study. Lawson’s observation that

**“*design is after all a process of creating, manipulating and managing information*”**

(Lawson 2004, 81) is shared by this research. Also his recognition of design as a social process where all parties are an important source of knowledge requiring direct lines of communication is also an insight that the architects interviewed for this study confirmed. Along the same lines, Achten discussing similarities and differences between industrial design and architecture process outlines that team design has not been studied to great extent (Achten 2008, 15-27). However, he focuses on discussing a theoretical framework, and thus observations on case studies remain on a general level.

Although Cuff and Lawson in particular discuss many aspects of the architecture practice in detail, they focus on analysing separate aspects of the practice, whereas for this research the acknowledgement of the process as a flow of the information between the participants is fundamental. Many of the subjects discussed by Cuff and Lawson such as the drawings, conversations, and knowledge are here situated and discussed within the trajectory of the process and looked through opportunities to improve the process.

### **3.1.2 Process-centric practice**

To emphasize the process can be a contentious stance, since architecture process is a term used both in a negative and positive sense. The negative views often emphasize the cumbersome activity, increasing bureaucracy, distribution of the process, diminishing influence of the architects and commercialism. These negative connotations and contradictory attitudes towards process originate already from the first edition of the AIA Handbook of Architectural Practice in 1920 (Wickersham 2010, 25).

**They continue to be expressed in Rem Koolhaas’ statement of one of the first large modern buildings the Empire State Building, as a pure product of process and thus having no content (Koolhaas 1978), like processed food devoid of flavour.**

These notions continue to surface with even greater frequency. An example involves the Why Factory think tank questioning when different inputs shift from productive to obstructive and conclude that the city is *"held hostage by the procedure"* (Maas et. al. 2009). The positive views of the process emphasize the need for more professional, organized and systematic architecture (Wickersham 2010, 25) or discuss process as methods of working such as MVRDV's complete surrender to it as a driving force of their conceptual experimental design (Annex 2). In this thesis the view is neither negative, nor positive; rather it recognizes that it is no longer useful to look at the architecture and design process as separate pieces of activities (such as drawing, brainstorming or discussing), or looking only at one aspect (such as creativity), or only through the common artefact- or techno-centric views. In fact the interviewed renown architects, as well as the project and senior architects, expressed challenges related to mainly the lack of overview, information and knowledge management and communication. This leads to a need to understand the process as the whole meandering trajectory from the beginning of the project towards and until the finished artefact and beyond. The architecture process needs to be seen as information (directly and indirectly related to the artefact), its exchange and coordination between all parties. The process is *"synthesis of creation and execution"* (Frampton 2010, 36).

The term practice is often interchangeably used to describe: firm practices; firm; customary activities the practitioner does; the discipline. In this research I refer to practice as customary activities a practitioner does during the architectural process, although these activities are always necessarily embedded within firm practices in the case of architecture. It is necessary to understand that there is no single architecture practice. The activities and procedures during the process change dramatically, according to Eberle, based mainly on the dimension of the project, which corresponds to the organizational capacity of the client. To illustrate his point, Eberle describes four categories of projects and states that in order to deal with the bigger scale of projects, the organization of architecture offices and firm practices needs to change from their currently common structure to meet the increasing demands of the projects and of the clients. However, he also warns that projects can be too big. As a result responsibility gets 'atomized' making the bureaucracy 'tremendous' and consequently the process ineffective.

**Both Eberle and Scheeren emphasized the importance of understanding the social context of a project. In Scheerens words one needs to understand *"what a place, a culture, the users, or the client can really become, or can do or cannot do"*.**

### **3.1.3 Dealing with complexity and dynamic context**

When looking at something through the process-centric view, the terms systems and complexity are useful. How something is perceived as what Bertalanffy calls a *"general science of wholeness"* (1969) requires determining its boundaries. Therefore, it must be recognized that what is meant by the 'whole' is determined only by the breadth of vision (Alexander 1968). In the case of architecture and design this notion of the systems boundary can also be explained as the context. This boundary, or context, is increasingly understood

as containing broader issues influencing design, such as the historical, social, technological (Alexiou 2011, 63) and political context making the breadth of vision larger. As Alexander summarizes, *“anything that makes demands of the form is context”* (Alexander 1964, 19). A contemporary view of context from social sciences is shared by this research. Asdal and Moser discuss that

**context is something irreducible, one cannot look at parts of it in isolation In addition context is *“sociomaterial”* and always in the making. It is not to be discovered or fixed, but rather to be continuously made and re-defined**

(Asdal and Moser 2012). Architecture is relatively slow, compared to other design disciplines, as mentioned in the beginning of the chapter, thus the context and its boundaries tend to change along the process, requiring constant re-evaluation of the projects. Especially in certain Asian countries the context can change very rapidly and radically, as Scheeren describes in the interview. He explains how dramatic change can occur, citing a project where a residential tower unexpectedly became a hotel tower two thirds of the way into the project. A change such as this has extensive consequences, which are very difficult to accommodate.

***“You have to be able to at any point completely re-assess, not only the givens that come from the outside, but even your own position in order to make sense out of a situation that maybe no longer makes sense the way you defined it earlier. [A] mix between flexibility and rigor is very important.”***

Although this and other projects by Scheeren are perhaps extreme examples requiring extreme measures, the continuous strive to understand problems until the end of projects is common in design, in particular when it comes to novel and complex problems (Conklin 2005, 4-6). Eberle explains the importance of understanding the context of a project that is dealt with in his offices through research in six chapters, each developed and refined throughout the process. These chapters range from understanding first and foremost all of the people related to the project (participants, parties, future users, social context), followed by understanding the implications of the different lifetimes; public infrastructure, structure, envelope, program and finally surfaces. Together these chapters explain the requirements coming from the urban context, reveal environmental concerns, facilitate finding the appropriate technologies, and help understanding the stakeholder interests and user needs – a method that is meant to work as a framework for any project.

When talking about architecture process it is also necessary to address complexity. The increasing complexity of projects is mentioned frequently today, as it was also by Scheeren, Maas and Eberle in the interviews. However, this issue has been continuously brought up at least since the first edition of the AIA Handbook of Architectural Practice in 1920 (Wickersham 2010, 25) and by Alexander in his famous book *Notes on the Synthesis of Form* *“today more and more problems are reaching insoluble levels of complexity”* (Alexander 1964,

3)'. Nevertheless complexity seems to be continuously increasing, as evidenced through a review of literature and through practitioner interviews. This can be observed for instance from the growing amount of specialists in projects; in some countries from the increasing amount of regulations, such as the 400% growth in regulations in architecture and planning in the Netherlands since the 80's' (Ovink, 2011); and in greater demands for efficiency. But, the increasing complexity should not surprise us as it is happening in all fields for several reasons (Brooks 2010,66-69). As Norman suggests, it is the 'state of the world' (Norman 2011, 2). If the increasing complexity is simply the inevitable state of the world, it is perhaps more important to address how designers can design for this complexity and avoid things becoming complicated, a term we often wrongly associate with complexity (Norman 2011, 2). An early proposal how to deal with complexity in design was proposed by Alexander in 1964. His mathematical decomposition technique suggested breaking problems into manageable chunks. Analysing and then assembling the chunks meant designer was to arrive to an overall solution (Lawson 2004, 11). Breaking problems and tasks into parts has remained an important strategy for dealing with complexity (although not as such a strict strategy as many proposed in the 1960s) and is also one element in Norman's recent list. He describes the tools for designers to deal with complexity: 'Properly communicated conceptual models, structuring tasks into simple and easily learnable modules, different framing of the problem – reconceptualization, automation, forcing functions, nudges and defaults and just-in-time learning' (Norman 2011, 225-245). Norman also cites earlier research by Nivergelt and Weudert, the importance of knowing the past, present and future (Norman 2011, 225), a necessity frequently mentioned in interaction design and information visualization literature. Kelly adds to this list that in order to manage complexity we need to increasingly rely on computerized means (Kelly 2010, 204).

Many of the above-mentioned strategies can be found from the interviews, highlighting how architects deal with complexity on a personal level and when leading projects. However, it seems all of the strategies have their advantages and challenges. Scheeren describes that for him the only way to manage complexity is to work with two opposite approaches, by being simultaneously both systematic and intuitive. Also a continuous 'oscillation' between going to 'painful' degree of details and zooming out to a very abstract level is important for him when managing large projects – a specific method he developed further during the China Central Television headquarters (CCTV) project. This project where Scheeren was a partner in charge is a perfect example of a complex project, significant both due to its importance for the city of Beijing and its scale. Not surprisingly Scheeren admits that his method requires enormous intellectual effort when dealing with such complexity. It is customary for designers to try and simultaneously understand the problem and formulate a solution. They go back and forth between "*high, medium and low-level activities*" (Conklin 2005, 4). Perhaps due to the high complexity of tasks, Scheeren has taken this strategy to an extreme level.

Differing from Scheeren, the strategy Maas uses to manage complexity and an overwhelming number of simultaneous projects, is to mostly remain in the overview level and to manage the cohesiveness of projects in another way.



**Maas discusses a method deriving from the Dutch conceptual design. Every project is led by a strong concept, which while being paramount for the design, also acts as a tool to simplify the complexities involved.**

He illustrates this through an example describing the library project in the area of Spijkenisse in Rotterdam. The main concept was to create a completely public building, which meant that all design and execution decisions needed to convey the idea of 'public', for example, by using the same materials inside, as were used outside. Maas sees that the concept is intended to facilitate everyone's contribution to the project, while also keeping it consistent. Eberle explains his strategy to manage complexity by saying, *"people should do what they can do well"*. He believes that architects need to embrace the specificity of architectural knowledge and recognize the paramount importance of other specializations within the architectural practice. This view is clearly manifested in his offices through modularization of projects and specialization of people. However, the modularization can also have negative consequences. One of the architects described a project that went on for several years, close to a decade. For example, architects working on the façade had little idea what was happening with interior and vice versa. This could in the worst cases result in incoherent design decisions and mistakes and in the best at least makes it difficult to move from working in one part of the project to another (Interviews Haikola 2011-2012).

### **3.1.4 Managing and communicating Information and knowledge**

Managing and communicating Information and knowledge were issues brought up by all of the 14 interviewed designers and architects during the course of this research. For instance, Schreen elaborates on the challenges.

***"Obviously with increase of scale and complexity of the projects the managing of information becomes an increasingly big challenge and I think there are relatively few people who are capable of managing larger and more complex fields of information. I am very curious if at some point tools will be born that really facilitate that. On certain levels they might exist, on the others they might not, on some levels I am not sure if they can exist."***

Related to communication Scheeren adds another related notion and describes that the principal, or project leader has to be careful to create a situation where people are able to comprehend the information they need to work with. He says, *"if you would bombard them with all the information they could capitulate"*. His method to manage the complexity his staff needs to deal with, is to act as a filter and to protect them from certain information and from overload of information. One of the interviewed project architects explained a tendency towards an opposite strategy in the office where she currently works. In recent projects, when the confidentiality allows, the whole team shares one project e-mail address and everyone has access to increasing amount of information (Interview Haikola 2012). Maas also discusses the issue of communication in projects. He recognizes that despite

all the efforts, mistakes inevitably occur. On the one hand they have to be accepted and positioned as a part of the profession, and on the other he states,

***“Everyone says that [communication needs to be improved] for a while, and still yes, we have to do it. There are a lot of doubles in the process, waste of time. In that part there is a lot to do.”***

The increasing amount of specialist knowledge in projects was also, perhaps unsurprisingly, brought up in many of the interviews. In the case of architecture and design, specialist knowledge can at times be particularly problematic if the aim is that it fully informs already the concept of the design. One of the architects explains, *‘We start to be more and more on the level where we don’t understand what we are working with anymore’* and said that fundamentally integrating sustainability in the projects would require sitting face to face with Arup (engineering consultant) 100% of the time (Interview Haikola 2011). Overall, the question of how to deal with all of the information and knowledge in projects becomes ever more important in the increasingly distributed creation and execution. How it can be effectively; created, collected, stored, processed, distributed, used and recycled and erased (Floridi 2010, 5). To give an example of the challenge, one has to wonder how much of the 3,454,204 image files stored in OMA offices’ servers shown at a 48 hour long video installation at the Barbican [2], not to even mention all the other files not included in the count, are effectively used. Or, are we currently engaging with a kind of compulsive information hoarding while waiting for more appropriate tools and systems? In the interviews and discussions many conflicting opinions regarding the gravity of the problem arose. For Eberle it is a very important issue. In his offices people dedicated to managing the database and the careful selection process determine what information is stored and what is erased in order to maintain a usable database to inform future projects. Eberle also states an important notion related to the working methods in architecture and design: *“They [architects] are trained to invent, but they are not trained to search.”* However, other people are less concerned about how we will be able to deal with information in architectural practice. Hovestadt speaks about a theoretical possibility of recording and linking all information about buildings from the smallest detail to the whole process, enabling an infinite database where everything is connected to everything else. In his view the answer to interacting with this information is provided by Google. *‘You write a word and get a text. It is not complicated’*. He outlines, we have semantic search now and images are coming. This view echoes Kelly describing how we did not ever think it to be possible to find appropriate information so rapidly amongst billions of documents. He also writes *“[d]iversity, in fact, will produce tools to handle diversity [Google being one such tool]”* (Kelly 2010, 287). As an answer to Hovestadt’s proposition how to record and link all information about buildings, Kelly anticipates and imagines a world where *“[eventually, every surface of the built world will be covered with a screen and every screen will double as an eye. When the camera is fully ubiquitous, everything is recorded all the time. We have a communal awareness and memory”* (Kelly 2010, 299).

{2} OMA/Progress exhibition at the Barbican, London October 2011 - February 2012

Consequently an important question, relevant for this research project became; what is the interface with which the participants and the parties interact with the information? When architecture is seen less as the artefact, and more as the information that is created and used in generating the most appropriate and desirable artefact, the process calls for improved coordination of the information within the network of parties. This necessarily leads to new roles for architects, perhaps to coordinate, define and manage the design interface (Tombesi 2010, 131) and in need for new tools to interact with the information.

Based on the interviews the complexity of projects and the amount of information appears to result in a constant balancing act between knowing enough and being able to focus. Each architect also seems to use different methods to deal with this challenge on a personal level as well as when leading a project. Here we are coming to other questions that seem relevant to consider when designing facilitation systems for the architecture process; how to manage complexity and find the balance between seeing the overview and having enough information without losing focus or completely 'capitulating'?

### **3.1.5 Transforming models of process**

Systems are always abstractions of reality with defined borders (Alexander 1968) and these abstractions are often described and represented through models. In design there is an abundance of models of what the process is, or should be like, but what is an appropriate model and representation of current architecture process considering the objectives of this research? Looking at the process as a 'whole' and through the information produced, the model needs to emphasize the different parties and the relation of information both to the parties and to the artefact in development. In that regard the 'triangle' of the client, architect and contractor, is still a familiar abstraction and dominant configuration of the current practice. This is also how the architects in the exploratory interviews seemed to understand it, although referring to the increasing amount of parties or a nested model of parties. Tombesi foresees that the 'triangle' is changing towards a network of distributed parties (Fig. 3) but that this change needs to first be enabled through contractual agreements and policies (Tombesi 2010, 117-131,136). Similarly

### **Krippendorff discusses a shift towards human-centric design where technology emerges "in networks of diverse stakeholders" through discussion and negotiation**

(Krippendorff 2007, 50, 63). Recently the network model seems to be emerging simultaneously, also in a more informal sense, Mori explains that "[the young people] also share and help each other a lot, they network and collaborate generously with each other across studios" (Mori 2010, 38). Thus, one could say the new model of practice is emerging from two ends; through the development of new tools and models of working that are being introduced from the top down and are becoming 'institutionalized', and from bottom up through architects who have started to collaborate in a more informal sense. In developing proposals to facilitate challenges in design process it is necessary to try and understand and take into account these evolving mental models participants have

of the practice. As designers we need to consider what kind of technologies can support the practice and enable the emerging models to work to their fullest potential, while recognizing the new challenges arising from them.

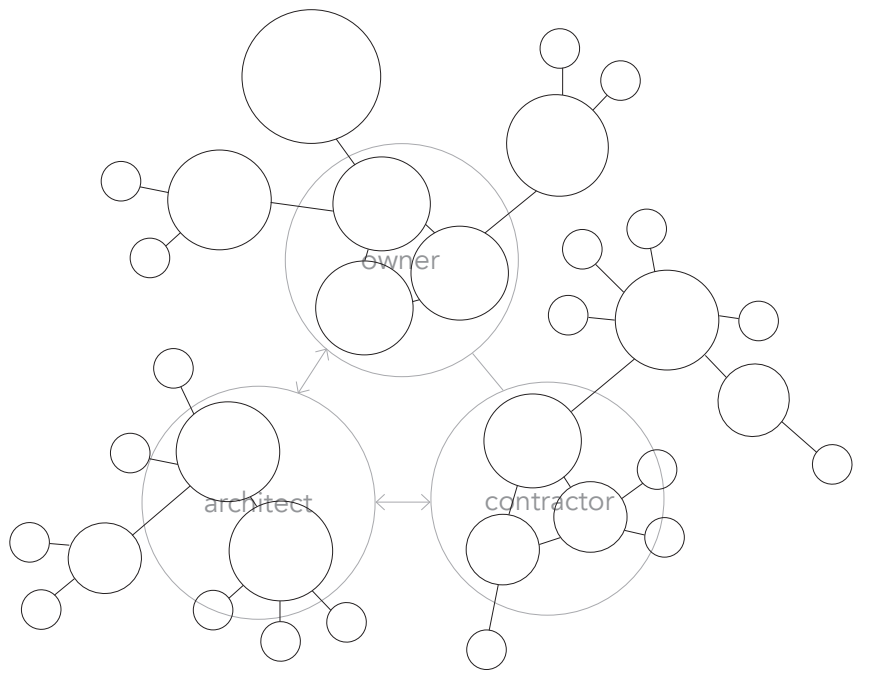


Figure 3. Illustration of the architecture process as a network, loosely derived from Tombesi 121,131 in Deamer and Bernstein 2010

### **3.2 Conclusions of chapter 3**

The changing architecture process leads to a necessity to understand it as information and its exchange between distributed network of parties, requiring more and better access, and appropriate methods of sharing that information between them. Some tools, agreements and policies are already facilitating this change, yet there remains a lot of work to be done, questions to be answered, and opportunities to be explored. The continuous re-evaluation of the context in its broad sense is important in order to determine what is relevant knowledge and information for any architecture process. The amount of this information, the alternatives, versions and related information is growing, causing difficulties in maintaining overview and keeping track of it during long projects and when retrieving it afterwards. Additionally the dynamic systemic nature of the process with shifting borders also makes maintaining overview difficult and demands flexibility from the parties and participants, and requires different tools and software applications to accommodate and embrace that aspect. This new view of the process demands better coordination of information, perhaps emphasizing a role for architects as coordinators and communicators of information, knowledge, vision and values.



**4.1 The three paradigms by Mitchell**

Mitchell formulated a thorough explication of three technological paradigms for design in 1994. Today, we are starting to explore and implement the possibilities of the third paradigm. The first paradigm “*designing as problem solving*” describes the role of technology as it emerged in the 1960s. This view doesn’t see design problems significantly different from other problems. The most important aspect that defines the role of computers is whether a problem is well, or ill-defined and computationally easy or hard. This understanding of problems led to leaving ill-defined parts for humans and well-defined for computers (Fig. 4. “*Organization of databases that facilitate efficient construction and manipulation of designs, and also support application of many different automated procedures, became the central research issue. [...] By the early 1990s, it had become the basis for a huge commercial CAD industry*” (Mitchell 1994, 240).

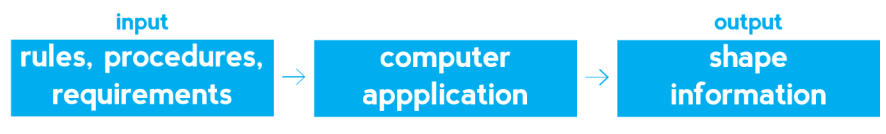


Figure 4. Mitchell’s first paradigm derived from Menges and Ahlquist 2010, 86-87

The second paradigm that arose in the 1980s ‘*designing as a knowledge-based activity*’ emphasizes the need to integrate specific domain knowledge into tasks that computers perform. Rule based systems that can provide and evaluate design options were developed, such as systems based on the idea of shape grammars (Fig. 5). However, Mitchell brings forth the problem with these systems that one can never know whether the “*knowledge-base*” and the rules are complete, even with the ability to modify them or by creating systems that can learn (Mitchell 1994, 240-241).



Figure 5. Interpretation of Mitchell’s second paradigm derived from Menges and Ahlquist 2010, 86-87

The third paradigm “*designing as social activity*” could be said to represent the current understanding of design and developments in the role of computer applications. An artefact is developed in a social process (increasingly in a distributed environment) through negotiation. Explicit rules that could be used as an input to a computer program do not exist. Thus, Mitchell lays out new requirements for computer systems. “[T]he agents (human or digital) concerned must have their own, local computational resources and must be linked in an efficient network. [...] [T]hey must have some form of concurrent, joint access to a digital version of the model – the proposal that is “on the table” – so that they can point and refer to it, analyse it, modify it, and so on. And they must be in close communication with each other” (Mitchell 1994, 242). The digital agents such as the ‘*Interpretation and translation agents*’ helping us make sense of hand writing, freehand sketches, speech, scanned images, and video signals, “*research agents*”, “*problem-solving agents*” and “*contract negotiation agents*” have recently started to appear. “*Reporting agents*” that learn about our likes and interests and suggest content in the “*sea of information*” are perhaps in the most widespread use today (Mitchell 1994, 243-245).

#### **4.2 The hybrid office – between analogue and digital**

Looking into the role of technology and computers in design offices from different disciplines, it appears that the tools and activities have changed due to new technologies; however, the roles and tasks of people have not (Khan et al. 2009, 30). However, in architecture they are starting to due to the need of new specific responsibilities and specializations, for instance related to the introduction of BIM (see section 4.6).

Khan et al. describe the current offices as ‘*hybrid offices*’ mixing analogue and digital tools and artefacts, which creates several challenges related to transferring from one to the other. They foresee that the ‘*hybrid office*’ will persist and the increasing distribution of work will continue to create more challenges (Khan et al. 2009), which in this research was very apparent through looking into bigger architecture offices that deal with large projects.

In the 1960s Negroponte saw as the goal of the future technology that we could communicate with computers using natural language (Negroponte 1969). This would bridge the analogue and digital worlds in one of the important aspects. However, it remains a big stumbling point. One reasonably successful example is the WolframAlpha answer engine released in 2009. It understands questions written in plain English (Fig.6).

Many other tools are in development to bridge the gap between analogue and digital, perhaps most importantly semantic web technologies, including software agents. Yet many challenges remain, including the ones identified by Khan et al. 1] In long periods of time it is hard to keep track of the evolution of design. 2] It is difficult to remember who made what decisions and when, and 3] remember what decisions were taken and why (Khan et al. 2009). I will return to these problems more in detail in the part two of the thesis, as many of these challenges were also brought up by the architects interviewed for this project



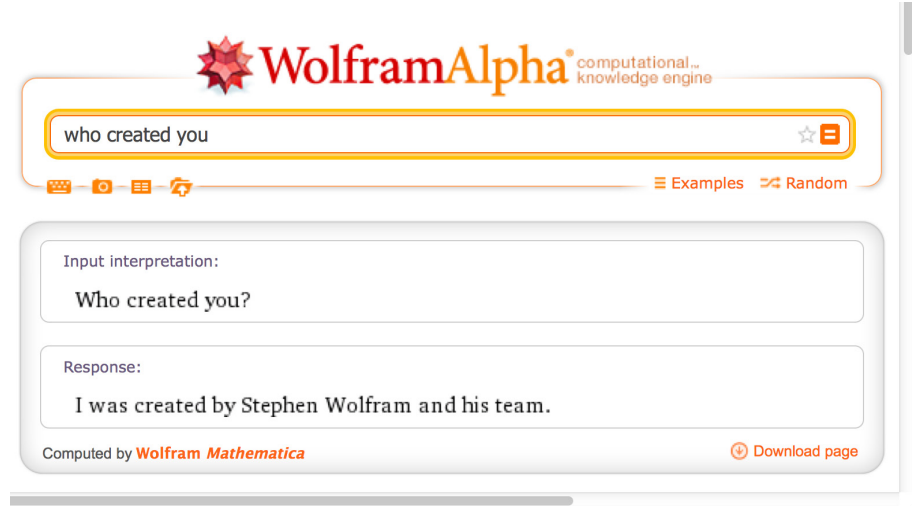


Figure 6. Screenshot from the WolframAlpha website

### 4.3 Levels of user involvement

The current technological paradigm should recognize designing as social activity. Therefore, investigation into the appropriate levels of user involvement is necessary in designing new systems.

This research project investigated in particular domain specific needs in architecture (and design) practice and aimed to understand the mental models of its practitioners. Despite that domain specificity and consideration of end users has received significant attention in HCI (and different fields of design), generic techniques and solutions are often applied without reflecting their appropriateness for the specific user group and individual users. Often the reason is that generic solutions are cheaper and faster. In some cases the needs of the specific user group are too uncommon to create a specific solution (Lieberman et al. 2006, vii-x). To overcome this problem the concepts of increased levels of user involvement such as participatory design and end user development (EUD) have gained traction in the HCI community. To clarify the differences between approaches, Fischer and Giaccardi discuss design time and use time. They suggest that not all user needs can be anticipated during design time and thus propose to under design systems and instead create open systems to allow users to create appropriate solutions at use time (2006, 432). Fischer and Giaccardi see that user-centered design places primary importance to the design time and therefore cannot fully satisfy user needs, whereas participatory design involves users as co-designers. Finally what they call meta-design (similar approaches are commonly referred to as end user development EUD) involves creating open systems that can be modified by the users (Fischer, Giaccardi 2006, 433,434).

In the case of architects and designers the user group is significant in size, and a large part of the users are very proficient with software tools. For example in architecture, scripting has become a commonplace practice. Due to the specific context of this research, a combination of user involvement methods was used and proposed. Firstly a more common

user-centered approach, involving several interviews and testing with practicing architects, was used. Secondly, as domain expert in design with experience in architecture, I was able to position findings into a larger context and translate them into proposals. Thirdly and finally, I suggest that applications for architecture (and design) practice need to allow some level of End User Development (Hovestadt Annex 4, Fischer and Giaccardi 2006, 427-457), as every office, context, and project is different. In particular in architecture, due to long and complex projects and increasingly dynamic contexts, the conditions and needs tend to change during projects.

#### **4.4 Discussion and criticism on the conventions of HCI**

During the process of this research I was confronted with the conventions from the HCI and in particular from the field of information visualization. Some of these conventions seemed worth questioning in the light of some of the interview findings. Much of the criticism is shared and brought up also from within the HCI community. In this section I will describe some of these issues as well as new directions and potentials.

##### **(D)evaluation**

Although certain HCI evaluation methods, such as some by Nielsen, have been commonly criticized as discount methods (Cockton and Woolrych 2002) for being easy and fast-to-do but questionable in terms of reliability, the criticism does not end there. Some authors have put forward other great concerns. Greenberg and Buxton describe several possible problems related to usability testing methods, such as killing ideas by testing them too early and getting the *"design right instead of getting the right design"*. In general they recognize the need (usually) for usability testing, but warn against *"designing by rule"* instead of *"designing by thought"* (Greenberg and Buxton 2008).

The widespread demand for usability tests, but frequent lack of resources to perform them has resulted in several problems. Dicks discusses the following ones: *"1] Misunderstanding of the concept of usability itself.[.] 2] Two types of problems with statistics: assuming that a set of quantitative statistics equals a usability test, and misusing statistical results, especially from tests performed without large enough user samples. 3] Using usability tests for verification rather than usability. 4] Lack of knowledge of the limitations of and the proper methods of usability testing to ensure valid and reliable results. 5] Testing for ease of use but not usefulness."* (Dicks 2002, 26) The first point, misunderstanding the concept of usability, is one that particularly resonated when reading the further criticism by other authors presented in the following paragraphs. Dicks uses definition by Dumas and Redish to clarify what is usability testing; *"the goal is to improve a product's usability, that the participants represent real users, that they do real tasks, that testers observe and record the participants, and that they then analyze the data and recommend changes to fix problems"* (Dicks 2002, 26). However, even this definition seems to overlook the specificity of user needs and capabilities of different users and user groups – issues that have only recently been considered by researchers.

### **Specificity of needs and capabilities of the users**

During this research and design project I experienced a contradiction between some of the HCI conventions, and what I believed based on the interviews and my experience to present novel and appropriate solutions for architects and designers. Recently studies have investigated the same concerns. Hassenzahl discusses the source of these concerns, the differences between what he calls the *'pragmatic'* and *'hedonic'* or the *'goodness'* and *'beauty'* of interactive products (Hassenzahl 2004, 320). Thus, among other researchers challenging the traditional approaches to developing and evaluating proposals and products. From the studies looking into this *'subjective side of usability'* (Hassenzahl 2004, 321) two main observations support the findings and proposals presented in this thesis. The first of these observations is related to the importance of beauty or appealingness. In his overview Hassenzahl states that

***“studies demonstrate beauty to be a good (often the best) prediction of products overall impression”. He continues to describe the well-known stereotype in social psychology “what is beautiful is good”***

(Hassenzahl 2004, 321). In other words, suggesting that beauty may even overrule the usefulness and effectiveness of a product. Although, it must be noted that the research into the methods to study the subjective side of usability is in its beginning and the relevance of beauty over time, for instance, has been questioned (Karapanos 2010, 173). The second, closely related observation is related to the extent of these subjective experiences. Some fields, such as information visualization, are based on human perceptual system (discussed in detail in section 4.8). However, it appears that the

***perceptual judgements differ even for aspects such as blur, motion and colour, which affects the overall judgements and preferences challenging the “principle of homogeneity of perception”***

(Karapanos 2010, 174). This leads to a necessity to consider the three levels of perceptions: *“uniquely personal”*, *“related to specific social or user group”* and *“universal”* (Karapanos 2010, 20 after Hofstede 2001). This thesis aims to address the second by studying the needs and abilities of architects and responding to the need of improved domain specificity in HCI (Plaisant 2004, 2).

***Thus, taking into account the significance of beauty and appealingness on the overall experience of a product, and the extent of subjective experiences even in perceptual judgements, the emphasis and approaches in research and design projects in many fields would necessarily shift.***

### **Interpretation and the subjects**

In HCI a large amount of methods are used from qualitative to quantitative and from analytic to empirical. An overview of the development of techniques, their prevalence and roles in the field can be read for example in Barkhuus and Rode (Barkhuus and Rode 2007). Through analysing CHI papers from 1983 until 2006 they find that the amount of studies including evaluation has increased, to become a component of practically all accepted papers. Some other conclusions include that it is very common to use students in the evaluation, which is not representative of all users. They also found a gender bias; studies are not using enough female subjects. They, as well as Greenberg and Buxton, also recognize prevalent preference for quantitative studies in HCI community (Greenberg and Buxton 2008, 113; Barkhuus and Rode 2007, 7).

Hertzum and Jacobsen while recognizing the need for easy and fast-to-do evaluation methods (mainly discussing cognitive walkthrough (CW), heuristic evaluation (HE), and thinking-aloud study (TA)) investigate the problems and provide suggestions on how to improve these methods. Their main argument is the *“evaluator effect”*, where different evaluators find different usability problems. One of the strategies presented to overcome the problems is to increase the amount of evaluators. However, Hertzum and Jacobsen write; *“[w]e believe that the principal cause for the evaluator effect is that usability evaluation is a cognitive activity, which requires that the evaluators exercise judgment. Thus, complete agreement among evaluators is unattainable”* (Hertzum and Jacobsen 2003, 201). In the same vein Forlizzi et al. discussing the role of design in HCI state that *“reproducing the same design process cannot be expected to produce the same results”* (Forlizzi et al. 2008, 24). For anyone with a design background this is normal and acceptable, whereas in certain scientific communities the role of interpretation and lack of complete repeatability in a process is a contentious issue.

Considering the examples of criticism on HCI and information visualization methods I have described, it is evident that on the one hand the methods and techniques used in this research project have their shortcomings and the choices can be criticized. On the other hand an ongoing discussion exists regarding development and evaluation of interactive products. Therefore, I am compelled to conclude that both the development and evaluation need to be done by thought, not only by rule as stated by Greenberg and Buxton (Greenberg and Buxton 2008).

### **4.5 Design rationale**

Having investigated dealing with information and knowledge in an architectural design process mainly empirically as described in the previous chapter, it is useful to now continue to systems for dealing with information and knowledge. The field of design rationale (DR) is relevant to discuss here, as it investigates similar challenges as discovered in this research, although presenting a very different approach. Although design rationale systems have been investigated and developed since the 1970s, none are in widespread use (Regli et al. 2000, 209) and little research has been done since the 1990s. Based on an overview of the literature, it seems that the majority of research focuses on engineering design, with some

examples of DR systems for architecture (more specifically architecture, engineering and construction, AEC). This section aims to briefly describe what DR systems are, what is the current state of the art, and reflect on their appropriateness for architecture and design.

## **Basic principles of DR and contemporary perspectives**

***“Design rationale in the most general sense is an explanation of why an artifact is designed the way it is”***

(Lee and Lai 1991, 257), Lee and Lai summarize. In the same journal issue Carroll and Moran describe the three motivations for constructing the design rationale: *“(a) to support reasoning processes in design, (b) to facilitate communication among the various players in the design process, and (c) to further the cumulation and development of design knowledge across design projects and products”* (Carroll, Moran 1991, 198). In a survey paper from 2000, Regli et al. outline in, perhaps more practical terms and closer to the needs expressed in the interviews for this research, what DR systems are meant to accomplish: *“to record a history of design process; to modify and maintain existing designs; or design similar artifacts”* (Regli et al. 2000, 209).

Carroll and Moran describe the different approaches to DR in the early 1990s; one being the capture of the rationale as the by-product of the design process and another that rationale must be constructed (Carroll, Moran 1991, 198). A contemporary perspective on this might be that, although some original rationale is present and captured, the rationale is also continuously constructed by the use of the information. Hovestadt was particularly clear on this view when discussing architectural information where meaning would only come from the context the information is viewed with (Annex 4).

DR systems can be broken into two main approaches: The process-oriented, suitable for dynamic domains, constructing a chronological history of the design process (include systems such as IBIS, DRL, and PHI); and the feature-oriented (or structure-oriented, Chachere, Haymaker 2011, 89), suitable for highly standardized domains as it represents information based on rules that govern the design process (Regli et al. 2000, 211-212).

### **DR systems in architecture**

Some proposals and prototypes of DR systems have been proposed for architecture. IBIS developed in the 1970 is a seminal example of a process-oriented system that Rittel developed urban design in mind. The working principle of IBIS can be described in short as follows. *“The key issues of IBIS are usually articulated as questions, with each issue followed by one or more positions that respond to the issue. Each position can potentially resolve or be rejected from the issue. Arguments either support or object the position”*. (Regli et al. 2000, 215). IBIS is composed of textual statements with browser using a graphical interface where issues, positions and arguments are the main components of the graph. From this basic set-up of IBIS, different further developments have been made, including Knowledge

Based Design System-IBIS (KBDS-IBIS). It aims to integrate the evolution and design steps of the artefact with the design rationale (Regli et al. 2000, 215). However, Chachere and Haymaker provide an overview of significant criticism of IBIS. These include IBIS being too simple and easily leading to inconsistent and large amount of textual information (2011, 89). The main argument of Chachere and Haymaker for the AEC industry focuses on the need of clear communication of the design rationale in order to develop a consensus about design decisions. *“Currently, there are many standards of communication and coordination addressing various components in the design rationale. Some address different components of the design rationale [e.g., building information models (International Alliance for Interoperability 2009), and project delivery models (American Institute of Architects 2008) and some overlap [e.g., Leadership in Energy and Environmental Design (LEED), U.S. Green Building Council (2008), and SPeAR (Arup 2006)]. Although each of these standards helps to clarify some aspect of design rationale, none addresses the full scope of relevant information with enough clarity to develop and communicate this rationale credibly”* (2011, 87). Chachere and Haymaker observe that in the AEC industry DR is theoretically linked with decision analysis (DA) and decision-based design (DBD), but that they focus on optimal choices leaving for instance communication to a lesser priority (Chachere, Haymaker 2011, 90). Despite that no DR system has successfully been introduced to any industry, Chachere and Haymaker suggest that the DR methods could become meaningful for the AEC industry by providing more clarity in analysis and efficiency in decision resources (Chachere, Haymaker 2011, 94-95).

The problems and to some extent the goals of the DR systems are shared by this research and by knowledge management systems (which will be discussed in one of the following sections). However, in the light of the current literature, perspectives, and technology, one of the underlying goals of DR systems to generate explicit design rationale (Moran, Carroll 1996, 2-18) seems unattainable and even unnecessary. Current literature from knowledge management recognizes that the need for explicitness and prescribed structures and hierarchies in digital systems is problematic (Grudin 2006, 1-2). The rationale is often implicit, context depended and dynamic (especially in design disciplines). Therefore, it seems reasonable to state that systems should treat rationale as such. How emerging technologies might enable this is discussed further in the section 4.7.5. Thus, perhaps the future of DR systems could comprise of two possibilities: Empowered with the semantic web technologies, new design process facilitation systems will benefit from and absorb some of the aims of the DR, making it an implicit and integral part of systems to deal with the design process; new DR agents, coupled with the semantic web technologies, will be able to retrieve even implicit and context depended rationale.

#### **4.6 Integrated Project Delivery and Building Information Modeling**

Looking into architecture practice one needs to take into account the recent developments in Integrated Project Delivery (IPD) and Building Information Modeling (BIM). Due to the introduction of BIM, the architectural process is changing (IPD has only been used in a limited number of projects and thus has not yet had a major impact), and the changes brought by it effect many areas of the practice as well as introduction of any new systems.

Firstly, it is useful to describe what Integrated Project Delivery intends. The International Council for Research and Innovation in Building and Construction (CIB) [...] *“defines integrated design and delivery as using collaborative work processes and enhanced skills, with integrated data, information, and knowledge management to minimize structural and process inefficiencies and to enhance the value delivered during design, build, and operation, and across projects”*(Rekola 2010, 266). In addition Integrated Project Delivery is a model of working that entails early collaboration of key parties, and shared benefit and risk (Lind 2012, 210-212). It is important to mention that the use of BIM does not alone make an integrated project, however, it is an important component of one. Despite of the recognized benefits of IPD, its adoption has been slow. This is due to cultural, political, legal and business related issues of architectural design and delivery that still remain largely unresolved (Holzer 2011, 472).

Building Information Modeling, BIM, intends software applications to construct a detailed digital model of a building. Ideally it is used throughout the different project phases from design to construction and operation. It aims to enable sharing of information and collaboration between the different parties involved in a project: architects, engineers and constructors among others. BIM models converge increasing amount of information about the artefact as possible and allow different parties to work on, and based on, the same model.

A BIM model can be used for several purposes: visualization, fabrication/shop drawings, code reviews, cost estimation, construction sequencing, conflict interference and collision detection, and many more (Azhar 2011, 241-243). Although BIM software applications are in widespread use and offer significant benefits, many challenges still exists and much work remains to be done for BIM to reach its' full potential (Deamer, Bernstein 2010; Holzer 2011). One of the many challenges and criticisms is of particular interest here, the 'techno-centricity' of BIM research. The research has focused to great extent on interoperability, but investigation into people and workflows has been marginal (Rekola 2010, 265; Holzer 2011, 466). In relation to this criticism (albeit about digital tools more generally) Deamer exclaims,

***“none [of the recent publications] examine the effect of this on how we – designers, architects, builders – conceive of our work”.***

(Deamer 2010, 19). Another challenge regarding BIM and other software applications used in architecture process is related to still prevailing fragmentation of information. Skidmore, Owings & Merrill (SOM) created a diagram (Fig. 7) of the different software applications that are used in the New York office. The diagram depicts around 30 different tools used to develop, model and evaluate a building, it *“makes apparent that the transition from computerized drafting platform to this smorgasbord of tools is a part of a broader shift in the relationship between design and construction”* (Bernstein 2010, 194-195) A diagram by Holzer (Fig. 8) is interesting as another example. It shows 12 software applications and their relations during different phases of a typical commercial tower project (Holzer 2011, 469).



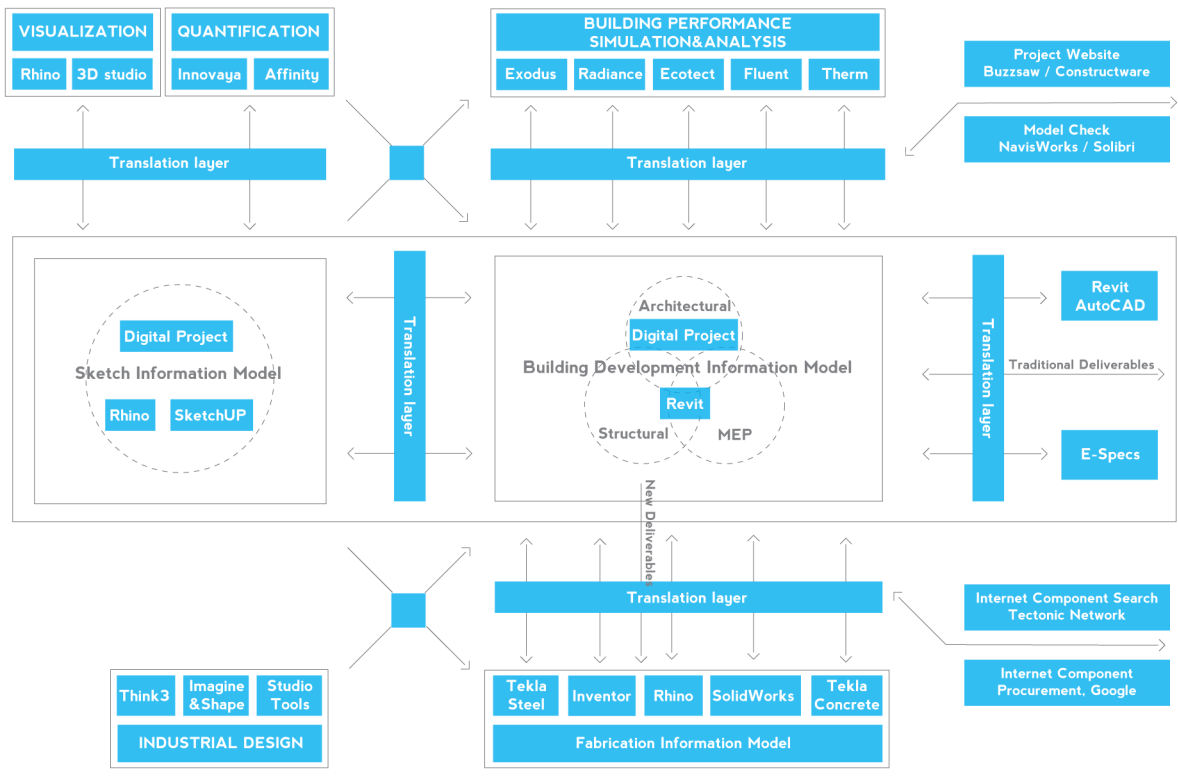


Figure 7. Skidmore, Owings & Merrill's software tools, derived from Bernstein 2010,195

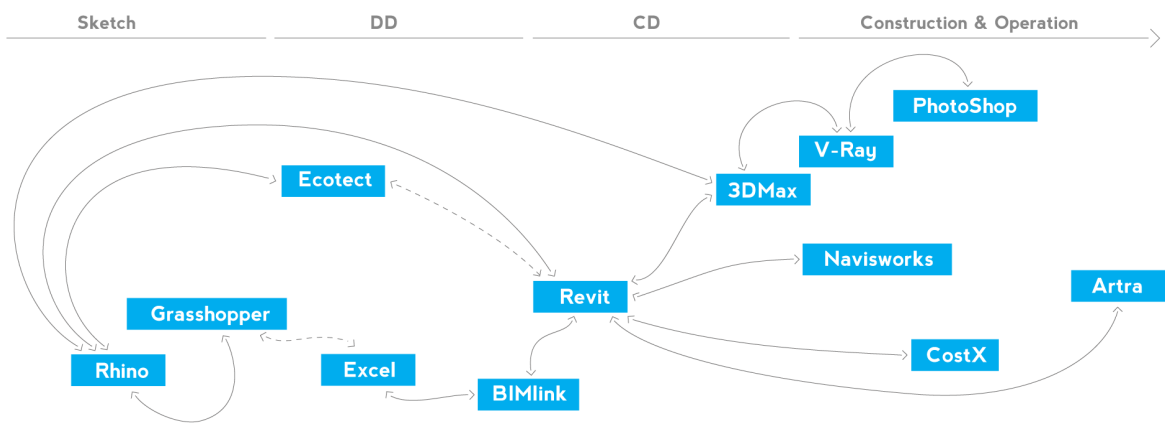


Figure 8. "Typical digital software ecology based on a commercial tower project" derived from Holzer 2011, 469



**However large amount, these tools are still not the whole story, several other software tools are used in the architecture process, generating content that is not directly related to the artefact, adding to this smorgasbord.**

Considering the complexity and sophistication of the above-mentioned systems, such as BIM and IPD models, within a PhD project it is hardly possible to propose a system integrating all information and taking into account all of the parties. However, it is possible to point out that it is necessary to improve integration of the heterogeneous smorgasbord of information that is generated in the architecture process - also of information not directly related to the artefact. In addition it needs to be recognized that each domain (in the case of this research, architects) have their specific needs and mental models on how to interact with the information. To counter the techno-centricity of the field, more research is required about how people interact with and communicate about information.

#### **4.7 Communication and information and knowledge management**

This section will look into some proposals and tools in communication and information and knowledge management. I will firstly discuss some current challenges and in the end reflect on the relevance of these challenges in the light of the emerging technologies.

##### **4.7.1 Communication tools**

In line with the criticism outlined in previous chapters and sections related to the artefact-, and techno-centricity of architectural research, there has also been little research in communication in teams (Otter, Emmitt 2008, 121). Although the research by Otter and Emmitt suggests that architects would prefer face-to-face synchronous communication, the interest in this research is rather the increasing role of digital asynchronous communication, due to larger teams and projects and their distributed nature.

In the recent years both generic and specific (for different purposes, organizations etc.) communication tools have been developed ranging from *"Facebook- style social networking tools; tools for sharing files, book- marks, and tags; wikis; community tools; team-space tools"* (Matthews et al. 2011, 1). Which one to choose for an organization can be a difficult decision in the abundance of tools: *"The complexity of these decisions often leads groups to adopt tools that are not optimized for their particular type of collaboration. Furthermore, despite this proliferation of tools, one tool is often not enough to satisfy all the collaboration needs of a single group. As a result, groups often cobble together multiple tools to serve their collaboration needs"* (Matthews et al. 2011, 1). Most architects interviewed for this study worked in offices using generic tools (such as e-mail, instant messaging, forums, group calendars and intranet), perhaps partly due to lack of time to find and learn new tools (Matthews et al. 2011, 1) and perhaps because large part of

communication is between several heterogeneous parties on collaborations that are often temporary.

Certainly the most widespread digital communication system is the e-mail. One of the problems explicated by an interviewed principal is familiar to everyone, not only architects: the unmanageable amount of e-mail messages (Whittaker et al. 2011, 2). Out of these e-mails many are unnecessary, and as a consequence it is difficult and time consuming to determine what is important and should be acted upon. Whittaker et al. also refer to several other problems with the e-mail (Whittaker et al. 2011). However, one problem particularly pertinent to architecture projects brought up by the project and senior architects is 'messy' forwarding and 'ccing' e-mails and attachments. Discussions are in the e-mails, comments in a pdf or word file attached to the e-mail. In some cases the discussion and the comments are in the e-mail with an attachment that does not allow comments. Thus, keeping many people up-to-date on the discussions and the latest file versions can be challenging. One of the architects attempted to articulate the problem:

***"In the e-mail you build up your communication and so I found I am facing a problem. I write to a consultant or to another party about my question, but if I forward all those answers to my team members, I have to get out [the file] to save it or like...write comment or...Things cannot be saved or recalled in a clean way."***

As a response to some problems with the e-mail, the use of instant messaging applications (either generic or developed specifically for organizations) has been proposed. A study into the use of instant messaging in the workplace outlines three factors why people would use it: 1] If large enough number of people are using it 2] the informal tone of the messaging 3] a method to get quick responses (Cameron and Webster 2005, 95-96). One of the project architects explained that their office had introduced one of the specialized instant messaging applications, but that so far it had remained practically unused and was not liked by the architects. However, she could not explain what exactly was wrong with it. The current instant messaging applications could also potentially present a problem relating to project history. If part of communication between people is through instant messaging, recovering discussion threads becomes increasingly difficult.

#### **4.7.2 Communicating about visual content**

In design and architecture large part of the communication is related to visual content and thus it is not surprising that problems related to communicating about and commenting on images, 3D models or other type of visual content, was emphasized by the interviewed architects. An observation can be made of essentially all generic communication systems; the current way of communicating could be seen as being 'backwards' when dealing with visual content. Even many recent software applications, such as Basecamp, and proposals such as ONTOarch (Aksamija, Iordanova 2011), adopt a familiar principle coming from e-mail, instant messaging and forums: files are attached to discussions. However, for architects and designers discussions are attached to visual content, for example when

commenting on drawings, floorplans, presentation renderings or diagrams. Currently most commonly used application to communicate about visual content is Adobe Acrobat that allows comments directly on the files. However, it has significant shortcomings regarding the needs of designers and architects: It only allows comments in its own file format; it does not support discussion, only comments; and the comments are not linked to a database and thus not searchable.

However, some proposals and tools exist that contain some of the above-mentioned features. For instance, systems such as Digital Ink and ScreenCrayons (Olsen et al. 2004) propose searchability of the comments, and in the case of ScreenCrayons use on any application. Since these proposals appear to provide some of the features that the architects were missing, it is of interest here to analyze these tools more in detail through the specific needs in the architecture practice. It is common that a particular file can be commented and discussed upon by several people over a long period of time to reach a satisfying result to be accepted, often by the project architect, and/or the director of the architecture office. It is of importance that the author and time of comments are recorded. In some cases the comments and discussions may be brief, in others very long. Frequently a file is commented on; the comments responded to, the file re-worked accordingly, and commented on again. In the case of file requiring long discussions 'hand written' notes, as in Digital Ink proposals, are not sufficient. Digital Ink is also designed to work with pen input. However, in architecture practice different types of input devices are used. Another specific need that was brought up in the interviews is to identify the criticality of the files. Architects expressed a need to recognize whether a file is for example, critical, finished, approved, or in progress. This type of need does not appear to have been considered in any proposal. ScreenCrayons adds some functionality to the Digital Ink. It allows typing comments, however, it does not consider the use of the application for projects in teams and the need of discussions between different people. ScreenCrayons also proposes a categorization of different color crayons that the user picks for each topic. Based on this research this type of categorization is not very practical for the very dynamic architecture practice. Rather the categorization (if any) has to be very flexible and customizable. In addition the search of the notes and discussions should be possible with different strategies, by providing any keyword, searching with a time frame among others.

Before drawing further conclusions about the communication tools, it is useful to look into information and knowledge management, as some of the tools are also used for communication and the overall trends will have impact on both communication and information and knowledge management.

#### **4.7.3 Knowledge management in organizations**

The challenge of knowledge management, affecting in particular large organizations is widely recognized. Many systems (document repositories; recording meetings, conversations, and e-mail exchanges; organizing discussions in document databases; and providing annotation systems [Grudin 2006, 1]) have been developed to facilitate these tasks. But in his overview Grudin lists several problems in these systems:

- Systems are expensive to create and maintain, limited in scope, and cumbersome to use.
  - The tension between tacit nature of large part of the knowledge, and requirement from digital systems to express that knowledge explicitly.
  - *"Digital objects are difficult to find. When found, objects are difficult to assess. Systems are not strong at identifying people who can assess objects"*
  - Users need to understand the overall formal system and categorization
  - Different people use different terminology.
- (Grudin 2006, 1-2).

Grudin also lists four potential directions for solutions: unstructured tagging, project weblogs, project wikis and search. I will return to these potential solutions further after discussing the information and knowledge management in the AEC industry.

#### **4.7.4 Information and knowledge management in the AEC industry**

In the AEC industry issues with data, information and knowledge management are pressing due to factors already mentioned earlier in this thesis, such as the complexity of projects, the amount of parties and heterogeneous information among others. Currently there are some tools and models to help manage these challenges. They include:

- The Industry Foundation Class (IFC), description of the building and construction site
  - ISO 15926, standard for lifecycle activities
  - IFC toolboxes, including several tools such as ArchiCad Teamwork and Autodesk Buzzsaw
  - BIM
- (Shen et al. 2010, 22-30)

However, similar and more challenges as described for general knowledge management in organizations apply in the AEC industry. A review paper by Shen et al. into systems integration in AEC industry thus brings forth similar notions: web-based collaboration systems is named as the biggest trend in a survey; and the future significance of the semantic web technologies for the AEC industry are recognized (Shen et al. 2010, 2,13). Through their review Shen et al. recognize several opportunities for further research and improvement, which include:

- *"Integration of wired and wireless sensor networks for real time data collection to support decision-making processes."*
- *"Development of a systems integration and collaboration methodology with a framework and toolboxes for the AEC/FM industry using emerging implementation technologies like software agents, Web services, and leading industrial standards like IFC, ISO 15926, and CIS/2, with further extension of ontology-based integration (including the Semantic Web)."*

- *“Integration of construction project lifecycle information (including design, procurement, construction, operation and maintenance) to support effective management and maintenance of built structures, facilities, and infrastructures. One example is the integration BIM and RFID.”*
  - *“Human factors and human aspects management”*
  - *“Proactive project information systems to efficiently disseminate the information from planning and analysis to project managers and users in the field.”*
- (Shen et al. 2010, 30)

#### **4.7.5 Discussion: Influence of semantic web technologies and big data**

Both in knowledge management for organizations and in the AEC industry the potentials of the semantic web technologies are brought up. As semantic web technologies enable recognition of natural language and connections between pieces of information they are recognized to offer solutions for a significant part of the current problems. An excerpt from the Wired magazine sums up the reason for the high expectations:

***“The most crucial intellectual property isn’t compartmentalized data in spreadsheets or databases, it’s writing – all that messy, untagged, uncategorized verbiage that sprouts out like kudzu wherever people bounce ideas off one another”***

(Silberman 2000). Silberman writes here about ‘Autonomy’, a company that develops systems that are able to extract text from almost any media (video, audio, stream). The systems are able to recognize connection between words and learn over time about these relationships. ‘Zooming out’ even further from the information and knowledge management challenges leads to recent discussions on the field of big data, or network science (or other terms used for the field). The field is interested in the large and increasing amount of data people leave behind. Fitting to issues described in the previous sections, Pentland outlines that it is possible to tell enormous amount of things based on information we leave behind, even if many of the things are not explicit. Pentland describes big data in an interview as a next generation complexity science because it includes people and moves from away from classes, towards individual understanding of micro patterns within the classes (Pentland 2012).

Although the fields of semantic web and big data are not directly topics of this thesis and thus will not be addressed to a great length here, their influence and the potentials offered by integrating them with new systems needs to be considered. Recognizing these technological trends and opportunities allows us to move past many of the current problems described in the literature and to consider new ones affecting the design of new tools. The new challenges include designing the use of the systems and the most appropriate interfaces to access the large amounts information for specific users. These questions lead towards the next section of information visualization.

#### **4.8 Information visualization: too much science too little design?**

This section discusses the essentials of the field of information visualization, and recognizing its issues reflects on the potential of an augmented version of the field - information aesthetic visualization. It is also of interest here to consider the challenges and trends of the field and their impact on the concerns of this research.

The definition of information visualization to '*develop effective visual metaphors for mapping abstract data*' (Card et al. 1999) both explains what the field does and its focus. The research into the effectiveness of information visualization techniques is mainly based on visual cognition and perception research (Lau, van de Moere 2007, 1). The benefits of visualizations are widely acclaimed: they are pre-attentive and therefore require little cognitive effort (Spence 2011), amplifying cognition (Card et al. 1999, 16) and allowing insight (Spence 2011).

**The various information visualization techniques have been studied and categorized in order to enable the choice for the most effective visual encoding of the particular information according to the human perception.**

Many books discuss in detail the different techniques and their appropriate use such as, *Information Visualization: Perception for Design* by Ware and *Information Visualization: Design for Interaction* by Spence. Due to the extensiveness of the techniques I will not discuss them here, but will move on to the trends and criticism of the field.

Without doubting the usefulness of visualizations (quite the contrary), as a designer I cannot help but to question the certainty in which different established techniques and their appropriate use are presented, and consequently widely applied leaving little room for creative design, or considering the specific preferences and abilities of different users, as discussed in detail in the section 4.4. These issues are outlined as a part of of the top concerns for further research is in information visualization, among some others that resonate with the concerns of this research. The top ten concerns in the field as outlined by Chen are:

**“1] Usability**

**2] Understanding elementary perceptual-cognitive tasks. [...] Mismatch between high-level user tasks and evaluating usefulness of visualization components.**

**3] Prior knowledge. [...] As a vehicle for communicating abstract information, information visualization and its users must have a common ground.**

**4] Education and training**

**5] Intrinsic quality measures**

**6] Scalability**

**7] Aesthetics. [...] important to understand how insights and aesthetics interact, and how these two goals could sustain insightful and visually appealing information.**

**8] Paradigm shift from structures to dynamics. From cone trees and tree maps to visualizing changes over time. Need for built-in trend detection mechanisms.**

**9] Causality, visual inference, and predictions**

**10] Knowledge domain visualization."**

(Chen 2005, 12-16) Lau and van de Moere discuss in particular the issue of aesthetics and introduce a broader view on the field of information visualization. In their overview graph of related fields, information visualization and information art form the two opposite ends of a continuum that contains also subfields of social visualization and informative art (Lau, van de Moere 2007, 4). Within this continuum they suggest the necessity to acknowledge *"information visualization techniques that combine information visualization techniques with creative design"* subsequently introducing the concept of information aesthetic visualization (Lau, van de Moere 2007, 1). Although what is meant by aesthetic is not entirely clear from the paper, in this research the term aesthetic does not refer only something being visually appealing, but to a broader notion of the aesthetic experience. This new understanding of visualization could perhaps bring the scientific, design and art communities closer together in the benefit of the field - in particular considering the potential significance of the subjective experience of the aesthetic, or beauty, as discussed in the section 4.4.

The number three concern, prior knowledge, is also related to the notions of subjective experiences discussed in the section 4.4. If one of the three basis on which we make perceptual judgments is related to the social or user group (Karapanos 2010, 20 after Hofstede 2001), the particularities of different professions should be better considered. However, information visualization relies heavily on the general principles of perception, not entirely taking into account the specific needs and abilities of different individuals or social groups and professions. The generalness and neglect of aesthetics might also present a particularly weak point of the information visualization field when creating visualizations for designers and architects. I suggest this due to designers and architects proficiency in dealing with visual material and the importance they place on the aesthetics and appealingness. I am suggesting this based on my own experience as a designer as well as based on the statements by the interviewed architects - one having described that she tries to make even all Excel sheets look 'nice'.

It seems evident that experience in a field is of great importance in how we experience and understand things (Lawson 2004, 7). Lawson writes about one aspect of designers' specific knowledge: *"it seems designers are able in some way to think visually"* (Lawson 2004, 51). I would like to extend the statement that in addition designers and architects are able to think spatially, as both visual and spatial thinking are a necessity of the profession. That brings us to an information visualization convention perhaps to be challenged, the strong objection to the use of 3D visualizations in particular in abstract data, due to several



perceptual and navigation problems. However, it appears that the effectiveness, insight and preference of 3D visualizations for architects and designers has not been studied and compared with the 'general users'.

Visualizing the architecture process includes yet another one of the top ten problems – shift from structures to dynamics. Visualization in and of the design process are mainly limited to modelling the artefact, modelling the evolution of the artefact, Gantt charts of the project schedule, and organograms and other diagrams representing components of the process. Research into visualization as an interface to the overall process seems to be virtually absent, with an exception of the study by Bouwel et al. They hypothesize about the usefulness of visualizing the asynchronous collaborative design process real-time. Their focus is the impact of the visualization on motivation, awareness and social dynamics. The proposal, Archibrain, visualizes the different design proposals as a traditional treemap. The visualization acts as the interface to navigate the different proposals. Each proposal consists of explanation of the proposal, images and comments (Bouwel et al. 2012). However, Archibrain is a very simplified representation of the architectural process containing limited information. It also remains unclear what the criteria were for choosing the functions and information to be represented. Although proposal was evaluated with students and young professionals, no consideration is presented (and seems not to have been their goal) about how experienced professionals would react to the proposal based on their knowledge and actual projects. Thus, what can be learned from the study by Bouwel et al. is limited to that it supports the hypothesis of this research that visualizations are potentially useful for asynchronous collaborative design process.

Visualizations seem to open up a possible avenue towards facilitating the architecture process. They allow easier and faster comprehension of complex information and allow designers and architects to interact with the type of media they are proficient with and seem to prefer based on the interviews. Some of the top challenges outlined for information visualization are explored in this research with designers and architects, such as, effect of prior knowledge, inclusion of aesthetics (or beauty/appealingness), shift from structures to dynamics and knowledge domain visualization. It also appears that visualizations have not been studied as an interface to the design or architectural process (aside from very limited studies) presenting a promising area of exploration and research. In information visualization projects it is common to apply an appropriate visualization technique and to follow information visualization guidelines. In this research the development of the visualization departed from notions of what could be an appropriate visualization for the architects, i.e. using a more user-centric and creative design approach. Although this approach is in disagreement with the mainstream understanding of the information visualization field, it is based on the need discovered in this research to develop more specific solutions as outlined in this sections as well as in the section 4.4.



#### **4.9 Conclusions of chapter 4**

Mitchell's three paradigms together with Pentland's notions of big data have provided an insightful framework for this chapter. The current shift to the third paradigm and beyond, is bringing with it fundamental changes. There is a growing recognition of design as social, dynamic, and context depended activity, where pre-described rules no longer apply. This new paradigm manifests itself also in the semantic web technologies and digital agents that can potentially resolve many of the technical issues traditionally pertinent to systems and tools for design, such as design rationale, project information and knowledge management; capture and use of implicit knowledge and rationale, and challenges related to the gap between digital and analogue information.

Although the new technologies offer many solutions for dealing with the increasing amount of (collected and used) information in the design and architecture process, collecting information from the process and integrating the different systems remain among the technical challenges. On the social side, human factors management and project information systems require significant improvements. The increasing amount of processual information also requires other new characteristics from systems. Information aesthetic visualization could offer an avenue towards facilitating comprehension of the information and a media type designers and architects are proficient with.

Increased recognition of the dynamic nature of the design process and of the specific needs and abilities of the users (individuals and social groups) also requires reconsidering the methods for designing new systems. Many of the still prevailing generic solutions in human computer interaction (HCI) and information visualization may need to be replaced by more specific solutions considering the subjective experiences. The traditional user-centric view alone is no longer adequate, but needs to be supported by End-User development (EUD).

To summarize: Many challenges in the design and architecture process will be facilitated by the new technologies, but the social dimensions need to be better recognized in the still artefact and techno-centric field. The technological advances affecting the design process are monumental, however it is fundamental to investigate better, novel ways how the specific users interact with the new systems.



Whereas PART II formed the arguments and outlined the problematic of this thesis through literature and interviews, the PART III will focus on describing the process of producing the concepts, proposals and resulting prototypes. PART III ends with the synthesis and discussion on the proposals and prototypes.

During the interview and design process in total 20 interviews were conducted, with 14 designers and architects, in 6 sessions (Fig. 9). Although many designers and architects were interviewed in the course of the study, some sessions only comprised of few interviews. This is mainly due to the choice to interview only experienced practicing designers and architects, based in different countries. Therefore, scheduling the interviews was at times challenging.

As described in the section 2.3, the overall design approach can be said to belong to the broad framework of user-centered design. Furthermore, the interview approach can be described as action research (Berg 1989, 196). In addition, my role in this project was not only a researcher but also a designer, trying to actively understand the architectural process and create proposals to facilitate it. Therefore, the content analysis from all of the interviews was interpretative from a point of view of and due to objectives of a designer (Berg 1989, 266). As the interest in this project was to understand the specificity or architecture, the interview methods were also considered to reflect this goal. Where possible the knowledge, ways of working, and the abilities of architects were considered and interview methods adapted.

Due to the limitations of this study several choices had to be made to prioritize what should be done and to which extent. In the Part II the objective was to develop a concept of a tool in collaboration with architects, create a working prototype with sufficiently representative interface, and test the tool with architects. The interest here was not to investigate details related to interaction or information encoding. Rather, the objectives were through several interviews to understand the potential of the concept, derive opportunities for the further research, as well as generalize some of the findings.

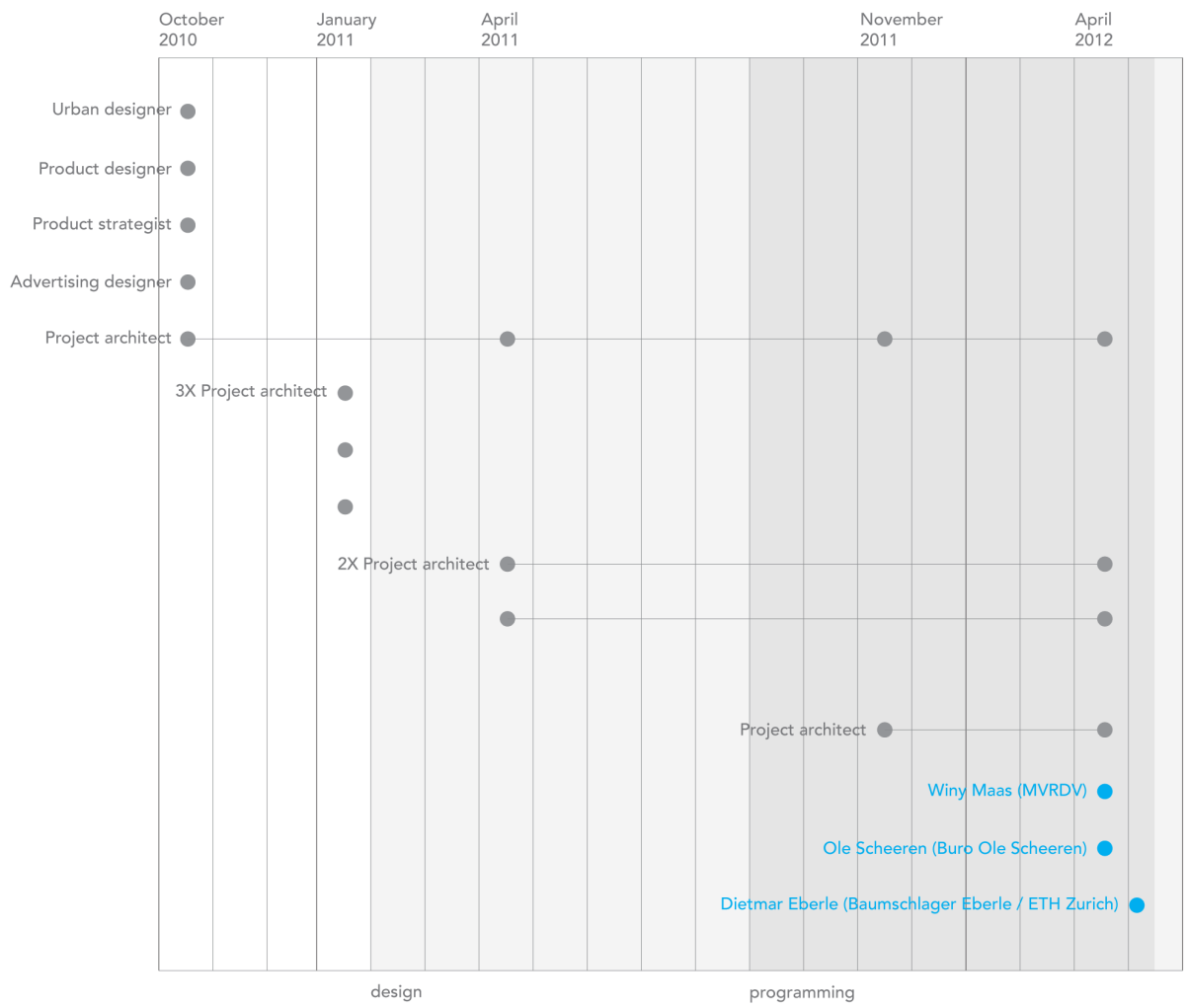


Figure 9. Interview process sequence, design and programming phases





### **6.1 Interviews: Problem framing and defining a solution space**

The first two sets of interviews were done very early in the process of this research to provide an empirical grounding for the research. Both of the interviews were very exploratory at this stage. In the first two interviews rigorous coding was not applied, rather the approach was to reveal relevant themes for creating a design proposal.

#### **The first set of interviews**

The first set of interviews was done with professionals from different design disciplines, following an interest and direction based on literature and experience from practice, that somehow the current tools and methods could be improved to facilitate the work of designers and architects in the messy and complex design process. An architect (DE/NL), an urban planner (PT), an advertising designer (NL/BE), a product designer (FI) and a design strategist (UK) were interviewed. Interviewees were simply asked to talk about their design process and problems they have encountered. I will describe some of the main themes revealed in these discussions.

The product designer outlined three main themes related to the process:

- Different disciplines working within a company often have different development needs that don't necessarily match and this can cause conflicts in the design and manufacturing process.
- So called 'corridor speech' where people who are not fully informed discuss their own versions of the issues sometime causing 'catastrophic' situations.
- The mental models of the designers and engineers don't match. Engineers prefer a linear way of working where each issue is solved before proceeding further, whereas designers would prefer a more flexible process.

With the architect the following notions were expressed in the first discussion:

- Many ideas are stunned in meetings and many things that are discussed are lost and forgotten afterwards.
- It is difficult to discuss abstract things with inexperienced people in the beginning of a project.
- Although different specialists usually learn to work together, the timing when different people should be involved can be difficult to determine.
- It is easiest to communicate through models, but drawings work as well.

The design strategists described problems he has observed in the client companies:

- The companies generally have a lot of information but information and knowledge

management is usually bad.

- It is necessary to engage different parts of the client company into the creative process to make them feel part of it.
- The organizational problems are generally related to people.

The urban designer:

- You create and 'artillery' for a problem, but discover the problem was not what it appeared to be.
- The opinion from the community can be very different from the proposal and the professional opinion.
- Problem with some engineers is that they resist new solutions.
- Projects are long and it is hard when a new person joins. They have to read through piles of papers from several years.
- Political agendas can result in strange reactions.

Although very diverse themes were brought up in these interviews, there are some connections between them. It is interesting to note that they are mostly related to communication, social issues and information and knowledge management problems. This confirmed that there were enough interesting issues to tackle related to improving the process and the tools. At this point architecture (specifically the architects perspective on the process) was chosen as the focus due to two reasons. Firstly, the main themes arising in the first interviews, communication, social issues and information and knowledge management in architecture are very challenging due to long projects and large amount of parties and participants. Secondly my professional network offered an access to collaborate with practicing architects.

### **The second set of interviews**

The goal of the second interviews with architects (four project architects working in the Netherlands) was to trigger discussion on potential directions for proposals and research. It seemed interesting to create something the architects could react on, to help them reflect on the tools they are currently using and bring out desires for new tools. Therefore, a set of cards were made where half of the cards represented existing tool groups (such as simulation games, on-line groups/ forums and high-functionality applications) and half represented directions for new tool groups, such as idea contributor, semantic references and process navigator (Fig. 10). The architects were asked to react on each card. As an interview method the architects found the cards surprising and nice, one referred to it as a "*catalogue of options*". However, this method resulted in large amount of information that was not useful for developing a new tool, evidencing that the method could certainly be improved. It could be said though that the method worked as in the discussions very interesting issues and perspectives related to knowledge, process and communication were also raised.

The most relevant themes regarding the interest in this research could be grouped in following categories.





Figure 10. Cards used in the second interviews describing a variety of tool groups

Process related issues and process tool potentials:

- In long projects it is difficult to have an overview of the process.
- Due to people frequently changing a need to record standard process and methods of working.
- Process tools would be increasingly useful in the current situation of increasingly tight budgets and demands for efficiency.
- In projects with different parties and ways of working process tools could be relevant.
- Process tool could help to organize content produced in projects.
- *"The risk is that it (process tools) creates bureaucracy, making things counterproductive again. So, I am deeply interested in your conclusions in that sense."*
- *"Design meetings are messy and terms come up, 'this one is like spaghetti'".* Everyone works in different way and makes notes and drawings. Information tends to get lost during and after meetings."

Knowledge related issues:

- Increasing amount of advisors involved, *"we don't know what we are working with anymore"*.
- How to share design knowledge?
- A kind of open source would enable being honest about sources and stimulate improvement.
- How to communicate and integrate knowledge in earlier stages of a project?
- How to get the right information/knowledge at the right time?
- How to pose your questions wider to get unexpected answers?
- *"There is a big brain drain [...] when people understand the steps they are about to leave again."*

Communication related issues:

- Professional management systems don't care about communication and the ethics in producing good architecture.
- Personal relationships are very important for the quality of the projects.
- How to communicate about ideas in a way that others can react to them (already early on in the process)?

Among the broad discussions, the above notions started to give indications towards a possible problem framing and solution space. It seemed interesting that although many tools and proposals exist in other fields for similar problems as the architects were discussing, there are, as illustrated by the literature review in the part I of the thesis, few research projects and proposals targeted for the specific issues in architecture. As a conclusion based on the second interviews the solutions space for new proposals was interpreted as; the need to provide a better process overview (of heterogeneous information) with improved information storage and retrieval that is more appropriate to the architects and better related to the parties and participants. How to communicate about this information better between the parties and participants was also decided as an important consideration in the proposal development.

## **6.2 Developing and introducing the concept: Information management for architects**

### **The concept**

The idea was to create a tool for information management for architects, designed from their perspective. The tool should converge (digital) information directly and indirectly related to the artefact, and enable communication about this information. Of course, as this thesis also emphasizes, architecture is a social and informational system and architects collaborate with many other professions during the design process. However, it was necessary to narrow the focus and it also seemed intriguing to investigate what information management tool for architects would consist of, based on their specific needs and abilities. As discussed in the Part I of the thesis, the amount of information collected, generated and used in the architecture process is large and increasing, and currently still fragmented. Based on the interviews a new tool would need to provide an easy overview of the process and a kind of a project memory, containing as much information of the process as possible.

It also needed to enable an improved way to communicate about visual content.

### **Visualization interface**

The main first question for creating the concept was, what could be an easy, efficient, and also appropriate interface to deal with the heterogeneous process related information? The solution proposed here resulted from two observations: 1] Architects are proficient and comfortable in dealing with visual and spatial information 2] visualizations are used to facilitate comprehension of complex information (see sections 4.4 and 4.8). Thus, the use of visualization as an interface seemed founded and appropriate. The much harder question to answer was, what that visualization should look like. As this thesis places great emphasis on the specificity of the architecture discipline, it seemed inconsistent to rely on established generic principles from Information Visualization, also considering the subjective side of usability (see section 4.4). At this point of the process a discussion with Martens, specialized in user-centered design, proved very helpful. His advice was, *“people don’t know what they want, but they can say what they do not want”*. That is, architects needed something to react on, not simply be asked them what kind of visualization would be appropriate to represent the process.

### **The first two proposals**

Two different visualizations were created and selected among other sketches (Fig. 11, 12):

- 1] A kind of three-dimensional Gantt chart (the thought was that perhaps architects recognize and respond to the familiarity of the form)
- 2] A three-dimensional representation of the different parties, inspired by from the ‘triangle’ of architect, client and contractor (see sections 6.3.1 and 6.3.2). Despite of the visual differences, the visualizations contained similar information and were based on time axis.

Aside from these two, other visualizations were also created, but the selected ones seemed to accommodate the necessary information the best. Both selected proposals were three-dimensional. It seemed that three-dimensional visualization accommodated all of the information better while retaining its clarity, compared to the two-dimensional sketches. And although information visualization literature strongly advises against using three-dimensional visualizations, it seemed appropriate to try it with architects based on literature discussed in the section 4.4.

The concept and the two versions were introduced to three architects, one female (FI/CN) and two male (DE/NL, P). The versions were shown as static images on the computer screen. The concept idea and main information linked to the system (3D as main view, people, teams, parties, phases, tasks, files and meetings) were explained verbally.

All three architects showed preference to the second visualization. One of the architects stated that the visual felt familiar. The office she works at had used a similar representation for a project, although with different content. However, the static visualizations did not provide much help in determining the functions of the tool, but did confirm that the overall concept seemed valid. In fact, one of the architects before there had been a chance to introduce the concept (she only knew that the discussion would be about developing a new kind of process tool) said,

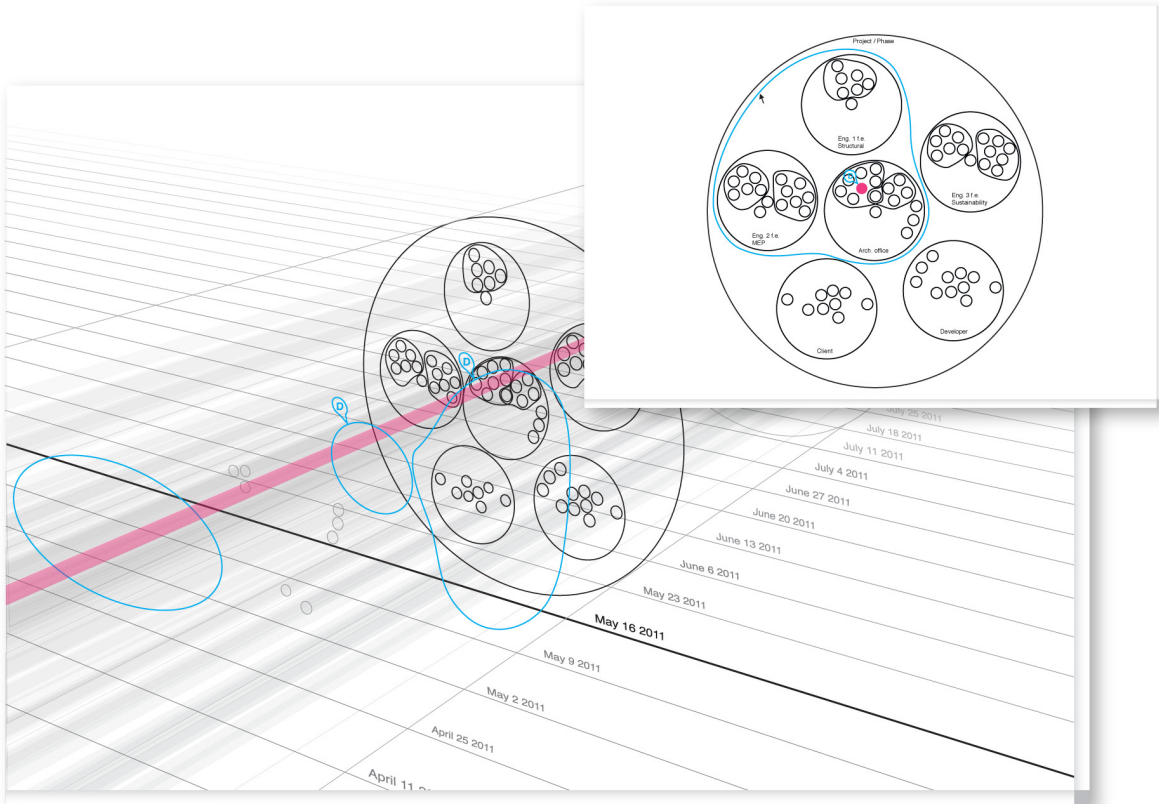


Figure 11. The first two versions of the concept. Version two.

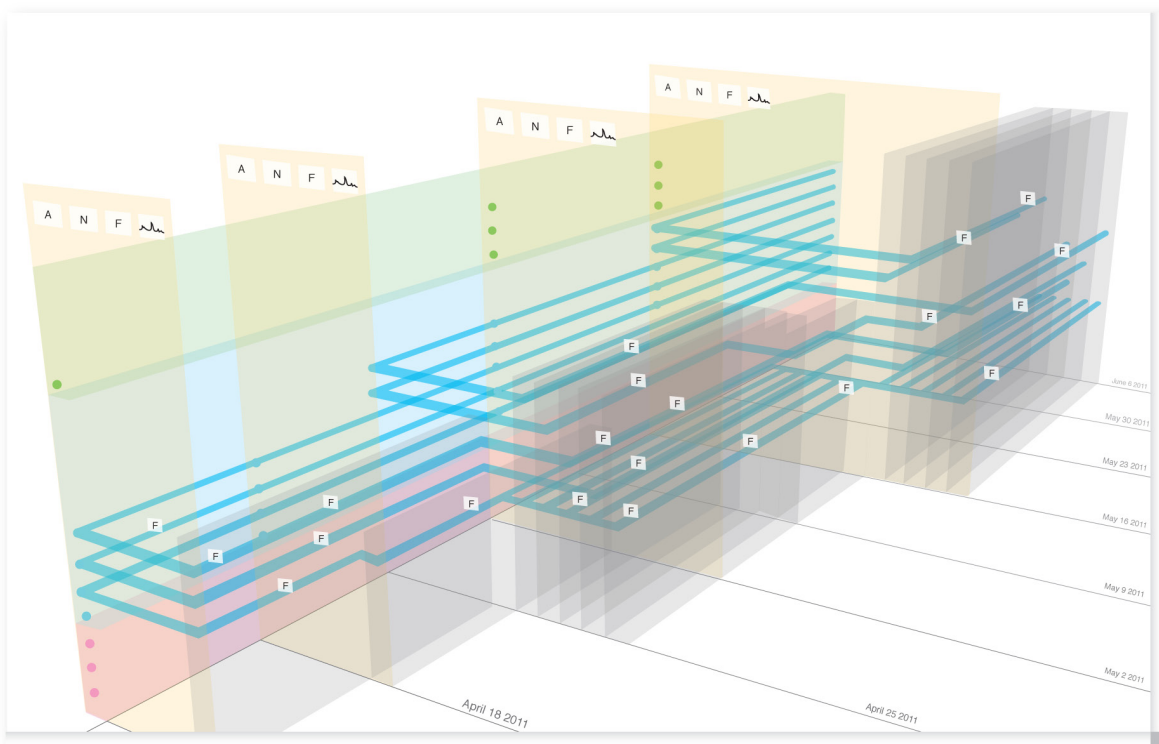


Figure 12. The first two versions of the concept. Version one.

*“It would be great to have a tool that helps to remember things and details in a long project.”*

After introducing the concept she also used the exact term that had been one of the key aspects of the concept, “project memory”. She explained,

*“project memory would be needed. It (the tool) would be necessary and I could see it working, although all these kind of systems require a lot of discipline from all parties.”*

This comment of the disciplined use is in fact very important. The criticism and the failure of tools such as the Design Rationale systems, are to some extent linked to the discipline it takes to use the tools, categories, and terminology consistently and to record things diligently in order for the systems to work. The new information and knowledge management tools need to liberate the users from these additional tasks and concerns, otherwise the tools risk defeating their original purpose.

### **6.3 Developing visualization interface, proposing main functions**

*“The language of cultural interfaces is a hybrid. It is a strange, often awkward mix between the conventions of traditional cultural forms and the conventions of HCI – between an immersive environment and a set of controls, between standardization and originality”*

(Manovich 2001, 91)

#### **6.3.1 Conceptual and architectural visual references**

In this section I will describe the development of the visualization that led to the final (within this thesis) interface proposal. As explained previously in the thesis, it seemed inconsistent to adhere solely to the information visualization principles and simply apply a visualization technique to the tool concept. Rather it seemed more appropriate to look for visual references pertinent for design and architecture and to what the tool should represent.

The influences for the visualization were two-fold. On the one hand, the current and evolving model (from triangle to network) of the parties in the architecture process, visualizations of social organization, alongside with the visual language of the typical documents and drawings from the architecture process, and known visuals from significant architecture projects influenced choices in the development of the visualization. These types of images form a part of the architects’ visual vocabulary (Fig. 14). On the other hand, visual references that were consistent with the ideas of the tool concept and what it should represent were collected. These references are mainly organized in three categories:



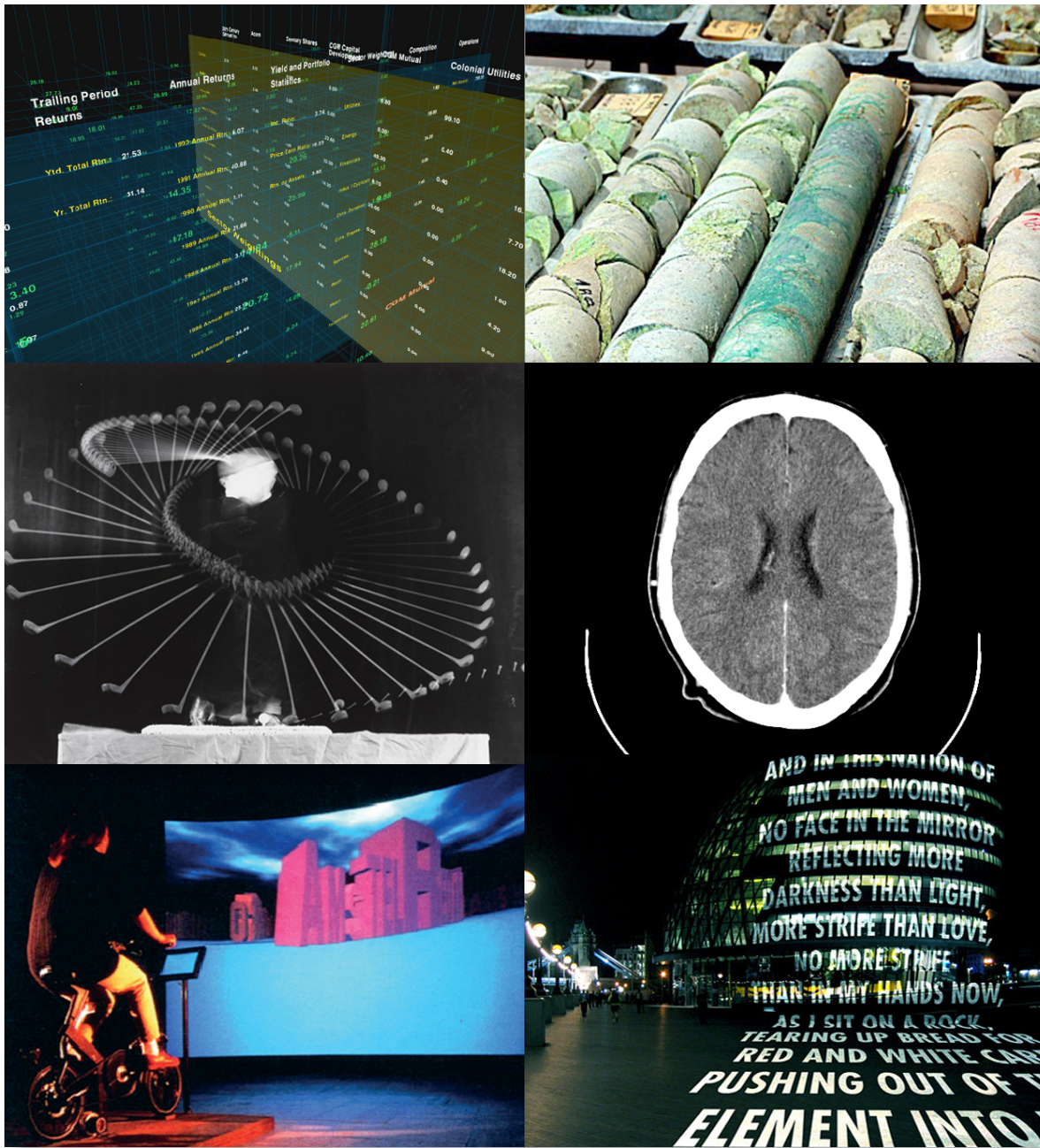


Figure 13. Visual references, 'spatializing information and slicing information and time'. From top left: Cooper, Financial Viewpoints; drill core samples of Escondidos, Chile; computed tomography of human brain; Edgerton, Golf Swing; Shaw, legible City; Holzer, External Stimuli



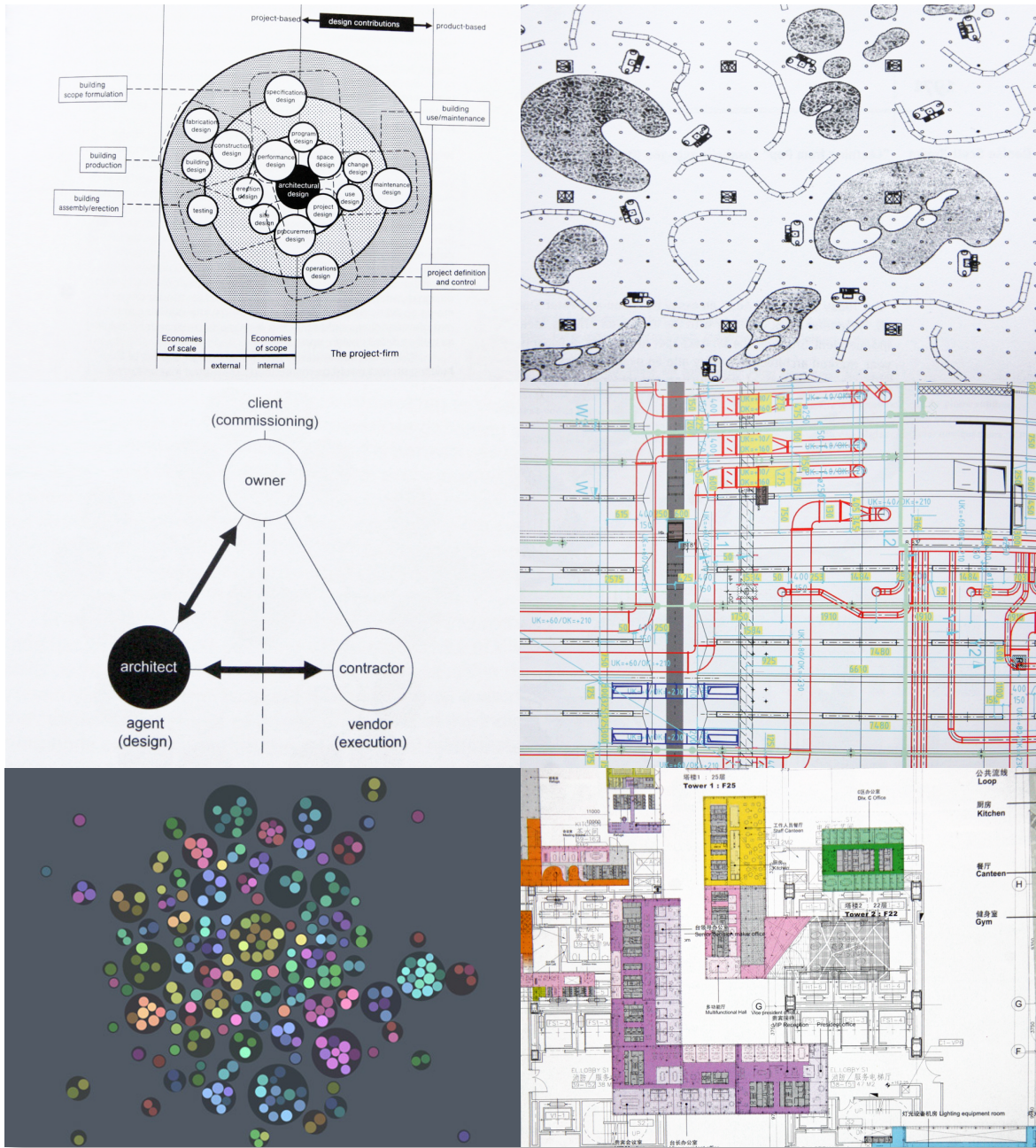


Figure 14. Visual references. images related to social organization and architectural references. From top left: Tombesi, The industrial context of a building project; Archizoom Associati, Non-Stop City; Tombesi, Triangle of practice; Detail of a drawing , sprinkles and ventilation; Bloom, social group visualization; OMA/AMO, CCTV building floor plans

'Slicing information and time', and 'spatializing information' (Fig. 13). The 'slicing time and information' category contains images of objects that enable us to look back in time. One of these images is of a chip of hundreds of layers of paint from decades of graffiti art from the Belmont art park in Los Angeles; another is an image of drilled geology samples. Mehretu's paintings provide a more artistic and also architectural reference. Her colourful paintings layer time and urban places into abstract compositions. More literal examples of 'slicing' that reveal hidden information, are images of computer tomography and high-speed photography. The second category, 'representation of behaviour and social organization' contains old and new information aesthetic visualizations. The third category, 'spatializing information' seemed relevant for two reasons. Prominent media theorist Manovich writes, "[...] *the computer culture gradually spatializes all representations and experiences*" (Manovich 2001, 80). This is interesting when developing a visualization to act as an interface for a tool that operates through cloud, and for architects whose work demands them to think spatially. Early examples of spatializing information are Cooper's Financial Viewpoints from MIT and the Legible City installation by Shaw. These represent two distinctively different ways to navigate abstract information in space. Art installations by Holzer provide more recent examples. She literally spatializes her messages by projecting them on the buildings, cityscapes and interior spaces. This combination of references represented the artistic, architectural and scientific interpretations of the main themes of the tool concept.

### **6.3.2 Creating the visualization - giving form for the architecture process**

***"For humans reality comes into being with form; prior to that there is only something our mental faculties cannot grasp"***

(Campanelli 2010, 109). This section will describe the visualization and the elements it is composed of. In addition to the functional objectives of the interface, the aesthetic quality was an important consideration (see sections 4.4 and 4.8). The different visual references, as already discussed in the previous section, influenced many choices for the visualization. Although the approach was thus more information aesthetic visualization, the aim was to find a balance between efficiency and clarity and visually appealing outcome, appropriate for architects. The design choice to avoid skeuomorphs [3] in the visualization and consistently also in the overall interface, was due to my aesthetic preference and opinion as a designer. This choice resulted in an abstract and simplified representation of objects.

Before describing the visualization I want to outline a few notions about the limitations in creating it. To be useful in real projects the proposed tool would be more complex and would contain more functions than possible to propose and implement in the prototype.

[3] In this case, elements in a graphical interface emulating objects in the physical world. Thus, one of the challenges in creating the interface and encoding the information for the visualization was, how to keep the interface simple enough that it could represent the



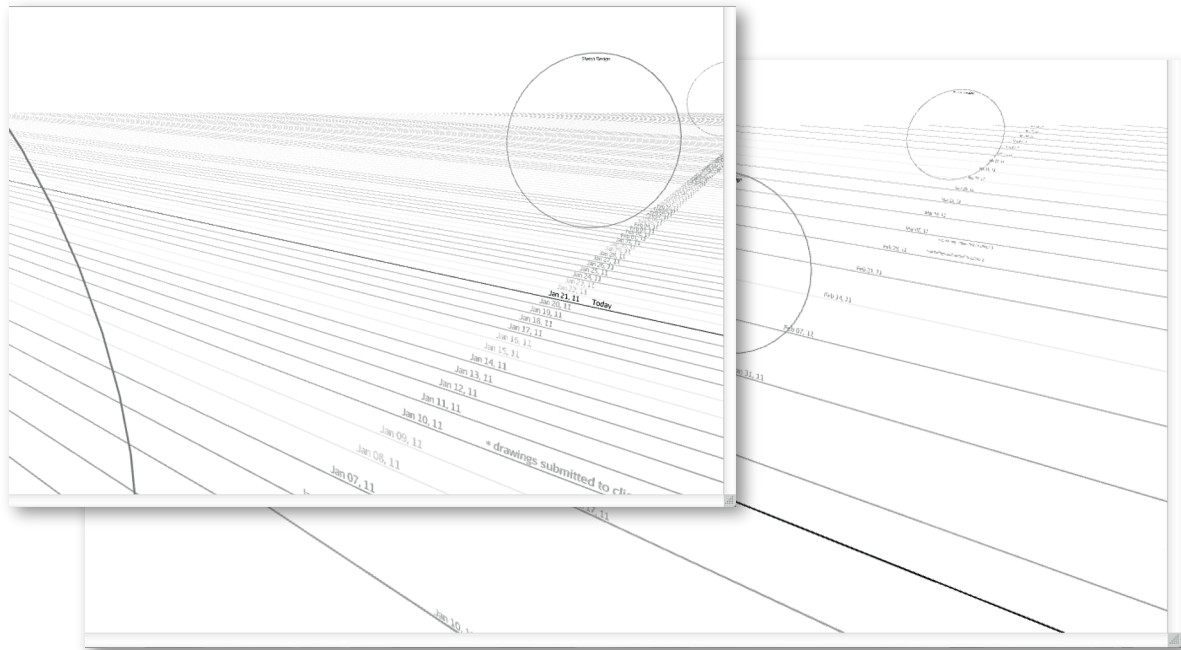


Figure 15. Timeline, weekly and daily views

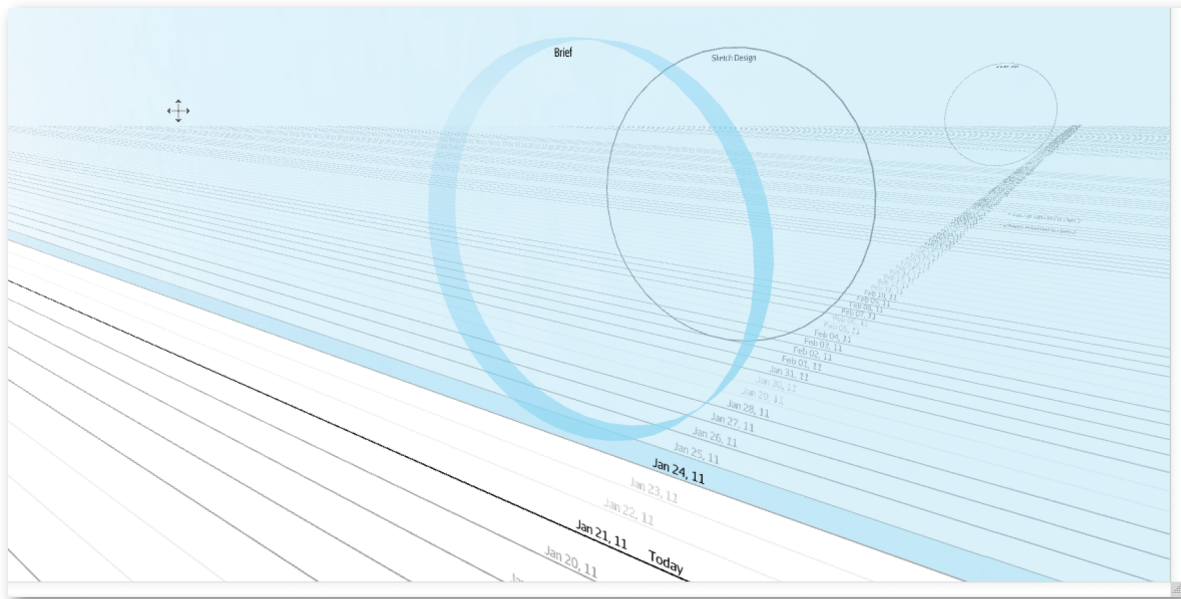


Figure 16. Timeline, blue selection plane

functions and potential of the tool sufficiently and be implemented as a testable prototype. Another challenge is related to the dynamic aspect of the architecture process; it would need to be further investigated how a visualization interface could accommodate new elements and customization.

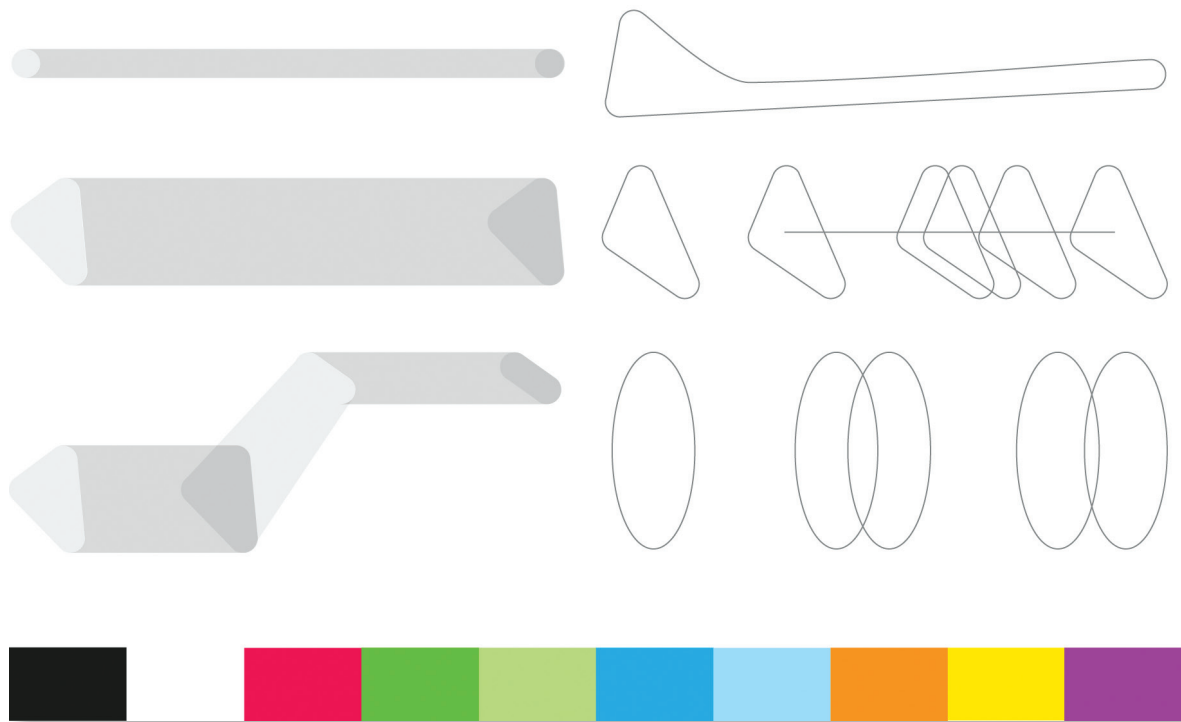


Figure 17. The object typologies and colours

#### **The main structure of the visualization:**

Time was an attribute related to all objects in the tool, as well as seeming to be an important reference point for the architects. Therefore, the horizontal timeline axis, represented by dark grey lines on a white background, forms the basis of the visualization. Zooming into the visualization either months, weeks or days are shown (Fig. 15). In the visualization the relations of objects are shown with enclosure, connection and location – 3D space plus time, XYZT (Card, McKinlay 1997). 3D views present some challenges outlined in literature, such as it is difficult to determine exact place of an object. Therefore, a movable (and removable) selection plane that highlights objects in the selection area was created (Fig. 16). Visually and functionally it is intended to feel familiar, as it resembles the selection in Mac and Windows operating systems.

#### **Object groups:**

Despite of the dynamic nature of design projects there seem to be some constant object groups that needed to be encoded into the visualization: People, teams, parties, phases, tasks, milestones/deadlines, meetings, files, time and communication. Due to the large amount of information in projects it is important that groups and objects can be easily hidden and shown and that the visualization transforms accordingly. The objects are visually encoded through line shape, volume shape and colour (Fig. 17). The colour palette is as limited as possible with distinctively different bright hues and black and white. The colour coding is retained in all views to maintain context. (Please note that screen RGB colours cannot be accurately presented in printed images.)

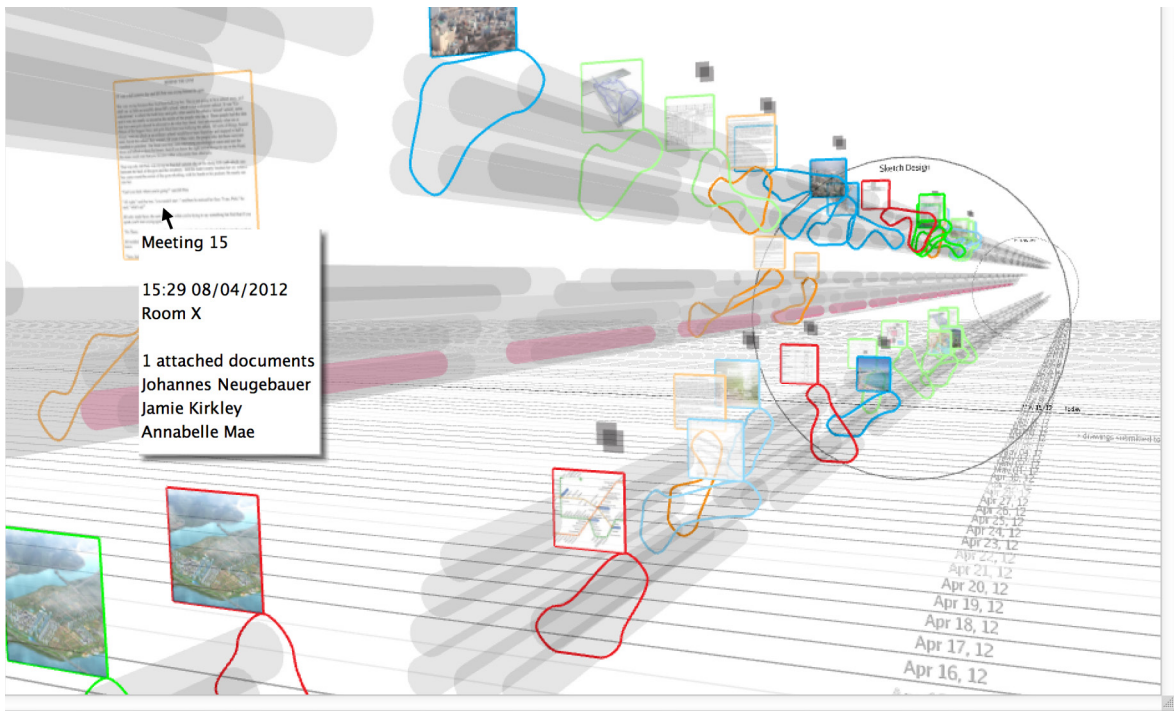


Figure 18. Screenshot showing files and meetings

Related to the social visualizations and organizational diagrams of architecture (discussed in the previous section), the people are represented by round shapes that are extruded into cylinders. The people (and other objects as well) only appear in the visualization for the length of time they are part of the project. Grey enclosure shapes, wrapping around people, represent teams. People and teams in turn are enclosed within bigger cylinders representing parties (Fig. 18).

Information within projects seems to be related to people/team/party or time, and thus those relations were used in the visual encoding. Files are related to both: they have a date of origin and an author. In the prototype the files are shown as enclosure lines around people/team who created or worked on the file (Fig. 18). However, in the case of people being hidden and only parties being visible, the files are shown attached to the party. Two of the interviewed architects commented that this would perhaps often be a simpler way to view the files. In the prototype the files have the following colours and statuses: bright red (critical), bright green (accepted), olive green (finished), cyan (in progress), light blue (tests/outdated). The architects expressed diverging desires about what statuses should be visualized, thus this feature may need to be customizable. However, they all agreed that the critical files need to be clearly identifiable and contain reminders. All of the architects also wanted previews for the files attached to the shape in addition to the options of seeing the file names and formats. Similarly to files, meetings are also shown as enclosure lines around people, with bright orange colour. Files can be uploaded 'into the meeting' and they are

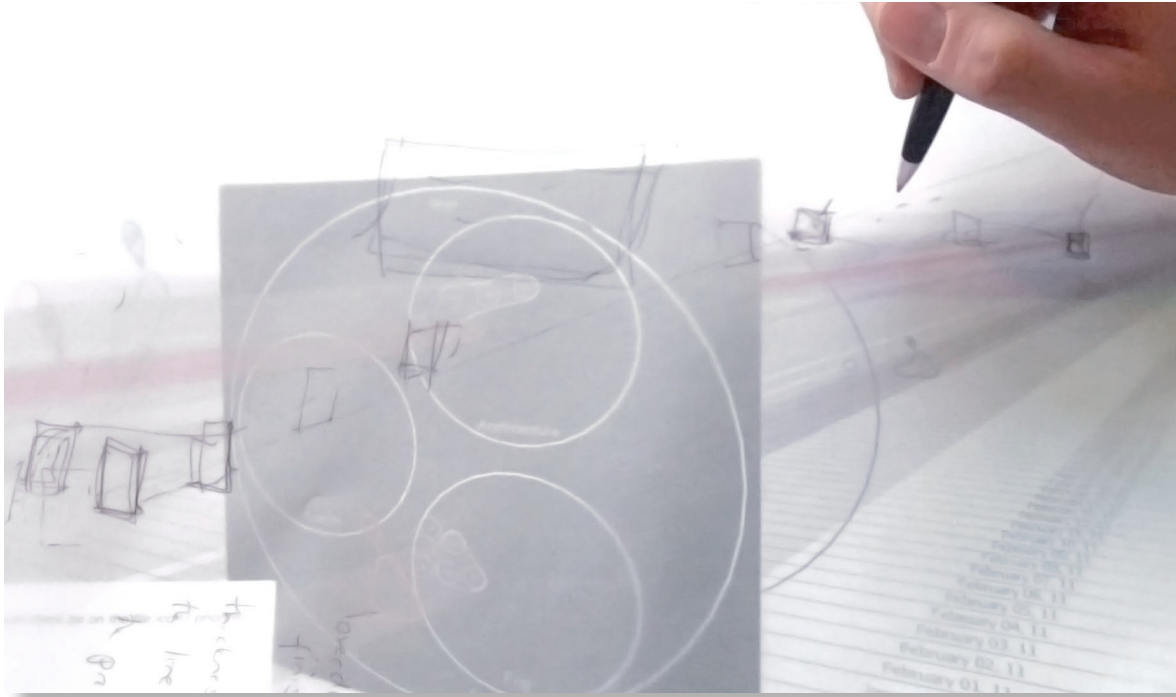


Figure 19. Interviewed architect drawing suggestions of the previews on the transparent paper / paper prototype

visually linked to the meeting shape (Fig. 18). Tasks are represented as purple enclosure shapes wrapping around people/teams/parties and continuing from one party to another. However, how tasks should be represented and what they should include should be further investigated.

#### **6.4 Interviews: Demo video and paper prototype**

The chosen interface concept was improved and functions designed to the extent they were known. However, before beginning the implementation of the interactive prototype some more input from the architects seemed necessary to eliminate the biggest problems from the proposal and refine the functions.

More detailed input was needed from the architects, and therefore an adapted version of the typical paper prototype interview was created. To give the architects a better idea what the software would look like on the computer, a demo video showed the main functions of the tool, including: How to create a new project; add people, teams, parties and files; and how to search and access information. In addition to the demo video, a paper prototype with screenshots from the video was used. To provide the architects more active, familiar and appropriate means to participate, the paper prototype was combined with sheets of transparent paper allowing the architects to draw suggestions on the screenshots (Fig. 19).

For the analysis of the interviews the transcriptions of the audio, some photographs, and sketches on the transparent sheets were used.

The questions in the interviews ranged from discussing the visualization to detailed aspects of the needed functions. Due to a pressing schedule to begin the implementation of the interactive prototype only two interviews were possible to schedule within the time available. However, both were with internationally experienced project architects: One female (TW/NL) and one male (DE/NL).

In the following paragraphs I will summarize the most important parts of the interviews that are a result of coding approach that loosely combines In Vivo and Descriptive Coding in that some parts are summarized and described, and direct quotes are collected from others (Saldaña 2009, 70-74).

The overall impression of the visualization interface?

- *"Abstract, but nice". "Reminds of WiiFit", "Clean table" with many players.*  
Difficult to understand at first, but probably can get used to after a while. The black square is *"harsh"*. Each project needs to be recognizable, maybe include logos of the different parties.

Overall functions, what is missing?

- Deadlines should be visible, perhaps with red line around the people (comment by one architect).
- Breaks, such a holidays or when project is on hold should be visible (comment by one architect).

How do you, or would like, to search for information?

- By using keywords
- Selecting a timeframe
- With file formats  
(by two architects)

What information is necessary about the files?

- Large previews of all files in the visualization (comment by one architect)
- Regulations and design brief should be easily searchable and recognizable, different from other files (comment by one architect).
- All saved versions visible and continuity of files (comment by two architects)

Are the file categories appropriate?

- The first one of the architects wanted: approved, overdue, critical, planned, in progress, finished. Urgencies should be 'blinking'.

The second one of the architects wanted to add what she now calls 'Ihide' folder. Outdated and not active files, but that may be useful in another project. She also wanted to be able to find the results, conclusions. Additional category she felt could be needed are presentations, documents, image and 3D.

Is the current colour coding appropriate?

- Different projects may have different colour coding. For example everything to do with façade yellow and structure blue (comment by one architect).

Assigning colours should be customizable was a comment by one of the architects,

and my interpretation based on the comments of the other.

How would you like to communicate about files?

- Draw and write directly on the files and see comments of the files or just comments separately. Both architects wanted to see the whole history of comments, instead of separate documents and e-mails. Now things cannot be saved and recalled in a “clean way”.

What things are difficult to remember?

- Meeting notes and decisions (comment by one architect).
- Continuous tasks (comment by one architect)

What would be practical for scheduling meetings?

- Should be able to link to programs such as Outlook (comment by one architect)
- Shared agendas in reality often not possible, sending invitation in here would be more practical. Would be good to suggest options and see ‘pending’ meetings here (instead of responding and waiting for e-mails). (comment by one architect)

What do the tasks need to include?

- Briefs, everyone’s role and final results (comment by one architect)
- Pre-set task would be practical, like building permission (comment by one architect).
- Deadlines could be packages of tasks (comment by one architect).
- Relation of tasks should be visible (comment by one architect).

As a conclusion from the interviews, some of the main points that were included in the further development of the tool: Overall the visualization interface is accepted, but some fine tuning is necessary; file priorities are needed, but they most likely need to be customizable (as well as colours), for the interactive prototype the ‘default’ statuses need to be refined; meeting options, ‘pending meetings’, need to be included; a new kind of communication feature needs to be created; continuation of the files need to be visualized; relation of tasks needs to be visualized; breaks need to be visible; information search requires different strategies (keywords, temporal etc.); large previews of all files need to be included.

Overall the interviews with the demo video, paper prototype and transparent paper were very successful. Both of the architects made a lot of sketches while speaking. It seemed to help them explain what they were thinking about, and it also made it easier to understand what they intended with their comments.

## **6.5 Creating the interactive prototype with a programmer**

A programmer [4] and two professors [5] as advisors from IEETA [6] at the university of Aveiro collaborated in the project for seven months. They all outlined in the initial discussions that the schedule was very tight for two persons to design, program and test an interactive prototype, especially something as ambitious as planned. Due to this limitation of resources many concessions needed to be made. However, we achieved a satisfactorily functional prototype. The aim of this section is to describe the collaboration process, the challenges affecting the final prototype and what can be learned from this collaborative effort. In practical terms how to collaborate within such a tight schedule, working parallel



seemed to be the most feasible solution. I created a set of tasks for the programmer and while he was implementing them, I worked on creating the next set of tasks. This worked most of the time, but as design decisions needed to be taken throughout the whole process, this parallel sequential way of working resulted occasionally in design and programming conflicts that needed to be resolved before we were able to proceed.

The programmer used Java as the programming language and JMonkey as the 3D engine - both open-source applications. The sequence of work for the programming was relatively standard: analyze the requirements, develop a working prototype and improve it with a cycle of reviews and improvements. The parallel working process, and occasional new input from the architects, resulted in changes along the way affecting the programming. Some of the changes did not fit easily into the original architecture that the programmer had designed for the prototype.

This resulted the last, eight version of the prototype being somewhat unstable. The application was written to run both on Mac and Windows and despite that Java should support both systems, in some cases the prototype had different behaviors. Although we were able to achieve a prototype that functioned to a satisfying degree, more resources (time and people) would have been needed to go beyond the level of the prototype that was created.

What can be learned from the experience of this collaboration? For one, that within a design PhD it is very difficult to work without collaborating with other professionals, as projects tend to cross many disciplines. However, appropriate collaborations are not necessarily easy to establish within the financial and schedule limitations of the projects. The circumstances were not perfect within this project either. However, without the opportunity to work together with a programmer this thesis would not have been possible. Acquiring the needed programming skills within this schedule would have simply been impossible. Even with intense collaboration of seven months only a relatively simplified prototype was achieved. However, based on the testing with the architects it appears to have been sufficient to achieve the objectives outlined in the beginning; to give indications towards the potential usefulness and appropriateness of the concept and of the main functions.

[4] Ricardo Machado

[5] Beatriz Santos and Joaquim Madeira

[6] IEETA, Institute of Electronics and Telematics Engineering of Aveiro





### **6.5.1 Tension between the 'Ideal' and feasible**

One major challenge in creating the interactive prototype was the tension between the programming feasibility (due to time or technology), and the 'ideal' or experimental solutions and features. Thus, some aspects of the prototype could not be fully investigated or implemented. I will here explain the bigger implementation challenges and return to the smaller ones when describing in detail the software application proposal in the section 6.6.

Ideally the tool would allow customizability (such as customizing object groups and creation of new object groups) and possibly further levels of end user development, but this could not be investigated or achieved in the prototype. Instead, in order to achieve a working prototype, we needed to use a typical system diagram including classes, attributes, operations and the relationships as a basis for the programming (Fig. 20). Based on a discussion with Hovestadt at ETH Zurich, as well as with a software programmer from Autodesk Research, a more flexible model for a software application is possible, which allows customizability, yet retains compatibility between the different 'versions' (Fig. 21). This flexibility, according to Hovestadt and some literature outlined in the part I of the thesis, is a key aspect in an application in order for it to suit the dynamic architecture practice. Thus, in future development it would have to be deeply investigated.

Another important feature that could only partially be implemented is the search function. Ideally any word combination could be used to search the information content from a database, but in the prototype only a limited number of keywords work to access content. However, this seemed to be enough to give the architects an idea of the potential of the tool, since everyone is familiar with the semantic search (enabled for instance by Google).

The third difficult aspect to implement to a satisfying degree was the navigation in the 3D interface. Many of the challenges in navigating a 3D space are well known. We were also confronted with some of the typical challenges, such as determining the exact position of an object and readability of text when it is at an angle. Since determining the position of an object in relation to other ones was very important for the readability of information, we implemented a blue 'selection plane' that did at least in part solve the problem (all of the features will be described in detail in the next section). Although we implemented navigation controls that are familiar from other 3D applications, the user can lose orientation in the 3D environment easily, due to not perfectly functional controls and often a small delay for the application to respond. In further research how to create an easily navigable 3D environment of abstract information for architects would be an entire research project in itself.

## **6.6 Description *Mneme* – information management and communication application**

This section describes in detail the information management and communication application proposal. Some of the features have already been briefly referred to in describing elements of the visualization, here I will return to those elements but describing them departing from their functions. The section 6.5.1 has already addressed some of the bigger implementation issues related to the prototype. In this section the detailed functions

and features are described as they were intended to work, with additional descriptions when necessary about how they were implemented in the prototype. To support the following paragraphs, see also the CD attached to the thesis, containing the video demo of *Mneme*.

After finalizing the prototype the name *Mneme* [pronounced ni:m] was selected for the proposal (Fig 22.). It comes from 'mnemonic device' meaning memory device, referring to the concept of acting as a project memory.

# Mneme®

Figure 22. *Mneme* software application registered trademark

### **The information presented by the prototype and the architecture of the application**

The information *Mneme* prototype presents is related to: people, parties, files, phases, tasks, communication and meetings. The user can access the related information through spatial, semantic and temporal search options. It is proposed that a real implementation would follow a client-server architecture, where the server maintains a database with the project data, and the client accesses that information and displays it to the user. In the prototype a 'dummy' project database is used to simulate a simplified ongoing project.

### **Login**

The login function, although very important part of real implementation is not implemented in the prototype. Login would be necessary for the application to know who is working with the software and would enable it to keep track of the information and provide the appropriate notifications. Although different levels of visibility/access levels of information were not investigated or implemented in the prototype, they would most likely be necessary in many projects. The login would enable the application to know the access level of the user.

### **The overall interface**

The information presented by the tool is heterogeneous and providing different ways to view the information and different levels of abstraction seemed necessary, therefore *Mneme* uses a multiple view approach with 3D, previews and lists (Woodruff and Kuchinsky 2000). The 3D visualization is the default view and provides a form for the design process, from which the user can filter the needed information through search, and switch to different views - offering first the overview, followed by details (Spence 2001; Shneiderman 1996). The 3D offers the overview (Fig. 23), list a more familiar way to browse information (Fig. 24), and previews a more detailed look into the files (Fig. 25). Files can also be opened in the appropriate application through *Mneme*. The views are synchronized sequential views (different tabs or the same window) to help maintain context when switching between different views.

### **Navigation in the 3D view**

Navigation in the 3D view of the prototype utilizes familiar controls from 3D modelling applications used in architecture and design (Fig. 23). The user can zoom by using the ctrl/apple with + or -, an area zoom, or a zoom control (utilized for instance by Rhino) where dragging down zooms out and dragging up zooms in. The zoom has three levels: days, weeks, and months. To create a smoother transition between the levels the zoom is animated. The user can also rotate the view around the visible area of the project. The user can select objects from the 3D view. In the case of files, a single click opens a preview, and double click opens the software application that has been set as the default in the operating system. Hovering over objects produces a window with more details. Since determining exact position of objects is difficult in a 3D environment, a selection plane was implemented (Fig. 23). It resembles the selection in the Mac and Windows operating systems. It can be moved forward and back with the arrow keys and by clicking on a date/week/month (depending on the zoom level). All of the navigation controls are implemented in the prototype.

### **The objects in the 3D view**

Objects are categorized through line shape, volume shape and colour. Files are 'enclosure' lines whereas tasks are 'enclosure' volumes, to give two examples. Each object category also has a colour, but with a limited colour palette). The colour coding is retained in all views to make it easier to switch between them yet maintain context. In the 3D view the relations of objects are shown with 'enclosure', 'connection' and location - 3D space plus time XYZT (Card and Mackinlay 1997).

### **The controls**

Although detailed interface design was not among the objectives of this project, interaction controls had to be created in order to have a functioning prototype. The aim was to keep the controls and buttons to the minimum and work mainly through the 3D interface and with the search function. User can switch between the different view modes through a dropdown menu in a tab. To create new objects, each object group is represented by a button. The graphic style is abstract, however, corresponding to the visualization. These buttons can also be used to hide and show object groups. In addition the interface also contains the controls to navigate in the 3D space, explained in the paragraph about navigation.

### **Search and filter**

When looking for information semantic search can be used to filter the information, for example, files by a certain person, or meetings in a particular phase of the project (Fig. 24). The prototype only allows search with limited number of keywords. It is proposed that in real implementation any word could be used to search the information content. In addition Mnome has a temporal filter. In the 3D and 2D combination view, the sliders allow viewing only the desired time frame (Fig. 27). This feature was implemented after two of the architects commented that it would be useful to quickly control the visible time frame.

### **Meetings**

It is intended that the user can plan meetings, access and modify information related to them. Planning a meeting consists of choosing the participants, providing other necessary

information, and up to 3 options for time and place. Once the information is provided, Mneme generates a pending meeting (in the visualization) that shows intended participants and who has already accepted the invitation. The user can also upload a file, in which case it is visually attached to the meeting allowing access to the information (Fig. 23). Once the meeting scheduling is complete, the intended participants receive a notification that they have a pending meeting to review. After the meeting has taken place, files can again be uploaded 'to the meeting' to allow access to decisions and information from the meeting. Meetings and attached files can be searched like any other information. The meeting feature is an early proposal since how it links to other programs such as Outlook is not investigated. In the prototype the meeting feature is only simulated since only one person can test the prototype at the time and it uses a 'dummy' project database.

### **Files**

Mneme is intended to manage the files related to projects and it does not use folders to organize and display them. Instead, the user can save/upload files and they are automatically placed in the correct temporal location and attached to the corresponding user and party. The user must choose a file status, shown through color, as 'critical', 'accepted', 'finished', 'in progress' or 'tests/outdated'. If the user selects a file as 'critical' Mneme prompts it to be assigned to another user and he/she will get a notification of a critical file expecting to be reviewed. File, or its preview can be then opened from any of the views. As one or more users can be working on the same file, Mneme visualizes with a shape who is, or has been, working on the files. When a file is re-saved, the files are connected to each other allowing to track file changes. In addition to the file statuses the users can choose to view file extensions, file types and/or previews. In the prototype the notifications related to critical files are simulated, since only one person can be testing it at the time using the 'dummy' project database.

### **The communication feature, the notes**

It is intended that the users can create notes for all files in the following ways: 1] opening the desired file full screen preview or 2] opening the desired file with the appropriate application, through the 3D, preview or list view. When the application is open (and directed to a shared location to be used for a project) a small transparent note is visible on top of all open applications (Fig. 26). Typing into the note small note starts a new discussion, and the signature, date and time are automatically added. The note can be moved around on the screen, on top of the open file, if a specific location is desired. When the file is opened again to view the note, it will appear at the same location on the file and screen. Cloning an existing note creates a new empty note. The people working on the same file, project, or selected people, will get a notification when a new note is added. They can open the file, see the note and respond to it. A full screen preview option is also provided, to allow quick viewing of files and notes without the need to open other applications (Fig. 27). The list view mode allows searching and viewing only notes; by selected author(s), in temporal or alphabetical order, or through a semantic search. When the prototype Mneme is running on the computer, the notes appear on top of the previews and on top of the open applications and the user can write into them. However, the prototype application does not recognize the part of the screen where the other application is open (this would require an image analysis algorithm, as explained in the section 7.3 and, therefore the prototype positions the notes sometimes outside of the open file. However, for the testing purposes the feature functions sufficiently.



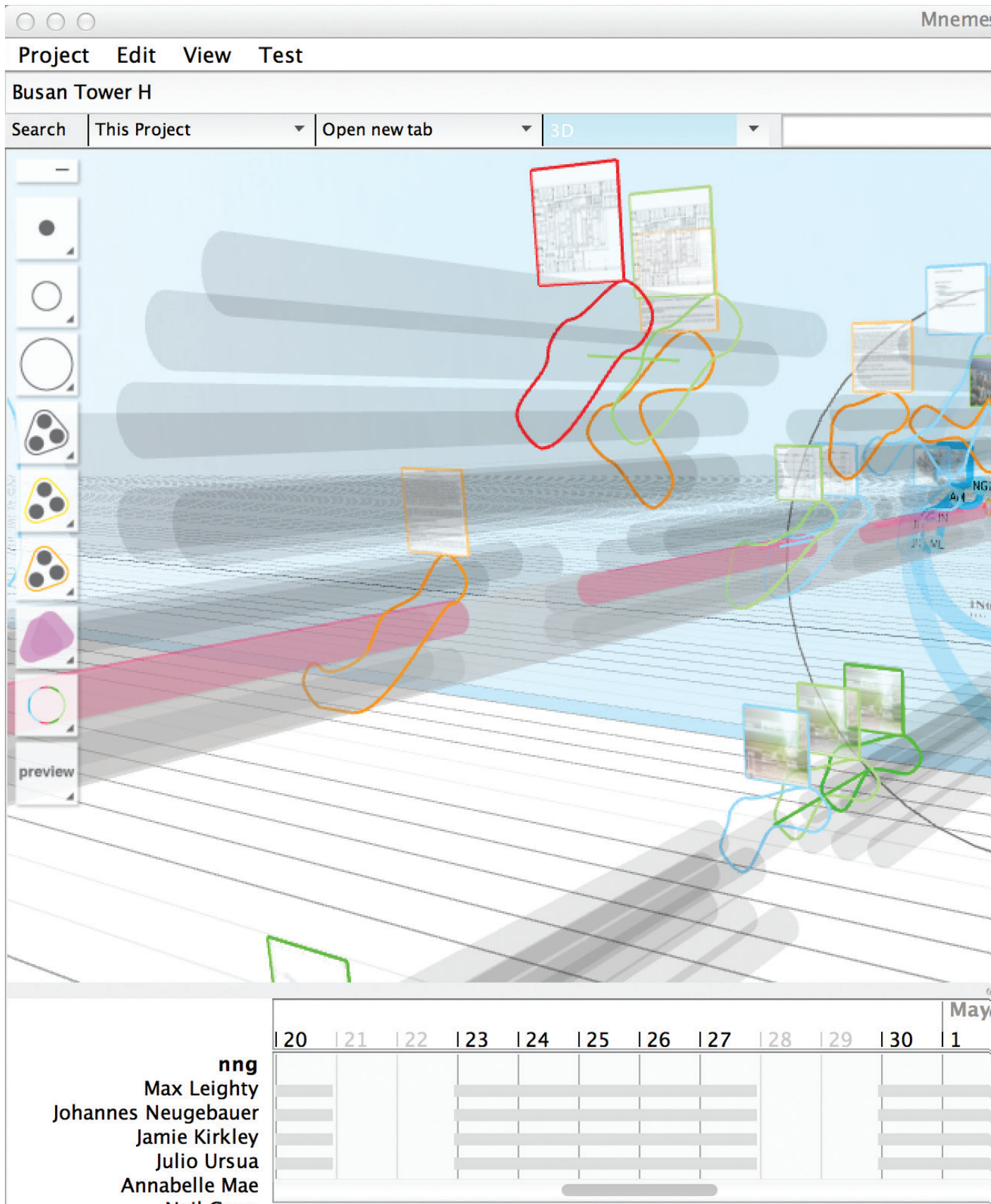
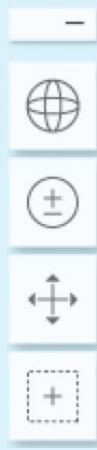
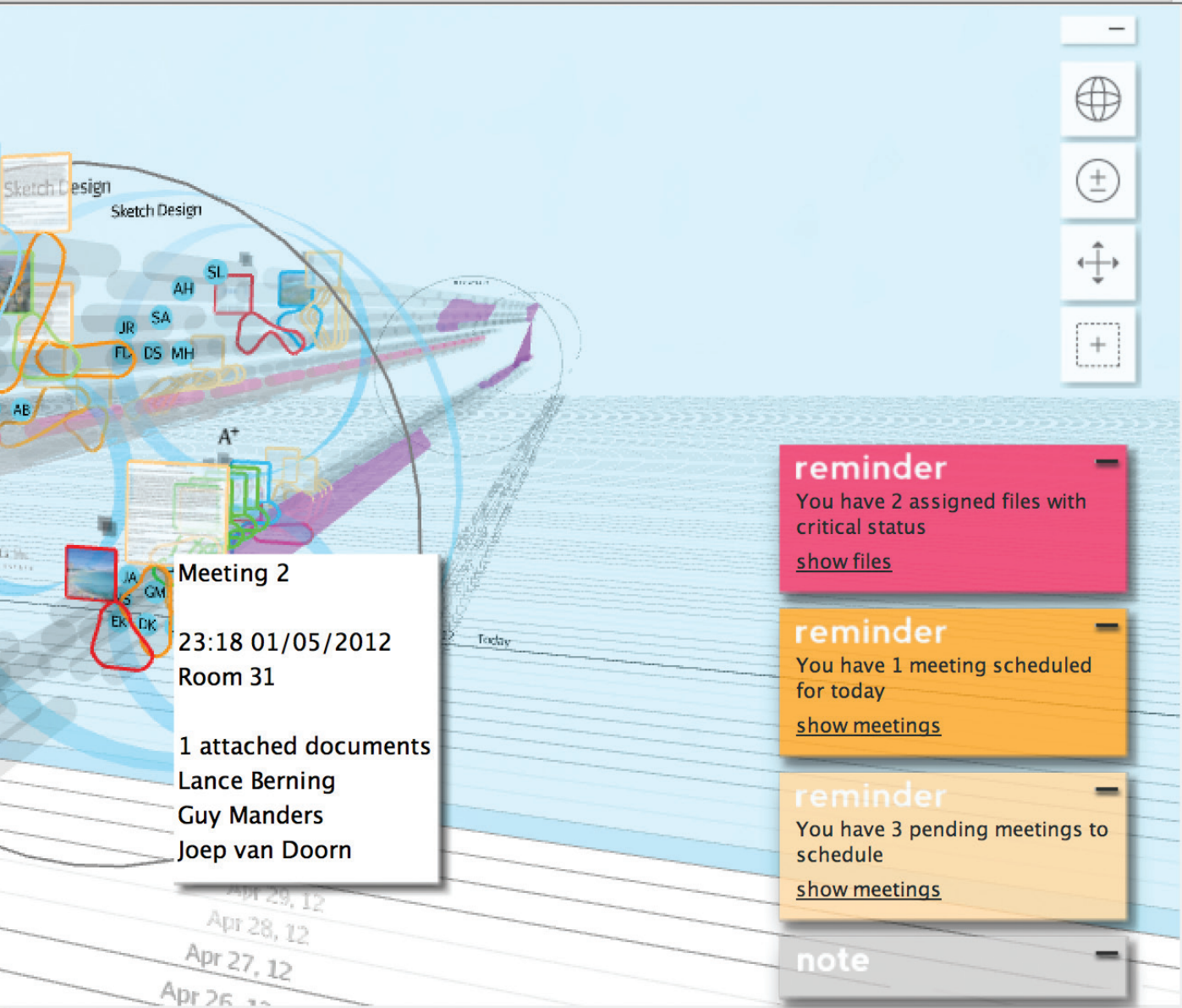


Figure 23. Screenshot showing the whole 3D interface: Tabs and search 'box' on the top of the interface, objects buttons on the left, 3D navigation buttons on the right and selection of the visible area at the bottom.





**Meeting 2**  
 23:18 01/05/2012  
 Room 31  
 1 attached documents  
 Lance Berning  
 Guy Manders  
 Joep van Doorn

**reminder**  
 You have 2 assigned files with critical status  
[show files](#)

**reminder**  
 You have 1 meeting scheduled for today  
[show meetings](#)

**reminder**  
 You have 3 pending meetings to schedule  
[show meetings](#)

**note**

Apr 29, 12  
 Apr 28, 12  
 Apr 27, 12  
 Apr 26, 12

12	13	14	15	16	17	18	19	10	11	12	13	14	15	16	17

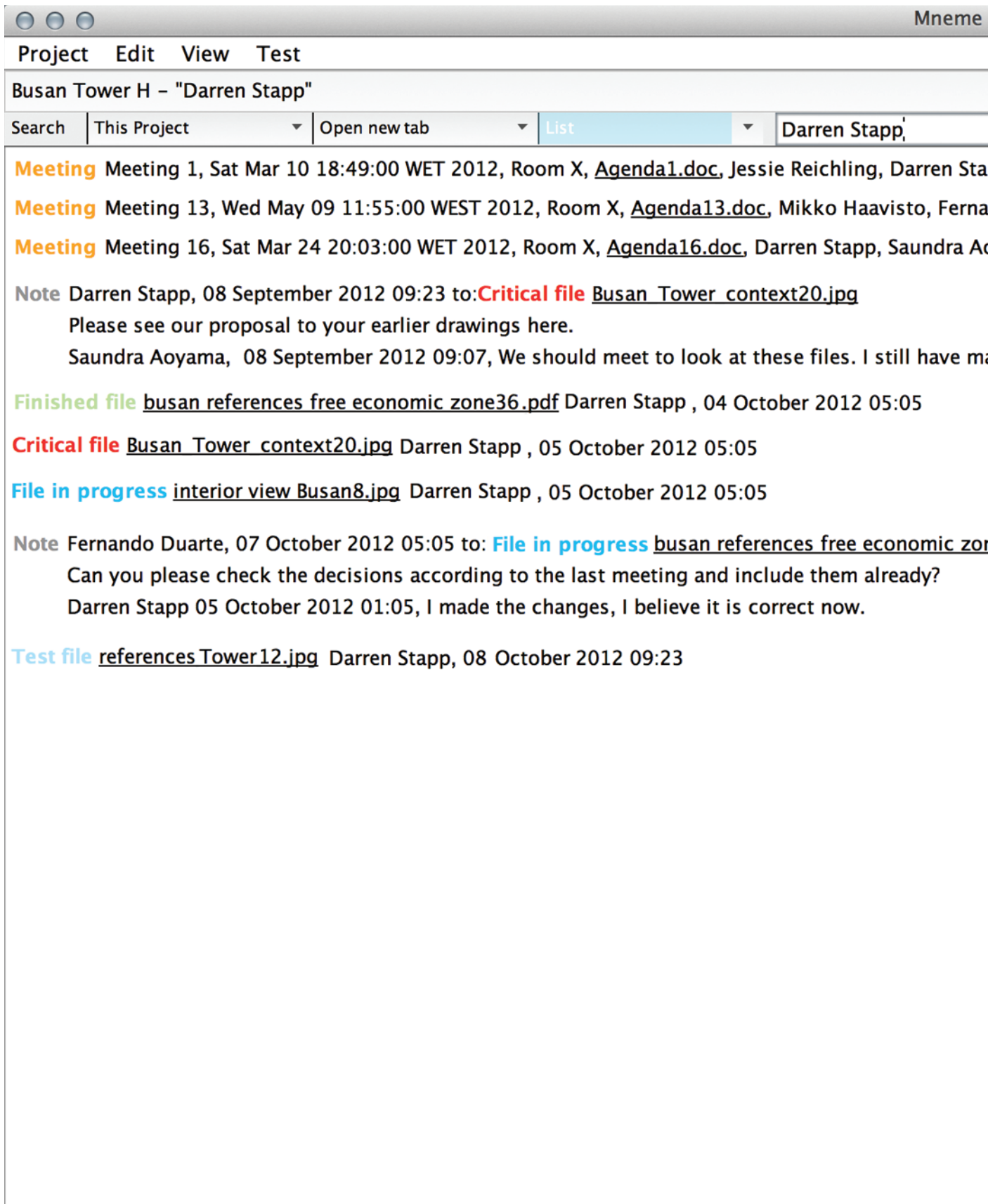


Figure 24. Screenshot showing the list view. In this case information related to a specific person.



e

Stapp, Audrey Hillery

Mano Duarte, Darren Stapp

Aoyama, Sonya Lablanc

many comments.

one36.pdf

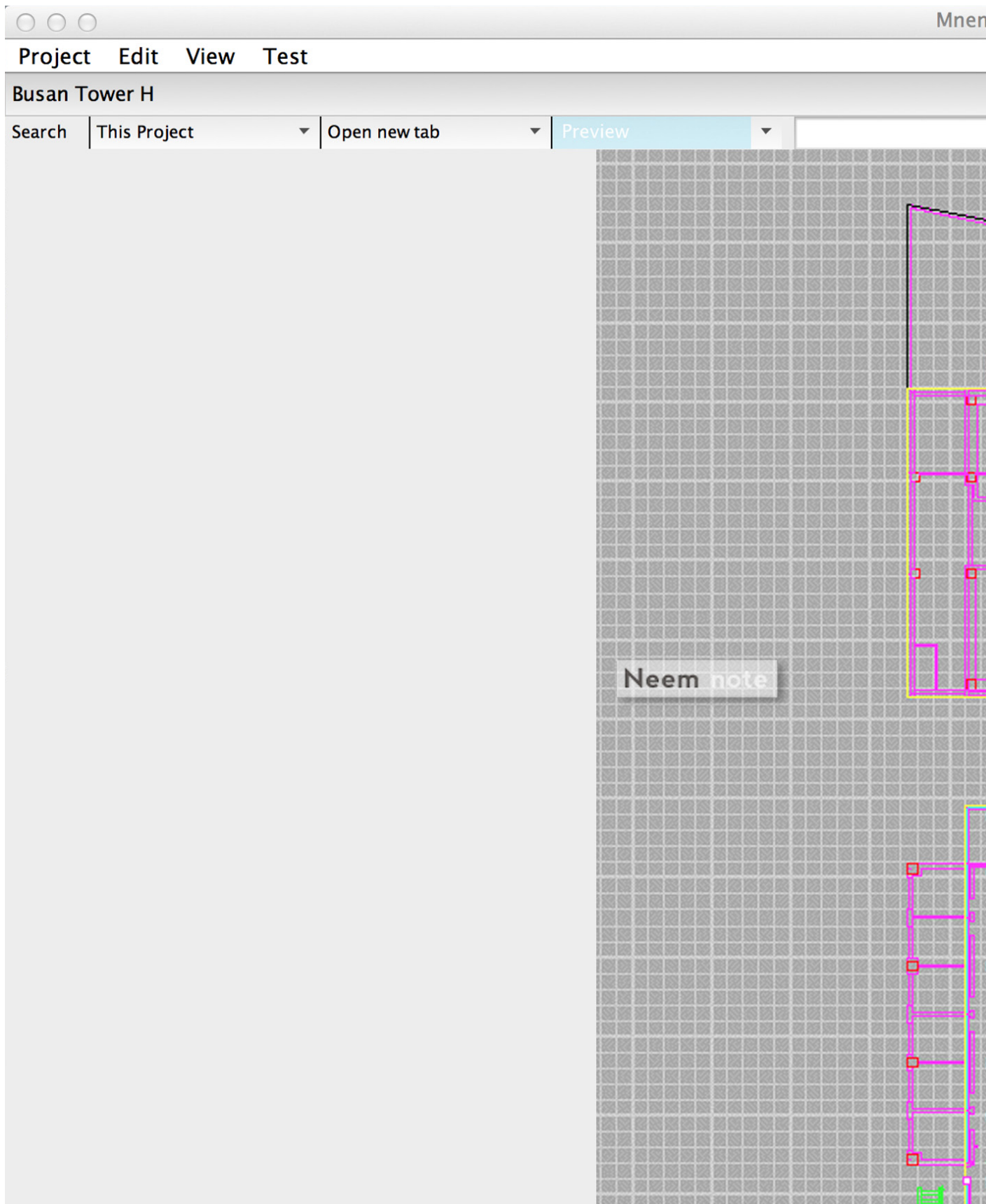


Figure 25. Screenshot showing the preview view. In this case an image file.

### Neem note

Isabel Andy  
05 September 2012 10:15

**Critical**  
Could the team make changes according to the meeting on the 02 September, as discussed?

John Reichling  
05 September 2012 12:10

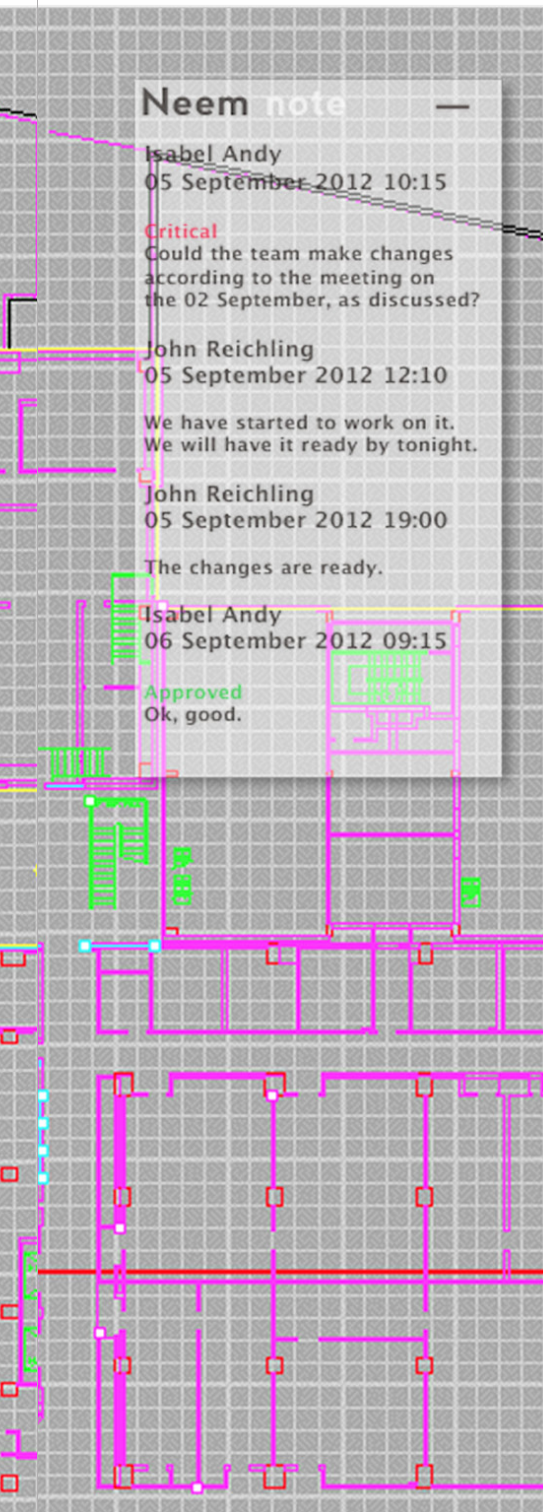
We have started to work on it. We will have it ready by tonight.

John Reichling  
05 September 2012 19:00

The changes are ready.

Isabel Andy  
06 September 2012 09:15

**Approved**  
Ok, good.



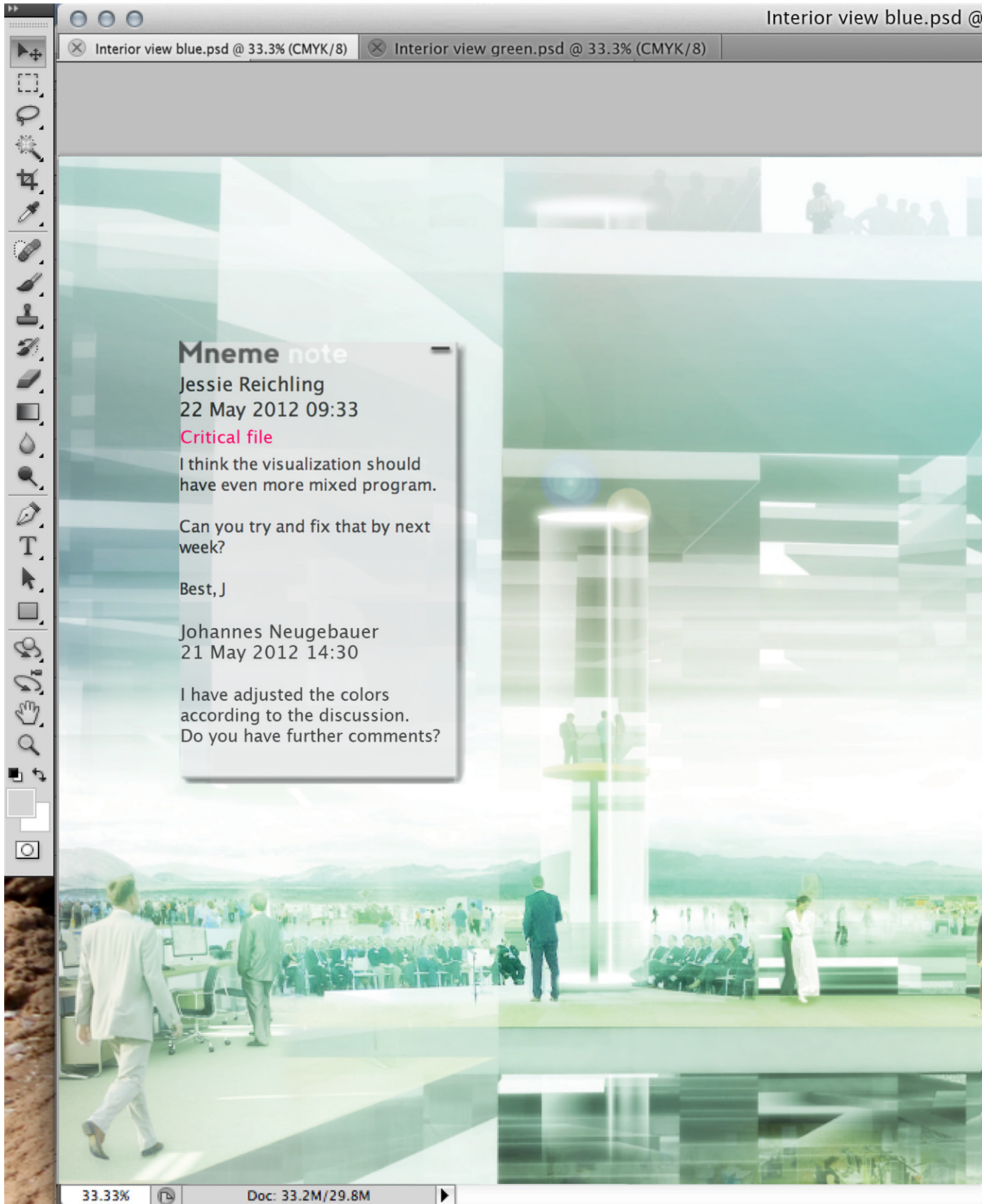
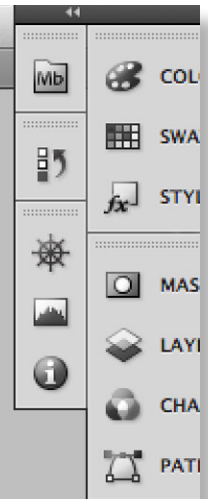


Figure 26. Screenshot from Photoshop, showing the Mneme notes on top of an image.





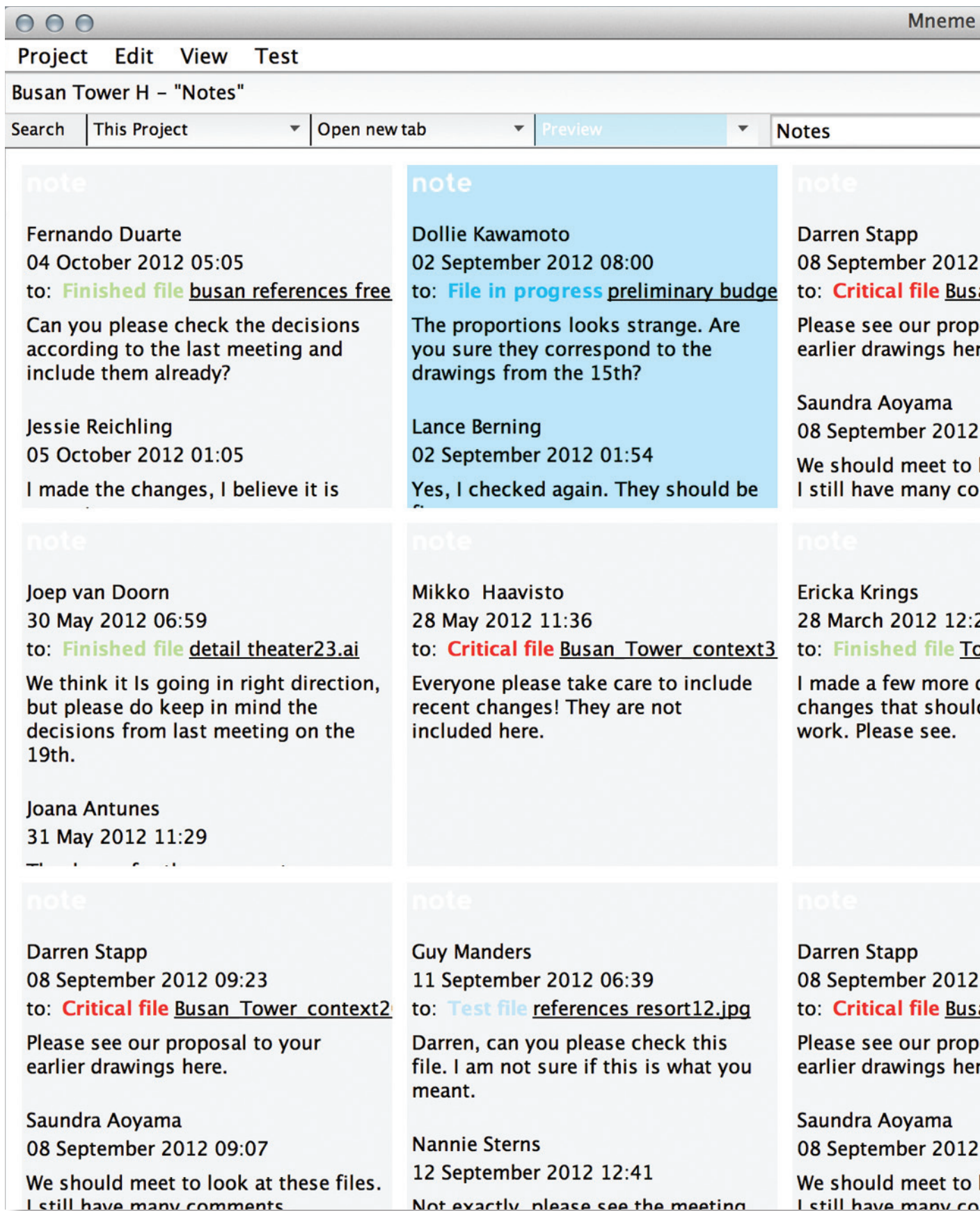


Figure 27. Screenshot showing the preview option of seeing only the notes.

<p>2 09:23  <u>Busan Tower context2</u>  proposal to your  ere.</p>	<p><b>note</b>  Guy Manders  11 September 2012 06:39  to: <b>Test file</b> <u>references resort12.jpg</u>  Darren, can you please check this  file. I am not sure if this is what you  meant.</p>	<p><b>note</b>  Audrey Hillery  17 June 2012 08:29  to: <b>Critical file</b> <u>Busan Tower context</u>  We should meet to look at these files.  I have many comments.</p>
<p>2 09:07  ) look at these files.  omments.</p>	<p>Nannie Sterns  12 September 2012 12:41  Not exactly, please see the meeting</p>	
<p>:24  <u>Towe H-early-sketch</u>  design related  ld not affect your</p>	<p><b>note</b>  Jessie Reichling  22 May 2012 09:33  to: <b>File in progress</b> <u>interior view Busa</u>  I believe there might be a budget  issue.</p>	<p><b>note</b>  Ericka Krings  28 March 2012 12:24  to: <b>Finished file</b> <u>Towe H-early-sketch</u>  I made a few more design related  changes that should not affect your  work. Please see.</p>
<p>2 09:23  <u>Busan Tower context2</u>  proposal to your  ere.</p> <p>2 09:07  ) look at these files.  omments</p>	<p><b>note</b>  Guy Manders  11 September 2012 06:39  to: <b>Test file</b> <u>references resort12.jpg</u>  Darren, can you please check this  file. I am not sure if this is what you  meant.</p> <p>Nannie Sterns  12 September 2012 12:41  Not exactly, please see the meeting</p>	<p><b>note</b>  Darren Stapp  08 September 2012 09:23  to: <b>Critical file</b> <u>Busan Tower</u>  Please see our proposal to your  earlier drawings here.</p> <p>Sandra Aoyama  08 September 2012 09:07  We should meet to look at these files.  I still have many comments</p>



## 6.7 Description *Neem note* – communication application

This section describes the separate communication application proposal.

Since *Neem note* is a simpler and smaller proposal, its name utilizes the simpler more phonetic spelling of *Mneme* [pronounced ni:m] (Fig. 28).

In addition to the prototype testing with architects, a number of informal communications with architects and designers from different areas indicated that the communication feature designed for *Mneme* would be promising also as a separate application and therefore, *Neem note* is proposed. It could be used for communication also in smaller projects, and for different types of project-based work. An additional reason to propose the communication feature as a separate application is that it is more feasible to investigate its implementation possibilities, since it is a much smaller and simpler application.

*Neem note* is proposed to contain all of the same functions as the notes feature in *Mneme*, allowing communication on any file type connected to, and searchable from a database.

For the application to work the users in a project need to appoint a shared database to be used by *Neem note*, such as Dropbox or ftp server. Creating a new note and responding to an existing one can be done the same way as explained in the previous section. *Neem note* reminds the users in a project of a new note the same way as with *Mneme*. However, *Neem note* is planned to work with list and preview views and does not have a 3D view.

The implementation possibilities and challenges of *Neem note* were investigated, and are explained in the section 7.3.

# Neemnote®

Figure 28. *Neem note* software application registered trademark

## 6.8 Testing the interactive prototype of *Mneme* and results

After the intense design and programming efforts we had an interactive prototype of the software and I was able to proceed to testing it with architects. Four architects tested the prototype: two female (FI/CN, TW/NL) and two male (DE/NL, P). In the beginning of each interview the architects received a short demo and instructions of the main features of the tool: the overall interface (buttons and the different views), how to create a new project, how to navigate an existing project in the 3D interface, how to search for information, what is included in the files, and how to communicate using the notes feature. After, the architects were requested to perform tasks related to these main functions of the tool. In the case they were unable to proceed, due to a program error, or other problem, instructions and help were provided.



To evaluate the prototype and the proposal the architects answered both quantitative and qualitative questions. The architects evaluated the tasks on five point Likert scale as well as by elaborating freely. Since it was not possible to test the prototype in real projects, they were requested to think how this tool might compare to the current practice and to the tools they currently use. The interviews were recorded by using software called Screenflick that captures both sound and the screen interactions. The audio was transcribed while taking note what the architects were doing with the software. All of the interviews took a slightly different course, due to the architects sometimes performing tasks in a different order, or asking questions about a function unrelated to the current task. Each interview contained more discussion about the prototype than expected, but that provided rich qualitative information. In all interviews the essential questions were answered, although some questions were skipped, mostly due to the fact that the interviews took a long time and not everything could be covered. In particular the architect number three had limited time for the interview and thus could not respond to all of the questions.

The transcribed interviews were first coded with, what could be called, a mixed approach of In Vivo and Descriptive Coding (Saldaña 2009, 70-74). It seemed necessary to both, take note of some direct quotes, and compress long explanations into useful descriptions. In the second cycle of coding these quotes and descriptions were categorized by the feature/function of the software they were related to and by themes that arose in the interviews. These categories are described in the following paragraphs (many smaller remarks are omitted due to the extensiveness of the interviews). To look at the “*evaluative diversity*” (Karapanos 2010, 174) a diagram with positive, neutral and negative comparison of some attributes and direct quotes the architects used in the interviews was created Fig. 30. Figure 29 presents the Likert scale rating from the interviews. It gives a general direction of the architects’ opinion on the proposal, although not all questions were answered by all of the architects.

### **Summaries of the interviews**

(the architects are identified with the same number as in the Annex)

#### **File representation:**

The file statuses were seen as very helpful. However, the shape visualizing who made the file was seen as less important than seeing which party made the file. The same comment was made by two of the architects. Two of the architects also requested to separate internal and external files. The architect 2 requested that the official submissions should have a file category and that file previews should be bigger in the visualization.

#### **Search through different strategies:**

Compared to current way of searching information in the projects, the strategies proposed by the tool were seen as much better. The architect 2 in particular appreciated that content would be organized more automatically, without having to enforce discipline in the naming of the files and folders. The architect 3 pointed out that the possibility to use different associations to find content (temporal, by a person, by status of file, by keywords) was seen as very helpful.

**Notes:**

The communication feature received a very positive response from all of the architects. It was seen as enabling a way of working that is currently not possible, such as, as eliminating extra work required to make pdfs and comment on them and eliminating e-mail attachments. To improve the feature the architect 1 requested a drawing feature to point to a specific part of an image. Two of the architects were also wondering about the necessity of having different visibility levels (although they appreciated the increased transparency of projects), one suggested: personal, internal and everybody. When the issue came up in the other interview, I suggested these three categories and the architect confirmed they might be appropriate.

**Large amount of information:**

A concern that was raised by architects 1 and 2, especially emphasized by the architect 2, who had recently finished a very large project, was related to the large amount of information in projects. The most important remarks in this regard were: *"I would only be worried about the visibility of information when it (the project) gets really complicated."* *"It would be really a trouble to find the information. In one year you have maybe a thousand files."* Both of the architects suggested somehow *"packaging"* for example the official submissions, which can contain hundreds of files. Both of the architects saw this scalability of the proposal and visualization as potentially the biggest problem.

**Visualization:**

The positive comments on the visualization were related to the better overview it provides. The architect 1 commented that the *"3D tube is revealing"*, identifying areas of big production and critical phases, and continued that the *"visual fits very well the projects"* he had in mind. The architect 4 stated that the proposal gives an overview of all of the information, which currently is unattainable. She added that the visualization looks like a *"big machine"*, but that it is a positive thing because it shows the *"complexity"* of the projects. The architect 2 stated that it is nice to see the timeline and that it is 'easier' to see the project in 3D. She added that at the time her office was trying to assemble a project history of a very large project and said it was 'horrible'. She stated that with the proposal it would have been as easy as snapping your fingers.

The negative comments on the visualization were very diverse. The architect 2 stated that it *"could have more richness"*. The architect 1 commented that the *"lines suggest endlessness"* and he wanted the projects to feel *"limited"* and *"under control"*. He also said it was *"not completely intuitive"* and anticipated it would be difficult for people not using it all the time. The architect 4 said that it would take time to learn, like *"switching from a PC to Mac"*.

**Requests:**

The requests of what should be added to the proposal are here explained in one category, as they are quite diverse. The architect 3 was concerned about how information from people related to the project, but not using the software could be integrated. The architect 1 commented that it would be useful to see several projects parallel. The architect 2 wanted the proposal to include budgets/money and percentage of time how much people are

participating. There were also different customizability suggestions, such as, to categorize information based on the part of the building.

**Insights:**

Three insights in particular seem worth mentioning here. The architect 2 realized *“ah, you cannot edit the history. It is like a legal report in that sense”* - which would be useful in projects. She also said *“it is like a project tomography, that is very cool”*. The architect 1 said *“you can recognize the belly (busy) phase of a project”*.

**The biggest benefits outlined in the end of the interviews:**

For the architect 1 the biggest benefits were the *“organization”* of the files (they are findable), the *“transparency of projects”* (which could make people more organized). For the architect 2 the biggest benefits were that the tool would help to learn about projects and familiarize oneself when joining a project and that the notes would enable communicating about files in a *“different way, regardless of the file format”*.

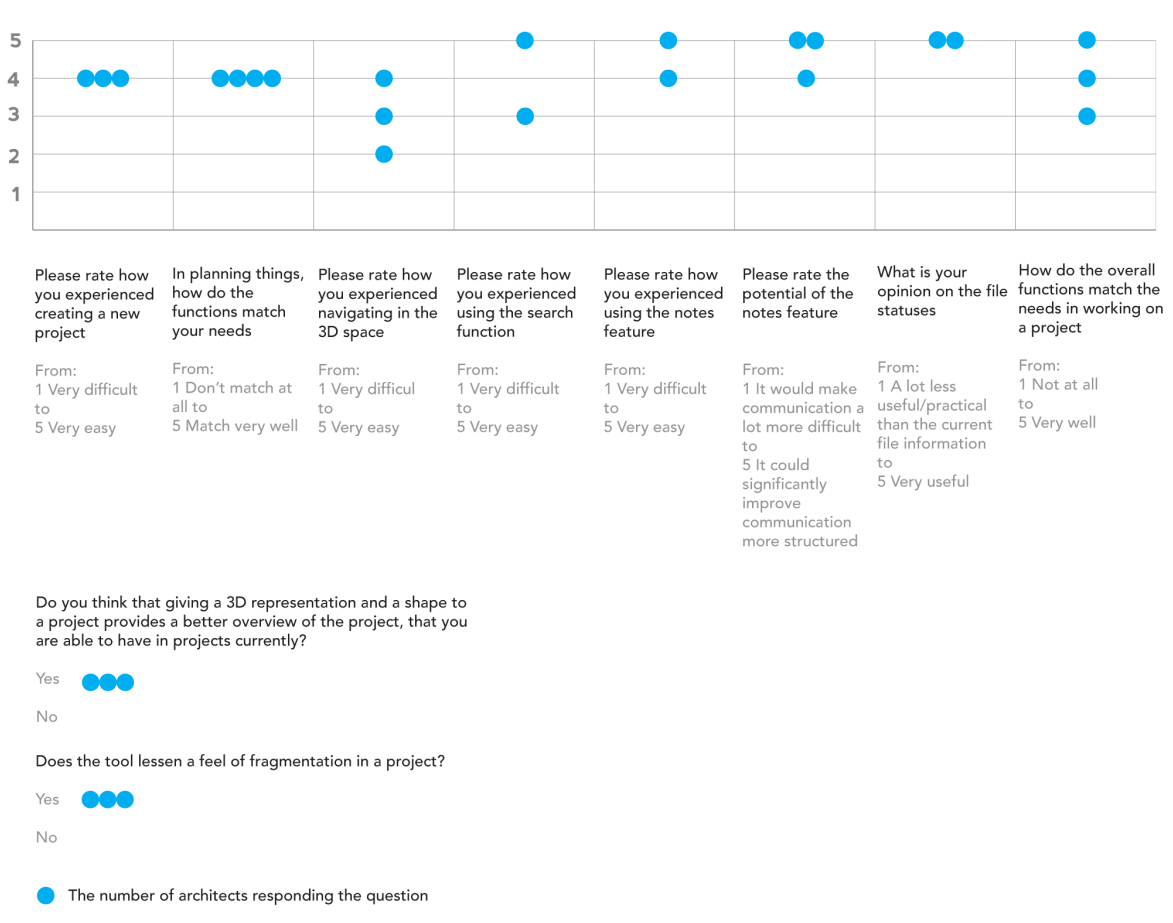


Figure 29. Answers for the quantitative questions in Likert scale

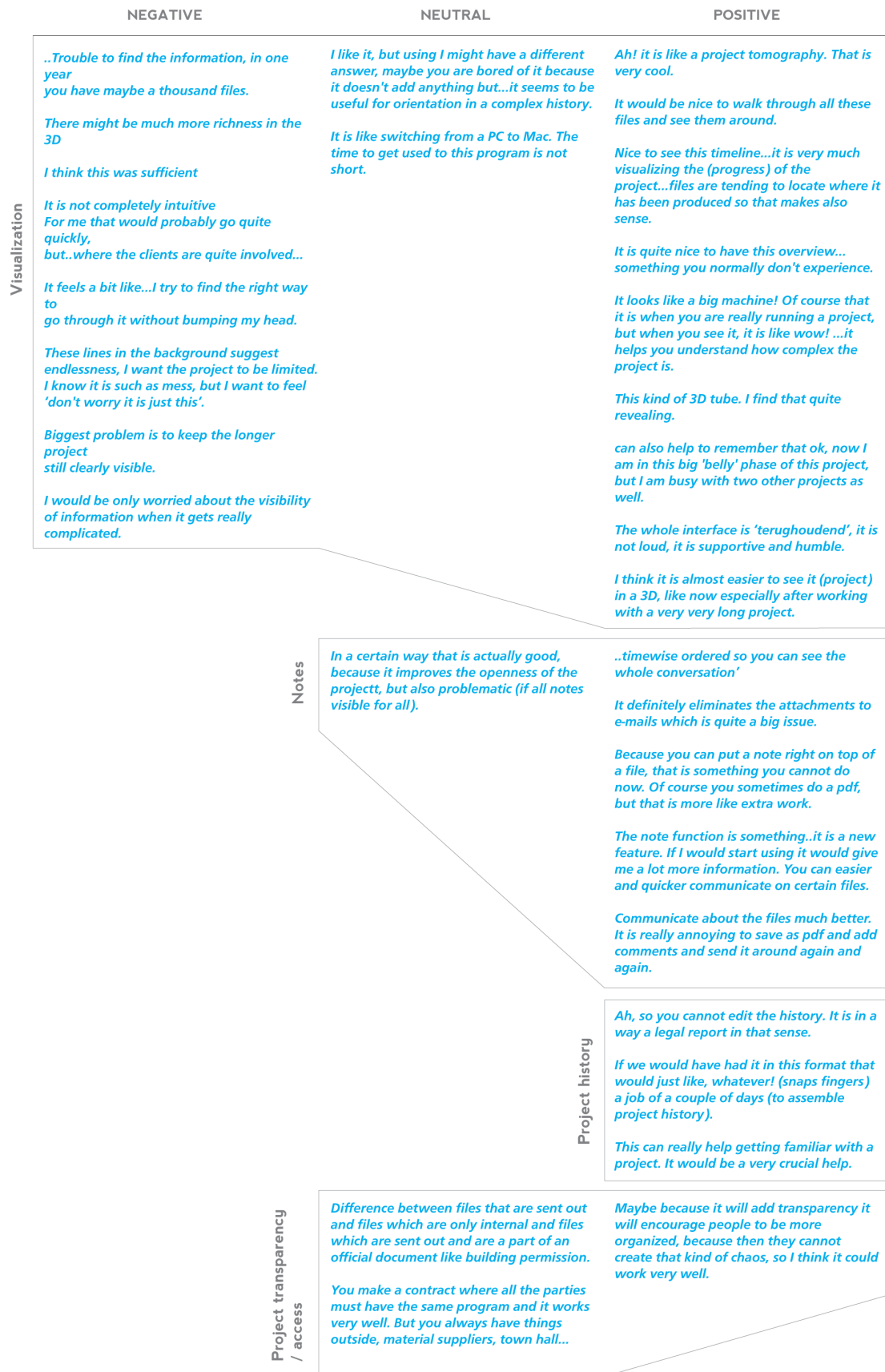


Figure 30. Direct quotes from the user testing

## Conclusions of chapter 6

This chapter has described the interview and design process in detail, and the approaches methods and techniques used in the process. The methods are described in detail in the section 2.3, however, to outline the most significant ones: Firstly the overall approach is user-centric with interview approach that can be describes as action research, appropriate to act both as a researcher and designer and to collaborate with the interview subjects. Secondly, the overall interest in this thesis was to investigate the specificity of the architecture process, from the perspective of the architects. Therefore, the methods of working reflected that interest; from the interviews with cards, to a paper prototype enhanced with transparent paper allowing sketching.

Already based on the first interviews it was evident that the majority of the challenges outlined by the interviewed architects and designers were related to information and knowledge management, communication, and social issues - confirming the gap left by the artefact and techno-centricity of the research, discussed in the Part II of the thesis. Thus, it seemed consistent to propose an (digital) information management and communication tool and investigate its specific functions and features deriving from the architecture practice. The tool proposes a visualization interface, utilizing visualizations potential to facilitate comprehension of complex information and architects proficiency to deal with visual information. Further, intrigued by the possibility of diversity of perception as discussed in the section 4.4, the 3D visualization experiments with the notion that perhaps architects would be more apt to interacting with it, due to their ability to think spatially.

Through interview and design cycle, the proposed concept was affirmed and the proposal refined. Owing to an intense seven month collaboration with a software programmer an interactive testable prototype of the tool was achieved. Due to the tension between the feasible and the 'ideal' prototype many aspects could not be fully investigated or implemented. However, the prototype enabled testing with architects. Overall, creating the simplified prototype while emphasizing the potential of the more complete vision of the tool, enabled to reveal interesting findings and fulfil the objectives set for the Part III of the thesis.



## 7

# SYNTHESIS OF FINDINGS AND DISCUSSION OF THE PROTOTYPES

This chapter presents a synthesis of findings of the *Mneme* prototype, based on the interviews and the prototype testing. The findings are presented based on the main objectives of this research and more specifically based on the main challenges the proposal aimed to address, namely: the lack of project overview; fragmentation of project related information and the resulting difficulties in access, retrieval and use of the information; and difficulties in communicating about heterogeneous information, mainly visual content. In addition to analysing the results in regard to these main problems, emphasis is placed also on the visualization interface.

The synthesis combines parts of the exploratory interviews, and later findings revealed in the interviews and the prototype testing. All of the interviews used an interpretative analysis, informed by the approach of and objectives of a designer (Berg 1989, 266). In addition the later interviews were analysed with a combination of In Vivo and Descriptive Coding (Saldaña 2009, 70-74). This chapter will also present an analysis of the implementation possibilities and challenges for both *Mneme* and *Neem note*.

### 7.1 Synthesis of findings and the prototype testing

How does the discussion in the section 4.4 related to challenging the traditional notions of usability in HCI and complementing them with improved understanding of subjective experiences, such as the importance of beauty or appealingness, affect the interviews and testing of the prototype and their analysis in this research? During the interviews and the prototype testing the questions and the discussion attempted to address both the usability of the proposal and its appealingness. Overall the proposal was received positively, in particular regarding its usability and appropriateness of its functions. When asked directly about the appealingness of the visualization the opinions diverged. However, during the interviews the people who responded more negatively to its appealingness when asked directly also made other positive statements about the visualization during other questions. Thus, it would be tempting to say that the proposal was perceived both as appealing and functional, but it is probably more appropriate to state that the direction of the visualization and the proposed functions is promising. However, further improvement would be needed for both aspects of the proposal. Although specific methods to understand the perceptual judgements of the interviewed people, such as the ones presented and proposed for instance by Karapanos (Karapanos 2010) were not used, the Figure 30. presented in the previous chapter, collects some of the direct quotes and attributes from the interviews, and distinguishes between the negative, neutral, and positive comments.

The notion about diversity in user experience, extending even to perceptual judgements also discussed in the section 4.4, is very relevant for this research when analysing the response of the architects to the 3D visualization. As discussed in the section 4.8, the field of Information Visualization bases its guidelines on general human perception, not on perception of beauty, or other subjective judgements. Thus, information visualization strongly discourages the use of 3D visualizations, especially for abstract data. However, all of the architects interviewed for this research expressed rather liking, or even preferring, the 3D visualization. Also in other informal (although recorded) communications product designers responded very positively to the 3D visualization. These notions together indicate strong reasons to consider and investigate the use of visualizations, even 3D, in software applications for architects and designers.

In the prototype testing the architects expressed experiencing greater overview of the projects than they currently do. The 'form' of the project, the visualization interface, seemed to contribute to that to a great extent. The results from the interviews and testing seem to indicate that a system gathering together heterogeneous project information and providing a visual overview of that information could be a useful tool in an architectural design practice. Based on the research utilizing a visualization as an interface for a software application for architecture or design has not been done before (except for some small experiments as discussed in the section 4.8) and thus presents a novel approach.

The issue of fragmentation of information is related to the lack of overview, but with the added challenges of being able to search, access and communicate about the information. Based on the interviews and the prototype testing the architects seemed to experience less fragmentation of information. They reported improvements related to the tool facilitating getting familiar with a project, finding information, and providing a project history during and after a project. The variety of search strategies and functions of the proposal, such as providing file statuses and full screen previews, seem to provide novel and promising directions to continue investigating features for an information management tool for architecture. Therefore, it does appear that tools for information management designed for the architecture process could benefit from collecting all of the heterogeneous information and providing more specific, yet customizable, ways to search, organize and communicate about the information.

The communication feature received a positive response from the architects. Although the sample size was small, here the unanimity of the opinions, and in addition a number of informal communications with designers and architects, suggests the feature has strong potential. The results suggest that it would make communication about heterogeneous content easier, more efficient, and retraceable. Some proposals exist that share aspects of the communication feature as discussed in the section 4.7.2. However, the novel aspects of the feature are related to the architects' specific needs. A particular file is commonly commented and discussed upon by several people over a long period of time. In the case of file requiring long discussions 'hand written' notes, as in Digital Ink proposals, are not sufficient. It is also necessary that using the feature is not limited to one input device. Other specific contributions are the ability to see and manage the criticality of the files and a



flexible way to search the notes (without categorization). The further improvement of this feature would include investigating the different visibility levels (and their customizability) of the notes, and including functions that allow pointing to and marking specific parts of a file.

## **7.2 Implementation possibilities and challenges of *Mneme***

The 'real' implementation of *Mneme* has not been investigated to as much detail as of *Neem note*, since *Mneme* is still an early prototype and would require further research and improvements before deeply analysing the real implementation. However it is relevant to collect and emphasize some of the findings for further research. These findings are related to both further research/design and programming of *Mneme*.

The challenges in implementation revealed during this research are related to namely: customizability/end user development, scalability of the visualization interface, security, integration of other applications and (other in particular more peripheral) parties and people.

The first challenge, related to customizability/end user development, has already been briefly addressed in this research. In order for the application to suit the dynamic architecture practice, the appropriate level of customizability would need to be investigated and implemented. According to the programmer who implemented the prototype, Machado, customizability would be the biggest challenge of the real implementation. The more customizability is enabled, the more challenging it would be to assure a stable and error free application. However, based on discussion with Hovestadt at ETH Zurich (Annex 4) and the research during this thesis, customizability is a necessity for the application to suit different approaches, offices and projects, while retaining compatibility between the different versions. According to Hovestadt and a software programmer from Autodesk Research (during informal communication) this is feasible, but difficult, to achieve.

The second challenge, scalability of the visualization interface, became an evident design related issue in the interviews regarding big architecture projects. The amount of information in big architecture projects exceeds what was possible to experiment with and implement in the 'dummy' project of the prototype. One approach to improve the visualization could be to firstly simulate a big project by using real project data in the prototype, make improvements based on the findings, and finally test the improved prototype in real projects. This approach could also be used to reveal some of the needs regarding the customizability of the application.

The third point, brought up by Machado, and also raised by one of the interviewed architects, is security. As *Mneme* is proposed to work as a cloud application ensuring the security of the communications and the files would be one of the important concerns in real implementation.

The fourth challenge revealed in the course of this research is related to the integration of *Mneme* with other applications and other, in particular more peripheral, parties and people. Although investigating this aspect was not part of the focus of this research, it is relevant to mention it regarding further research. *Mneme*, would have to integrate with the existing practices and tools used in the architecture process. Firstly It would have to be investigated which tools used in architecture process would need to be linked to, and how, with the proposed application. Secondly, the proposal is demonstrated to present potential regarding its use by architects, however, further research would be needed to investigate how other parties and people would access the system and how the proposal could be improved to fit the overall social system of the architecture process.

### **7.3 Implementation possibilities and challenges of *Neem note* (and of the communication feature in *Mneme*)**

In order to understand the implementation possibilities and challenges of the *Neem note* application (and at the same time the communication feature in *Mneme*) another programmer was consulted with [7]. This section describes his analysis of the programming feasibility of the proposal and three implementation options.

The first implementation option would be to create a plug-in for each software application in order for *Neem note* to see what they are doing when they are open. This is an extremely time consuming solution, since each application needs a custom plug-in. Also the governing idea that the *Neem note* works with any application is not fulfilled as it is not feasible to create plug-ins for all applications and situations and keep them up-dated to a satisfying level. The second is the currently most feasible option, but prone to errors. In this option the *Neem note* is programmed to make screenshots of all open applications and to observe what they are doing by analysing the images. The proposal, *ScreenCrayons*, by Olsen et al also uses this approach (Olsen et al. 2004). This is a better solution than the first, as it is generic. However, it is heavy for the CPU and hard to implement, since all image analysis algorithms are very difficult to create and can fail. It also presents other possible problems: it cannot distinguish positions when it comes to repetitive patterns; and if a user changes a file without having *Neem note* open, the application cannot recognize what has happened. According to the programmer all of the problems have possible 'workarounds', but they may not be reliable enough to make sure the users do not experience problems. Third option would be the best of the three, but currently not feasible. The operating systems would enforce the software applications to report what they are doing at which time and *Neem note* could then simply use this information for its communication portal. Currently there is no need for operating systems to request this type of information from applications.

At the moment it seems difficult and time consuming, but possible to implement the *Neem note* application by using the second approach.

[7] Michael Marti

## 7.4 Conclusions of chapter 7

This chapter has presented a synthesis of findings of the *Mneme* proposal, based on the various interviews conducted in the course of this research, and the prototype testing. This chapter has also described the implementation possibilities and challenges of both *Mneme* and *Neem note*.

The synthesis was constructed based on the main objectives of this research and more specifically by presenting findings related to the main challenges the proposal aimed to address, namely: the lack of project overview; fragmentation of project related information and the resulting difficulties in access, retrieval and use of the information; and difficulties in communicating about heterogeneous information, mainly visual content. Certain emphasis was also placed on the potential of the visualization interface. It can be concluded that *Mneme* proposal and the 3D visualization interface present potential to improve the overview of the architecture process and of the associated information. The visualization can also be said to provide a promising direction to represent the architecture process appropriately. However, the opinions of the interviewed architects diverged when asked directly about the appealingness of the visualization. The interviews and the prototype testing also seem to indicate that *Mneme* lessens the fragmentation of information by converging the access to the project information through one application, and by providing a variety of search and organization strategies derived from the architecture practice. There also appears to be evidence that the communication feature in *Mneme*, and the separate *Neem note* application, present strong potential to make communication about heterogeneous, mainly visual, content more appropriate to the architecture practice, as well as easier, more efficient, and retraceable.

While the synthesis discussed the potential of the proposals, the following two sections focused on the implementation. The analysis of *Mneme* was focused on the challenges, possibilities, and concerns regarding the necessary further research, design and programming efforts. The analysis was based on findings during this research as well as input from two software programmers and interview with Hovestadt (Annex 4). The aspects of *Mneme* requiring most further research are: customizability/end user development, scalability of the visualization interface, security, integration of other applications and (other in particular more peripheral) parties and people. The biggest challenge appears to be to implement appropriate levels of customizability while retaining compatibility of the resulting different versions. However, according to Hovestadt and a programmer from Autodesk Research during information communications this is difficult, but possible, to implement.

The analysis of the *Neem note* was more focused on the programming feasibility and the different implementation options investigated by a third programmer Marti. It can be concluded that the second implementation option to use image analysis algorithms is currently the most appropriate and feasible. On the negative side, the option is difficult to implement and might result in some problems affecting the users. On the positive side the option is generic and would provide a way to achieve the proposed functions and features.



### 8.1 Contributions of this thesis

The contributions are explained as pertaining to the objectives of this research and to the design inclusive methodology: to improve understanding, in this case of the architecture process; and introducing novel concepts, in this case of a software application with improved more domain specific solutions compared to existing systems and tools (Horvath 2008, 17-18). The empirical work supported and substantiated by the literature review has enabled the introduction of novel strategies, approaches, and techniques to facilitating the architecture process and have demonstrated potential directions for future research.

Related to the improved understanding of the architecture process this thesis has recognized that current research is highly artefact and techno-centric (Deamer 2010, 19; Holzer 2011, 465; Otter and Emmit 2008, 121; Rekola 2010, 265), which has resulted in several oversights in systems and tools. This lack of focus on other issues manifested itself also in the practitioner interviews; majority of the challenges described by the designers and architects were related to the overall information and knowledge management, communication, and social issues. Therefore, this thesis has proposed a process-centric understanding of architecture and focused on investigating it as a social and informational system. It appears that the bigger the project, the bigger the challenges, and more distributed creation and execution. This demands in particular improved digital support considering the overall process and a horizontal approach to the systems and tools. Of the issues revealed in the interviews this thesis has focused namely on addressing fragmented and insufficient project history and information, lack of project overview and challenges in asynchronous digital communication. These issues have been studied from the architects' perspective on the process. The thesis has introduced a software application proposal *Mneme* to facilitate these challenges.

### 8.2 Limitations of this study

Due to the ambitious nature of the objectives of this research and of the design proposal, this thesis has certain limitations. The choice to include only practicing architects with extensive experience in the study in order to understand their specific needs and abilities, meant making concessions in the amount of subjects and the interviews. Regarding the prototype, the schedule and technological limitations resulted in tension between the feasible and the 'ideal' solutions in the implementation. While the prototype was sufficient to demonstrate the validity of the concept, certain aspects and features could not be

implemented or studied: The prototype could not be tested in real project settings; the scalability of the visualization will need to be further investigated; the extent of customizability could not be investigated or implemented, which will be fundamental in the real implementation; further research will also need to include how other parties participating in the architecture process interact with the application.

### **8.3 Contributions and future development of *Mneme***

Although many information and knowledge management and communication systems exist and have been reviewed in this thesis, they seem insufficient considering the above-mentioned needs in the architecture practice. Therefore, the software proposal *Mneme* focused on these specific issues.

In order to create a usable project history and help managing information, *Mneme* introduces a novel approach to converge and provide access to the information directly and indirectly related to the artefact through a single interface. Whereas in most communication applications files are attached to discussions, in *Mneme* and *Neem note* discussions are attached to files. They respond to issues in generic applications, such as the cumbersome e-mail sequences with attachments and of the extra work required to create pdfs with un-searchable notes. In particular, the communication feature in *Mneme* and the *Neem note* differ from other proposals in that they implement architects' specific needs; to communicate about heterogeneous content directly on the files, create a record over long periods of time, keep track of the criticality of the content, and enable search and access of that content and communication.

As a possible direction to address the lack of project overview this thesis has proposed visualizations as an interface, and has evidenced their potential through interviews and user testing. It is suggested that a visualization interface will provide an improved project overview, facilitate understanding of the information and aid retrieving and accessing the information. Moreover, based on the interviews and testing the architects found the proposed visualization relevant and suitable to the process. (See also CD attached to the thesis containing the demo video of the *Mneme* prototype.)

#### **The future development of *Mneme***

The research opportunities and needs in order to create a fully functional software application entail both; further collaboration with architects and other parties, and design and programming efforts. A possible way to proceed with the development will be to start by simulating an architecture process in the software prototype using real project data. Whereas the PhD research focused on the architects' view on the process, at this stage other parties will need to be included in the development. It will need to be studied whether they have specific needs from the interface and functions, and does each party for instance have their own version of the software. Architects and representatives of the other disciplines will need to test the simulation and be interviewed in order to make improvements for the design and better understand the programming requirements. Once the design is improved significant amount of programming and design efforts will

need to be allocated in creating the actual software, including the required levels of customizability. The fully functional tool will need to be tested in real projects, and design and programming adjusted to fit the problems arising from using the tool in practice.

### **The contributions of *Mneme* for other domains**

This research has recognized and utilized the potential offered by visualizations for the problems of information management in the architecture process. The visualization interface was developed specifically for the domain of architecture, mainly for three reasons: Their recognized effectiveness to provide an overview and rapid comprehension of complex information, architects' proficiency with visual information and visualizations, and architects emphasis on the appealingness on visual information and visualizations. Compared to other design domains architecture was chosen as the focus domain since it deals with very complex fields of information during long periods of time, and therefore provided the most appropriate example case. Although the software proposal was developed for the architecture process, therefore deriving the functionality and visual encoding from that particular domain, several informal communications with practitioners from other design disciplines suggest the software proposal could provide potential as a basis for developing similar tools for other design domains. Furthermore, it can be hypothesized that the methodology, methods and approach used in this study to develop the software proposal may provide interesting examples for researchers in other domains dealing with project information related problems.

### **8.4 Contributions for alternative approaches in future research**

Encouraged by the criticism towards certain HCI and in particular Information Visualization methods, approaches and techniques (Barkhuus and Rode 2007; Cockton and Woolrych 2002; Dicks 2002; Greenberg and Buxton 2008) and of the importance of subjective experience and prior knowledge (Chen 2005; Hassenzahl 2004; Lau and van der Moere 2009; Lawson 2004, 7), this research has utilized and developed domain specific methods and solutions. Most importantly, this research did not apply established visualization techniques, but proposed a visualization developed through understanding the architecture process in collaboration with architects, thus differing from what is customary in the Information Visualization field. Based on the literature and the interviews, this thesis has suggested that visualizations, even 3D visualizations, may work better for designers and architects, as it is a media type with which they are familiar and includes interaction techniques with which they are proficient. It seems designers and architects also place great emphasis on the appealingness of visualizations. This expressed preference is interesting both regarding designing for this particular user group, and in general regarding the extent of subjectivity in perceptual judgements (Karapanos 2010, 174). Acknowledging these notions will open up an avenue for alternative approaches to HCI and Information Visualization, and perhaps an opportunity for designers to contribute with their specific skills and abilities to these fields in more convincing and meaningful ways.

The overall recommendation from this thesis is the need for increased domain specificity, beyond the prevailing techno-centricity of current research, and considering the overall

process including the social aspects. The user-centric view is not adequate when designing systems and tools for architecture or design practice, but needs to be supported by End User Development. On the one hand the specificity of the architectural and design knowledge and ways of working demand more specific methods and solutions, and on the other, the dynamic and diverse nature of the projects demand increased flexibility, which has to be reflected in the design of new systems and tools by creating open systems (Hovestadt 2012; Fischer and Giaccardi 2006, 433-434) allowing them to be customized to fit different approaches, scales and contexts.







Annex 1-4 and 6-7 have been edited for grammar corrections and shortened to present the relevant part of the discussions. Italic typeface and quotation marks are not used, since all text is quoted.

## **ANNEX 1**

### **Interview Ole Scheeren**

**14 April, Beijing**

**Ole Scheeren (OS)**

**Pirjo Haikola (PH)**

PH In addition to having worked on many significant buildings you also have an extensive experience in working in different countries. Which has been most significant in informing your approach, the different countries and cultures, or what you have learned about different projects and the relationship between different parties?

OS I guess both. There is certain interest that is underlying the work in general. There are things you repeat when you do projects but at the same time there is a highly specific work depending on the context. And by context I mean a number of things, the location and the client, and in a way maybe primarily the psychological environment in which projects exist.

PH You mean the social context in terms of people involved?

OS Yes. I think trying to understand what a place, a culture, the users, or the client can become. What they can do or cannot do. What things are imaginable in a particular context and are totally unimaginable in a totally different one. From the experience across the different places I have worked in you see what you can transplant, what can you bring from here to there. Whereas you also become aware that some things could never work in a particular environment. I think those two sides play an important role.

PH Would you say that you start a project by analyzing the social context?

OS Obviously as architects we have to always deal with the specific spatial programmatic context. But, yes indeed, I try to understand for example where is the client coming from, what are they trying to do with this project, what could you do with this project that is maybe beyond what is on the table so far.

I also try to understand the culture of use, or potential use of the building. If you build a theater in Taipei, you have to understand a little bit about the theater culture there. Or, if you build a residential project in Singapore you need to know how people live. What does it mean to live in the tropics? What does it mean to live in a society that is very wealthy and sort of well contained? What do these things enable? But, then obviously look very closely what are the current limitations of that environment and what hasn't it gone beyond. With those parameters present, what could you imagine as ways to go beyond the current status

quo. I think it is a synthesis of these aspects that manifest in a project.

**PH** How would you describe you go about doing this, what kind of tools do you use?

**OS** I think one tool is dialogue and another is experience, for example.

By dialogue I mean seeking detailed and profound exchange with your client and with your local architect, partners and the entire environment that you have to plug into and collaborate with. The clearer you can define that relationship from the get go as a collaborative platform the more successful it will be in the long run. It consists of very abstract levels, to contractual, and working relationships. Obviously the personal relationships are also always part of projects and there is a certain amount of exchange between individuals where you seek to generate a shared space of understanding and ambition that in ideal case guides the project.

By experience I mean basically being there and absorbing. I realize that for me it becomes increasingly very important. But, obviously as you get older, you have spent more time in more places so it is a very useful basis. Still, first you need to get to know a situation and try to unlearn a situation. You think you know so much about it, which is very dangerous because you are full of preoccupations. This means I spend as much time at the location as I can, day and night. I look around, sometimes not at all very focused on anything but simply absorb and discover what I see there. What that city is about, what people do, what is really odd, or really exiting about it. It is in a way very naive approach.

**PH** What you describe is an interesting contrast to the other ones I have interviewed. They have certain methods to analyze a place, yours is more 'experiential'.

**OS** I realize that the older I get, I can admit and have the courage to say that this actually plays an important role. When I was younger I was much more focused on the rationale and methodology and that still plays a very important role in our process and a lot of things are quite rational in a way that they are being dealt with, but I believe you need more than that. I think you need a lot more layers that guide you through the many decisions you have to make. But you need to also challenge the situation with methodological, systematic set of tools as well. I think that the co-existence of these two play a very important role for me.

**PH** You said you try to go to the location as much as possible and understand it, but how do you communicate this knowledge to the team that is working on the project? How do you express what do you see as important in the project?

**OS** It is a continuous challenge. The internal dialogue in the office and how much you manage to communicate is as important as the dialogue with the external parties. I think there is a certain amount you can communicate and there is a certain amount you can never communicate. That is just the sense within you that remains very personal. Yet the challenge is to communicate and share as much as possible with your collaborators. I don't go so much to them to say 'this has to be done like this and this like that'. I try to communicate where I am trying to take the project, the essential values that we identify and care about and try to maintain throughout the process. Obviously it is never something you outline

once and it is clear, it needs continuous re-definition. In all of our projects, especially with those scales, time frames and the ambitions, things change quite a lot.

**PH and the people change quite a lot.**

OS When people change there can be a dramatic impact. You have to be able to at any point completely re-assess, not only the givens that come from the outside, but even your own position in order to make new sense out of a situation that maybe no longer makes sense the way you had defined it six months, or a year earlier. I think a mix between flexibility and rigor is very important. To have the courage to re-assess and to declare that something you said was essential before might no longer be.

**PH This very difficult internally and externally.**

OS Exactly, because then your own staff says, 'but you said that before and we can't give up this thing', and you have to explain that 'I said that, but if you look at the situation now you have to simply re-think'. I think this is something that in particular in the Asian context now plays a great role. Things happen so quickly but also in some ways so courageously. Things change so much. I started a building that was an office tower and it became a residential and hotel tower one third through. So what do you do? In some ways you have to be extremely strategic in the way that you plan things, give them certain amount of flexibility. If you start to plan a residential project here, the so called unit mix, i.e. the apartment sizes and configurations client gives you at the beginning, is never what is going to be built at the end. You have to be able to go from very big to very small. This is not easy to absorb architecturally because things have totally different implications on many levels, but you have to be capable in maneuvering in this environment where also efficiency plays a greater and greater role. Architecture is not at all in the same place that it was 50 years ago. You cannot compare projects that are designed today with a bunch of case study houses done there and something done for the expo there. It is a completely different reality and if your efficiency isn't, depending on the country, above 85% it is just not going to be built and there are not so many ways to get it there, there are actually very few. Once you understand these frameworks you understand why the world looks so homogenous. These frameworks don't leave a lot of space to maneuver. The challenge that I see in our work is to very precisely analyze and understand these frameworks. This is another side beyond what we started with, to identify where you can manipulate these frameworks within themselves and find ways to reinterpret some givens and out of that create new architecture.

To explain that through examples, two projects I did in Singapore and also a studio I was teaching in Hong Kong where I am a visiting professor. I called that studio 'core values'. The interest for me with that studio was twofold. It was the dual meaning of the term core values. The most essential values, so just simply sit with the students and talk about what is important in what we do. Maybe in a very general way, what do we think architecture is about, what do we think life is about, and simply have a discussion that I in my own education process was largely absent. People never asked what the essential conviction of what you were doing was. They always asked what is your concept, did you

do it consequently or not, if you did good, if not not. But, that is actually the opposite of good architecture, because the best architecture is always inconsequent to certain extent. If you just define a principle and then stick to it the end result is quite banal and boring. You have to know when to break your own rules without destroying them. Then 'core values' very literally about the core of a building and all the values that are embedded in it. Because, once you start to study, especially commercial architecture, residential architecture and office architecture, and particularly obviously high-rise architecture, the core dictates everything. Primarily it dictates the economics of a building, because every space that is wasted in the core cannot be sold making it commercially inactive, inefficient space and developers are all about maximizing this. Then there are the building regulations that primarily culminate in the cores, such as the exiting stairs, fire partitions and so on. Furthermore the building stability system typically is also manifested in that element. You realize that all this determines to a great degree what your building is. But, most architects want to design a shape from the outside, so they think about that. In Hong Kong, one of the most vertical cities, we said with students, we are going to look at your environment in the most boring way, but what we will do is we will not only analyze what is the core, its history, what determines it, and what are all the regulations, but also see why does the architecture that you see and you live in look like that. It is largely result of these parameters. And then discover what you can manipulate in this very nuclear set of interlocking givens that are quite hermetic in their own way. Where can you break those open and do something that allows you to build a totally different building. We had some really interesting, some totally unrealistic and some also extremely realistic results. It became a way to introduce the core, the substantial values in a general sense back into architecture.

That is something I realized through our own work when I designed The Scotts Tower and The Interlace in Singapore. It is an environment so obsessively concerned about maximizing efficiency, where literally every square centimeter has to be used. It is to a degree of complete absurdity that if you really look at it, it does not make sense. But, this is how the system works and if you don't know how to operate within that system and somehow serve that system it just not going to happen. These two projects were in the end manipulations of the core, that allowed me to generate a completely different building shape and managed to fulfill all the efficiencies and other things, but in a way that nobody had thought of yet, because they always came from the other side to the issue.

**PH Did you do these analyses in a very 'manual' way or did you use some specific tools?**

**OS** We didn't use specific software tools. It is also less manual than intellectual, you have to process a lot of information and really understand the mechanisms to then reinterpret these mechanisms.

**PH I guess the first part has to be done more intellectually and then you could use different tools to test your thinking.**

**OS** I think so, and this brings us to a completely different part of the discussion. I think we are living in a crisis where the computer has replaced thinking to a large degree and I can

see that increasingly with younger staff, but increasingly with almost everybody. To give a very blatant and simple example, on the computer you can make endless changes to a drawing, it is infinite, whereas before when you drew by hand you really had to think before you inked that trace, because you could only use your razor blades twice, otherwise you had to redraw the whole plan. You were forced to think before you did and now everybody does before they think and that has a fundamental impact on the making of architecture.

Then we have to ask ourselves if we are just utterly conservative and panicked to be over at some point if we don't get what is coming and what is the future. How valid our concerns and old values are. It is a little bit of a daring definition, but I feel I am one of the last analogue architects. If I look at the other younger people who have their own successful offices I see a very big difference in their practice, in their presentation, in their interests and in the way that they do things. It probably has partly to do with the fact that I grew up as a son of an analogue architect. I learned everything only by hand or by mind. I think after me comes maybe a decade of the 'inbetweeners' that are already totally committed to the usage of the tools, but they are not the ones yet who live the tools and I think the truly interesting shift will come when the generation comes into full force that has internalized those tools. I think we will see quite a dramatic shift in the world completely beyond architecture. But it is also a question of what impact will it have on architecture.

**PH Do you see interesting tendencies in architectural process and architectural tools? What makes you excited about the future? Conversely what makes you terrified about the future of architectural process and tools?**

OS In general, I believe the future is exciting. If we are not optimistic as architects, we cannot do our job. I think we have to continuously project and inject optimism in what we do and through what we do. One has to be acutely aware of ones potential transformation from progressive to conservative, or traditional, or defensive. Having said that, there is obviously a concern of the, indeed tool driven, or very fragmented processes, as they emerge. While the world seems to be more and more connected it is at the same time more and more fragmented. Certain networks or surfaces replace other types of relationships and in some cases are meaningful. The physical has been greatly affected by the digital. How one perceives relationships or how relationships are formed, maintained and what impact that has on physicality of things. At the same time I don't believe, and again maybe that is almost a conservative position, that physicality will no longer play a role in the near future or never. I think in that sense the reality of buildings and architecture play an incredibly important role and understanding experience of that will forever have a certain meaning. We are in a period where we struggle with the decrease of actual experience because everybody consumes via media and image has become the wrap for everything. You can see that a lot of architectural practices are primarily concerned with the image production and not with the production of realities. Again, if you are asking about my methodology or interest, I am deeply interested in reality and I deeply interested in generating and affecting reality. I am neither interested in ideas alone, nor execution alone. But, I am really interested in the process, what it takes and how it can generate a true idea and then translate and transform that idea into reality and what that does to reality and with the reality. I am not

interested in architecture as rhetoric, I am not interested in architecture as only good stories, I am not interested in architecture as renderings, although we obviously still have to produce a certain amount of these things as they are inevitable tools of deliverables, but if communication stops at that point, I think that is quite terrifying.

PH Going back to the bigger projects and the people that work with you. You already mentioned how you need to keep maintaining the overview and keep flexible on changing you strategies and so on. Within this project I have also been interviewing a lot of architects 'in the middle' who are dealing with the bulk of the content in the projects. They sometimes say, 'we don't know what we are working with anymore', in terms of this fragmentation of information, which is one big concern in my project. You have obviously been working on many levels in projects, perhaps now more in the overview level, yet I get a sense you are trying to keep the hands on feeling of the projects. What for you are the biggest challenges in the projects and what do you see are the biggest challenges for the architects that work for you?

OS Obviously with increase of scale and complexity of the projects the managing of information becomes increasingly big challenge and I think there are actually surprisingly few people who are capable of managing larger and more complex fields of information. There are also relatively few people who can, not only manage it, but can even comprehend it. As you work on these projects it becomes indeed increasingly the issue.

I am very curious if at some point indeed tools will be born that really facilitate that. I think on certain levels they might exist, on other levels they might not exist, on some levels I am not sure if they can exist. Because again the issue is, managing complexity is something that, and we are almost going back to the beginning of our conversation, can only be done with two things simultaneously. One is systems and methodology and the other is intuitive sense. Challenge then is to maneuver between these two levels. I must say I am involved in my projects, all of them so far, to almost painful degree, where sometimes I know more details than the people that work on the details. I developed that relatively early on in my process, but it is something that I had to develop much further particularly in CCTV because of its scale and complexity and also the number of people involved and the issues at stake. The continuous oscillation between looking at things very abstractly and from a far and the diving into extreme levels of detail and trying to define those in relation to the larger whole is incredibly important. It is a huge effort to do that all the time and it requires enormous intellectual discipline. Not only to be the big thinker or only the technician, but in a way both. To know exactly how something works, but to be able to contextualize it in very different ways and levels beyond that. I think that is ultimately the main role that I see for myself is to be able to maneuver between the scales.

For me the strange thing about this issue in the office is the resistance. Because, whenever I ask the people to do things that would enable them to have much greater overview they just don't do it. This is one of the frustrations I have. There are very simple tools to do that. One tool is to make sure every week the latest plans are pinned up on the wall, so everybody in the team can see everything. I walk by and can see what is going on, it is a struggle forever. I am really using the simplest example I could, but the teams don't enable themselves to at least amongst each other to have the overview.



Then obviously comes the bigger picture. There, another complexity enters the game, which is, how much does one need to communicate? How much should one communicate? It is all connected to understanding. If I would say certain things that I know to the team, they might get confused or freak out because they cannot evaluate the implications. You need a certain amount of knowledge and experience for that. As team, office, or project leader, you have to be able to put people in a situation where they can comprehend what they get and are not completely overwhelmed that in the end doesn't help the process either. This is something very difficult to understand for people in the middle levels, who always feel they don't have enough information. But, if you would bombard them with all the information you have to deal with they could capitulate. That management of information is really not easy. You want your team to be very well informed, but still focused.

The single biggest tool for everything now is e-mail. Everybody e-mails everybody. I have 600 e-mails per day. You wonder how you could ever possibly process 50% of that and 80% of that is anyway meaningless. It shows the danger of self-perpetuating tool that disables its initial power that is to improve communication. It is easy to copy 48 people in every e-mail and then 48 people have to read what you have written. The sheer overload of information actually block people from knowing anything and resolving anything. The problem is if you spend your day reading all of these e-mails, what do you actually know afterwards and how relevant is it?

**PH Is the process the engine for creativity for you or is it somewhere else?**

OS For me creativity is somehow connected to desire, desire for a certain meaning in things, for generosity for enabling things and for creating scenarios for possibilities. On the one hand there is the process of collaboration and on the other there is also the effect of what something does - also when it is out of your hands. That is a very exciting thing to imagine, things that happen afterwards once it takes its' true life and meaning. Also the dialogue and the discourse throughout the process needed in order to realize the projects, where you have to engage parties in a particular way. Motivate them, see the differences and align interests. Generation of desire within the whole group. If you fail to generate any desire in your client, nothing is going to happen. But, the desire that exists with your client might be slightly different from your own and might be slightly different from all of the other parties involved. To try and comprehend the nature of these differences and to be able to formulate and generate those desires as a part of a process is a key thing. At the same time for me it is not all, it is not enough, this is just the work we do. It is neither all about the materials and so on, and it is not about the process of getting there, it is about what is there in the end, what does it do and what meaning does it have. For me this process is not the end of it, the process is not the only meaning, but the process has an incredible meaning by itself and necessity to achieve the final thing.

## **ANNEX 2**

### **Interview with Dietmar Eberle**

**Zurich, 3 May 2012**

**Dietmar Eberle (DE)**

**Pirjo Haikola (PH)**

PH I understand from discussion with Prof. Hovestadt and from different publications that you have developed a very efficient method of designing buildings for your offices. Could you explain it a bit?

DE I have been developing a method, which you can implement, at least that is our idea, in every place of the world. The method is based on the question and the experience of what architecture should be good for. Architecture is looking first of all, for the most specific thing. I think one of the big developments of our culture and society is the 'difference' - not being 'the same'. The richness of the future developments will be the 'differences', which have been developed in the past. The question for me has always been; what are these 'differences' based on? You and I in our very modern thinking, end up always with the same results. But this destroys the richness. I like that in Paris I have a very different feeling than in London. Question is; how can we in our architectural thinking understand the specific qualities, which generated these differences?

When we speak about an architectural product nowadays, it has five overlapping systems. The key to understand these systems is the lifetime, because in the questions of efficiency it becomes increasingly a key question. You can say that the theory of architecture in the 20th century was very much related to the understanding of the program, but in a long-term view, a program in a building has a lifetime of about 20 years. Why do we always start with one of the shortest-lived things in architecture?

We develop projects in five time frames and six chapters. Numbers I will give are mainly based on the data on the maintenance of the building structure done in the middle of Europe. The first and the most important chapter is the A, all the people that are integrated into a project. It is a question of human relations. To have a clear understanding of what they can contribute, how they can contribute, how they communicate to each other among other things. This chapter A is only about persons. I believe the differences are much more represented by persons than by topography, by sun, by wind, by rain or other things. All these things are important, but the most important ones are the thinking and the expectations of the people and their cultural and social positions.

The second chapter B deals with the average lifetime of more than 200 years. When we ask, what will remain that long, it is normally the organization of the public infrastructure. You try to understand the city, the streets, the topography and some parts of the infrastructure. They are not changeable, so you need to have a clear understanding of this timeframe. It is about urbanistic understanding of the situation. For me it is not that important if the project is one building site or a district, but all these relations to the site have such a long lifetime.

The third chapter C is a lifetime of about 100 years. In a lot of countries it is the lifetime of the structural security of a building. When we understand that the resources will become more and more limited, considering the lifetime is one of the simplest architectural answers. When we speak about the structure it is the load bearing structure on one hand, but it is also the security structure, which means all the vertical elements like escape ways, transportation, big shafts and vertical truss. Normally you are not able to change these in a building.

The fourth chapter is the envelope of the building. Normally according to economics, it has a lifetime of about 50 years. The envelope has to deal nowadays a lot with the optimization and energy performance of the building and also with the image contribution to the public. Then the fifth chapter is the program. This normally has a lifetime of about 20-30 years and afterwards you change the use. The way you use the building is not determined by the building but by development of technology and society and they change. The sixth chapter is about the surfaces of the building. The inner surfaces with all of the materials; things people see, touch and deal with.

We try to organize the design process in relation to these five different lifetimes and six chapters. The design process is to find out what will be the question and the demands, in relation to the product and in relation to these chapters. Sometimes when you do something very small only chapter four is important. I always say the most important design issue for doing the design is to decide which of these different chapters are important at which time of the process. When you talk with a developer, they start with four because it is marketing for them, when you speak to cities they talk about B. This very simple organization gives you a possibility to have hierarchy and understanding of the products and it generates the possibility of understanding the 'difference'. For example in this chapter B you have to have deep understanding of the cultural conditions of the site. On this planet we don't have a zero site, there is always something. This method is an idea that relates to more efficiency and which relates very clearly also to the understanding that people have very different understanding and interests in a project. You have to manage these different levels of interests.

**PH Do you have specific tools to analyze things in each category?**

DE Yes, and in each of these categories, for example in the envelope question we have a chapter to analyze the time and the radiation for example. In the surfaces chapter you analyze and understand the maintenance issues of different things. In each of these we have very specific tools representing a little bit the state of the art.

**PH Can they then relate to different phases of the projects?**

DE No, the phases are a development of all the chapters in this direction (draws A,B,C,D,E from top to bottom and arrows from them to the right) so it becomes more deepened over time. Nevertheless they always stay in their different chapters, but they always become more complex and the amount of information is increasing in all these levels.

PH Another thing relating to your method, from what I understand you have already for years been recording a database, a knowledge base of your projects. What do you consider to be relevant to record and what do you use from it?

DE Databases always have one problem, you can put every trash into them and then you cannot find anything any more. What we put into the database are the things we use based on the experience and then they are allowed to go here (draws arrows from the chapters going into the database) There has to be experience, report and check and there are some people who are responsible for the knowledge and the database. In the end I believe in people.

PH So it is a half digital, half human system and process.

DE Digital is always human in the end. There is no digital world without the human. I think there has to be a selection process, which makes information reusable - which project and part will be a basis for which part. If you don't do this selection process the amount of information is too much and you cannot use it anymore.

PH I want to ask a very specific question about the database, do you have some kind of content management system, or is it simply folders and things like that?

DE Our whole stuff is organized very simply. We have one folder system related to company information, we have one folder system related to the group information level and then we have the project information level. On the level of the ongoing projects, all the information that is being produced is documented and only out of the experience, we put something into the database. Then you have a lot of search criteria... it is... but you know the problem much better than I do I believe.

There is one problem of architectural education; they are trained to invent, but they are not trained to search. Therefore I have to control this to a certain extent. The question is not to increase the database. The question is to reduce the database up to a limit, which makes it possible to find something you can use in a reasonable time.

PH Efficiency is increasingly important in bigger projects; how do you manage with the demands?

DE I think it is very important to understand this. The success in Europe and modernistic thinking that started in architecture in the beginning of the 20th century was mainly related to the understanding of the organization of an industrial process. There you find an example of how to manage a process and this really gave a big quantity development for Europe. In 1910 we had about 15m<sup>2</sup> of built area per capita, in 2010 we had about 90m<sup>2</sup>. There was a dramatic quantity progress. This quantity progress increased our quality of living, lifetime, standards and social order. The question now is what of this knowledge will be useful for developing countries. China has about 28m<sup>2</sup> per capita but they want to increase their

quality of life up to levels that we are used to in highly developed countries. At the same time we know that a lot of things we did here had a very bad quality - in ecological issues, in energy performance, in some social issues and so on. What parts of this knowledge that was very successful in quantity, can we develop in quality? That is a very basic question a lot of people don't ask. For 90% of the knowledge we have to develop better strategies. At the moment the developing countries adapt a lot of this quantity knowledge because their problem is quantity.

**PH Do you have an example of your projects where you were able to, to achieve this?**

DE In 2001 we were asked to do an energy-optimized building in Beijing and worked together with Professor Keller who is a physicist here at the ETH. We had some principles first, such as we only use technology you have there and we try to do everything in China. When you speak about energy performance you have to speak about comfort to energy performance. We built this between 2002-2005 in China and still there is not a building like this in the Netherlands. There are buildings that perform about 70% less than normal buildings but in the Netherlands it is not possible. I did three or four projects there and they invest in the wrong direction.

Anyway, we did this in Beijing. We also did some of these examples in Vienna where we can prove they perform much better. Maybe you know the former dean of MIT? He is Chinese and he went back to Beijing. He called me and said, 'You know I live in your building'. I asked 'why?' and he said 'It is still the most comfortable one I can find in Beijing.'

There is a chance that the developing countries will learn much faster than we can, because we think we did things right the last 50 years, so why should we change?

**PH So this is perhaps your hope and excitement for future?**

DE People are very pragmatic; they do what is most efficient. Modern things can be much more efficient for them than traditional things, that is what they learn. They know this balance between quantity and quality becomes much more important. We have a problem that maybe 60% of the European building stock is done only in 30 years, between 1950 and 1980 that is the big challenge.

**PH What are the biggest struggles you see in the process from your experience?**

DE Be careful, I would say there are four categories of projects. I like categories. What makes a category in relation to a project is the dimension, because it represents the organization of the client.

There are projects from 3 to 5 million. There what does the client normally have? No organization. He believes in himself, I want to do this. Then there is a next category, maybe from 5 to 20 million and there the clients have some kind of staff responsible for different questions. The next category is about 30 to 80 millions and there you have clients that are organized very professionally. Then you have projects over 80 millions. There the client has a lot of organization and all of it has one issue. Nobody wants to be responsible for

anything. The number of documents, discussions, meetings, and decisions is tremendous.

The problem is that according to the different levels of projects you are working in, you need very different levels of information on these different issues to be able to manage a project. Therefore, this chapter A is one of the key questions. With whom do we deal with? What kind of information do they need? In a project we try to separate information very much in relation to what kind of organization, client and staff will be involved in the process. This is an instrument that helps you. In the smallest category I say, maybe it is better to go for a drink. In the other categories the level, quality and education and abilities are very different. From our experience 30 to 80 millions is the best quality of projects. There you have quite a professional staff and you can work most properly. It is dangerous when projects become too big, they don't work anymore. I always say that responsibility is atomized. Depending on the organization and dimension of the project there will be different challenges. I think that is one big issue, we speak about one challenge and we believe that over here it is the same as here. No, it is very, very, different. There is no one strategy to manage a process. Depending on the understanding of the people involved in the process they are very, very, different. So, as I said before the most important thing is to understand who is involved and which procedures have to be followed and so on.

We should understand that the form is the result of the process. Not the other way around. When one focuses on the form and then thinks about the process, I think it is very strange.

PH I agree. Actually what I prefer to say is that process is the engine for creativity.

ED Don't talk to me about creativity.

PH I have to ask you one question related to that. What for you is creativity in architectural process?

ED When I speak about an architect or a designer I have to ask, what are the key abilities somebody has to have to call himself afterwards an architect or a designer? To speak about architects, in the end the key the thing what we can do in education is the ability to generate a form. But, you have to have this ability for generating form based on knowledge. You have to be able to generate a lot of knowledge and based on this knowledge generate a form. You don't have to generate all of the knowledge; that is what a lot of people can do, that is what science can do, but you have to understand it and to work on this knowledge. For example, to be honest, I would say, 80% of the students will never reach this. In the end they will not become these form generating guys. In the end it is little bit about the process. But, first of all I really believe in this key ability. For the future of architecture I think it is very important that we have to learn it only makes sense when it is knowledge based. And by that I mean timetables, money, processes, involving people, using different information levels and things like that. How to deal with this amount of information properly? For me creativity is combination of these two keys. That is what I believe makes people into architects.

**PH** How do you deal with issues of communication and organization in your offices? There are many offices, does that result in difficulties in communicating information for example?

**DE** Communication on some level is a complicated issue, but it is not that complicated when you give up the idea that you communicate everything yourself. I am organized a little bit differently, I have eight companies and at the moment in none of them I am the CEO. Because there are people who can deal with these issues of business and organization much better than I can - the question is only do you let them do this? I think it is one of the big issues in a lot of architectural practices that maybe the designers think that they can deal with a lot of other issues but they cannot. At a certain dimension you have to do this, otherwise you cannot operate. That is a very deep question. What is the understanding of an architect or a designer? And you know that a lot of very successful people went bankrupt. They were focusing too much on themselves, they believe this ability of generating the form is the only key. No it is only one question of a lot of other questions you have to deal with.

**PH** What do you see as a tendency or a need in architecture?

**DE** I will go back to this issue of quantity and quality. We understand that quality becomes much more complex, because then architecture relates to many more different levels, social, cultural, economic, environmental and so on. But everyone has a certain amount of knowledge capacity. You cannot endlessly increase this, if not through digital media. I believe strongly that the organization or architecture companies have to become more complex. More different people, with more specific knowledge have to be represented. The traditional architecture organization is very much related to this kind of client of the smallest category from 3 to 5 million. The majority of offices are only able to deal with this. When you want to leave this limit you will have to change. But this is a bit the question of development of our economy and our society and if the percentages of these clients becomes bigger the traditional organization works well, when the workload in the other categories becomes bigger then organization will have to change.

## **ANNEX 3**

### **Interview with Winy Maas Rotterdam 16 March 2012**

**Winy Maas (WM)  
Pirjo Haikola (PH)**

PH Has the MVRDV method of working been formalized into rules or tools that are used in the process?

WM Yes and no. Yes, there are tools that we consider very useful in making tests, exploring one or two parameters and showing how far that can go. That is one way that leads to concepts, which we can compare and look at the pluses and minuses. That is used in almost any process – to discuss both internally and present results if needed to a client, because it is not necessarily needed. Sometimes we present only the conclusion to a client and don't show the rest. Sometimes we work with the client to make a selection. It depends a bit on the subject and on the client. That is the yes part. The no part is that a certain kind of curiosity is there to do almost the reverse, to ask initially from the team members to come up with ideas, a free method which is classical in a way. That is also a way to go beyond the prescribed borders that could be there in the parametric method.

A third thing I would like to add to the yes and no part is a longer term element, how in time we have been working on this parametric knowledge and on limitations to find out where the laws find their end. The data scapes were about that, leading to certain innovations. This lead to posing another kind of question; do we have to change the law behind what is underlying this data scape or not, and if you change that law what is then the next law that appears, the next limitation? That is what KM3 was basically about. After we aimed to work that knowledge into a kind of evolutionary process, and all the scripting experiments were about that. Finally after all of the evolutionary process we wanted to even go into speculation, I think The Why Factory is about that. That series is a way of enlarging the scope and testing the methodology of the office.

PH You don't see a contradiction between using on the one hand very parametric method and on the other completely free method?

WM No, because they simply establish a freeing up. That is in the beginning part of the project. Second element where can we liberate ourselves so that the unknown is explored is choosing for a concept where there is a world of contradictions and it gets defined through the unexpected translation. You have a moment of unknown in the beginning, but you also have a moment of unknowns in the end. To give an example, we started the library project in Rotterdam Spijkenisse with a simple sentence, 'we make a completely public building'. The implications of that concept are that even the doors and the volumes should be out of bricks. How to make solutions in the brick work for all the acoustical needs that were there



lead to surprising beauty and surprising new products.

**PH How would you respond to a statement that process is the engine for creativity?**

WM You are talking with the one who embodies that. For me this is a complete confirmation of what I and we try to do. There is a complete surrender to that, maybe as a reaction towards star architecture that was based only on intuition and behaving artistically. It can flourish this epoch also because due to education and current situation where people are able to talk about what they think and therefore contribute even as layman to the process. The processes have become much more public and confronted with criticism beyond 'the table' itself. Why then not open your case and be completely open for Twitter.

**PH It is interesting because often the artefact is discussed a lot, but not the process that made the artefact.**

WM If through giving criteria to the artefact you make the process behind it clear, and that gives it meaning and understanding, maybe the questions don't come, because people understand it. That happens a lot and that can be a quality.

Conversely in the case of, for instance the Pig City stacked pig farm, the project opens itself for argumentation and therefore contributes towards the process of communication and evaluation that is embedded in it. The target can also be discussion.

**PH Do you see problems in that the process and method drives and the artefact is a direct outcome of that and sometimes you don't even know what comes out?**

WM Well, there are criteria within the process, which you want to achieve. You have to put these criteria in, in the beginning. If you don't do it then you don't get the product that you aimed for. But, your question implies that if you give it completely to the process it can lead to a mediocre thing. That is why I want to stress that you have to put those criteria in, in the beginning. More and more I see that, like this week in Canada, we discuss immediately the project from the beginning, what are the things that surround it. The limitations or something like that, or the tradition of, in this case skyscrapers.

**PH In a way what you are saying is that in order for the process to lead really well, you need to gather all the parameters in the beginning that you want and need. You cannot add them later on.**

WM Yes, and the last parameter I would say is that 'I would like to have your mobile phone so I can talk to you at any second of the day in case there is a problem', to have an emergency break at any moment.

**PH No system is bullet proof.**

WM Of course not, from many sides. The complexity of these projects is too big to completely forecast the outcome. And that is not interesting either, because innovation has

to be discovered. The word innovation per definition, the new, and how to incorporate that in these kinds of things in pre-scriptive processes. The opposition is another technique that the whole avant-garde is using always, to see what the conflict will give.

**PH That is of course used here also.**

WM Yes, true. The third technique of innovation is extrapolation. To go further with one thing than you could have imagined, to push things to their limits. It is continuously a method on our tables.

**PH To talk more about the process in terms of everyday work. In the interviews I have done, the architects explained feeling lost and that they lose the overview in the sometimes very complex process. What kind of tools do you use to avoid that?**

WM The whole conceptual age that we are in now and that is celebrated by the Design Academy Eindhoven and offices like OMA and us, where the concept already is a way of simplification and steers already most of the components into a specific direction. We can defend that kind of working, the conceptual method. That helps. When we did the castle and the client started to understand the fragmented castle and that every decision was based on that. So, in the end even every craftsman working on the building knows that he or she has to work in that way so that helps to connect things. In an urban plan it is even more important. The only thing you can add to that, to deepen that aspect is that the concept is not a one liner, it should be deep enough to allow for a product that can cover all of the demands and that is open for innovation itself. We need criteria and critique for that word, concept. Only in the art world you see critique, but in architecture and urbanism I don't see much.

**PH Maybe you have seen it, felt it, that the architects can get lost in the process?**

WM Me personally no, because I think by nature, I am more focused on the overview than the others.

**PH You deal with the information on a different level.**

WM I steer and I get a range of summaries. Maybe I am more a manager in a way than an architect. Keeping the overview for a project I think is the only way to get the horses in the same direction.

I must say that you need a lot of time for communication. That I experience a lot and sometimes you are too late with communication and then you see cracks in the quality of the project. There needs to be an acceptance that cracks are part of our profession, the scars that occur.

**PH Perhaps communication is something that can be improved?**

WM Definitely, but everyone says that already for a while, and still yes, we have to do it. It is a matter of concentration; you need a lot of people to work on that part. And there are a lot of doubles in the process, a waste of time. People complain that we have to talk again about something. In that part there is a lot to do. Maybe your system has to help. When you open your computer it immediately gives alerts because you didn't talk about something. Check-ups. Those kinds of things are good to have on board.

**PH Could you describe some other challenges you have in very big projects?**

WM Like I said, the lack of communication leads simply to mistakes. How to position them and how to live with them is also an extension of the overview. Simply to admit that there are mistakes, and to show them is one way of dealing with it. It is easy when you can blame others, like one column in a building was badly poured and there was a crack in it and the company wanted to restore it by putting concrete in the hole and I said, 'no put transparent stuff in it so we can show it'. It is like a grotto in that column which is actually exciting and one starts to wonder if it would not collapse at some moment.

If it is my fault, that I should have done communication before; that requires more courage. The issue of making things explicit can turn it into another richness, not to mask it but if there is a problem then I paint it pink. Enhancing the problems.

**PH You have said that anything can be parameterized, do you still believe that?**

WM I do, more and more. When I first said it, it was provocative in the world of architecture but not in the world of science. In the world of 'creativity' it was like a red flag. We spoke a little bit about it already, because it doesn't mean that I can pre-parameterize - that I didn't say. But say, post-parameterization is also, a way to get more knowledge. If I have to react on the spot, in that split second I am at my best and I put all my analytical powers and all my knowledge and my experience in it and it forces me to give the correct answer. So that is one moment where all this parameterization comes together. To analyze that after the fact, why you made a hierarchy in that analysis, is an intriguing post-analysis and it helps the process. Maybe people say it is intuition and that is fine. It is a sincere concentration of all the knowledge. That is always a moment that I love a lot when it happens and to analyze that afterwards. Another thing to reveal, to give a free fall, like in the Euro Towers project we started with Lego. First no scripting and then half way through bring that to one focus and the third moment was to script it, what you have done. That is also a way of parameterization.

I remember the process when we worked on the Philharmonie in Paris to make a completely accessible roof, everywhere. Everything that comes from the inside could be used on top on the outside. These parameters mean that any piece of the program leads to an accessible slope or stair. Funnily now one of the tower projects is completely parameterized that. So, we didn't do that on that moment, we didn't have the time to script it and now you have it under control.

PH We are discussing a lot about parameters related to the artefact, how about parameters related to the architects working on the projects or other people or WM emotions PH are those parameters that somehow come into play?

WM Yes, because if you have ten people in the room you get another project that I must admit. The input of people is inevitable, I think it is a good thing to accept that, to also to say yes, I did not have that person on board, therefore, the project is less conceptual for instance. That is part of the game. You cover that by having three conceptualists and five form setters for instance. The human parameter is impossible to do without, especially when you have to cover a work with more people. But of course one steers, so it is less extreme as we now suggest.

PH Do you see interesting tendencies in architectural process and architectural tools? What makes you excited about the future? Conversely what makes you terrified about the future of architectural process and tools?

WM Mostly I am quite transparent about that, the whole copy paste issue, we turned it almost into a project. It is very vulnerable but also very good. This frustration has given something. That others are able to do due to other parameters and luck and they can build it earlier than you. That frustration in a way has been turned into a project.

PH Is that your way of dealing with the things that scare you, taking them in a using them in projects?

WM Mostly yes. And not wait with that. Accept it as fast as possible, otherwise you become cynical. It doesn't mean you can control all these fears, no. The market goes in all directions all over the planet. You lose a competition and you win another. The complexity around that theme is bigger than to be said in one sentence.

There is a fear that pieces of our society turn into zones of fear themselves and people don't want to experiment anymore. I will endlessly protest against the popularization of our society that is happening, not only in political sense but also in real-estate where you get retro architecture because of that. You invest only in things you know, because you think then you get a certain price out of it.

In the consumer society now due to the social media there is an enormous anonymous group of commentators that partly steer the world. They can break people and help people. But, there is an enormous risk in the anonymity where you can say anything, because there is no responsibility and that deserves a protest. I am happy to fight, but not with lack of responsibility.

The excitement. The pure globalism, I am still excited about that and maybe I should re-address that now. That remains one of the most beautiful things in architecture and urbanism. That one can work all over the planet and be concentrated on different places. It is easy to work everywhere. We are working in Ghana at the moment and it is fantastic. Of course you need culture, climate and other inputs in these different places, but the ability to

work easily everywhere that is an excitement in itself.

There could be more excitement if the world of technology and the world of research and other domains would open themselves a little bit more and that architecture could be more positioned in that world. Universities are still not very collaborative and there is a redundancy of similar studies. There is still a lot of work to be done.

## **ANNEX 4**

### **Interview with Ludger Hovestadt.**

**24 February 2012**

**Ludger Hovestadt (LH)**

**Pirjo Haikola (PH)**

PH What kind of tendencies or trends do you see in architecture and design tools and what do you expect from the near future?

LH I have been for 20 to 25 years in this field of integrating architecture, architectural design, design, building production, management of building processes, different aspects of different engineers, the users of the buildings and so on. I have made three major observations.

In the first 20 years I realized that everyone struggles with the same problem. I think the integration is not the question; of getting more elements, wider tables, more connections. It is not a question of networking, I think. I think it is a question of abstraction.

The next observation from the last 5 years is the phenomena that everyone is using computers, which means that we as specialist are out of the game. Somehow I think in these kinds of applications as well. Because everyone, instead of using computers for Word and Excel and so on, in a primitive way, now start in the research and end in the practice where they have computers as constituent parts of their work. People are somehow overwhelmed by the performance and the possibilities of the machines and they stop thinking about architecture and that is a very strange phenomena. Therefore, at our chair we went further with abstraction. There are some promising developments as well in the next round that is coming up. The next observation is, has been for 25 years, and has not changed, that the driving force is not the architecture. You presented this UML scheme, I think in the end it will need to be much more complex, because the complexity goes exponentially with the amount of tables. If you really want to cover a reasonable part of the processes of the planners and so on, it grows from this complexity. This is a traditional way of making models, building information models BIM, and the international foundation classes are one unit, hierarchy, which is pure nonsense. What we established here in Switzerland is called CRP online, multi-hierarchy systems, where you can have pragmatic hierarchies for each building and even interchange data so we are not restricted to one hierarchy, or one scheme, to be able to learn from other buildings. So, you can have individual hierarchies and still exchange data without centralized scheme. I think that is very important.

PH Ideally, I would like to have a more customizable system, however that seems very difficult implementation wise.

LH You need another set-up. What you currently always have with BIM, what I was discussing with international foundation classes, in principle you have one hierarchy and you are able to expand this hierarchy, but you can't have an alternative versions of that,

because then you lose compatibility. The CRP is a description to the very details of a building of the hierarchy of the process and this means you can have different hierarchies, co-existing hierarchies, and still are able to exchange data. I think these models go towards the abstraction. This means that the model doesn't need to be specific, prior to the building design. In this case if you are pragmatic in the hierarchy, a building can be first then the model, and not first the model and then the building.

**PH So, you would say you have a software prior to the building that you customize according to each building process?**

LH Yes, so by building the building, you are building your semantic model. In principle this is working also. This is in my perspective very important. This is the model side and this changes a lot the set-up of a system and you can do it in a way of communication as well. You don't have to have a strict scheme but it is a kind of a default. Therefore, you can have different attitudes, different companies and so on.

I think from the point of computer science it is not necessary to have a unique model for all, because the models are somehow the verticals and what you are introducing is something like social media, communication first and then the model. You are somehow focusing on the communication, which came up with all the tools of social media. What you are introducing is that you have a certain understanding of how these processes work and that the buildings are working and there is a tier statement that you can have a specific model that is important. What you are introducing is the importance of supporting the horizontal, the communication between all these parties. You are behaving very much like a content management system, integrated somehow in the architectural design. You have a kind of a timeline and classification of different processes and different operations and different kinds of collaborations.

**PH What are the tools restricting us from doing? There is always the criticism that the possibilities any tool provides, excludes what it outside of its possibilities, as Ben Schneidermann describes the problem - or rather an inevitable consequence.**

LH What I find very interesting in the last few years, it has again to do with the specificity of models. In principle in social media and communication, but most radically extended and introduced by Google. What they are doing is a completely new game - and therefore they are this successful. It has something to do with mobile phones and ubiquitous computing and so on, which will give a major input into building design. The most interesting thing is thinking of a building as a logistic infrastructure, not as a formal representation. That is why CAD systems are not really appropriate for that. What Google is astonishing in, and we think it will be the direction and we are trying to get implementations on that in the next round, Google has no model. They are 100% opportunistic. How they are doing that, being operable without a model? They have any model. They link any data with every data, in that way they are dealing with infinity because they just connect everything with everything. There is any model in that. So, what you do is just tell questions to this data and then they present you answers. There is the selection of the set of documents, this is index, clear algorithm. The challenge is to get it in the right order, so ordered list of documents is what

Google is presenting you. By selecting the first you say good, if you look further... hmmm he is looking for something else. Just by doing it day by day, everybody, they build up a certain behavior of this thing and you don't have to understand why this is working it is just that people are looking at it that way. Google is completely absent of any meaning, which means it has no model. It is pure operation on bits. The point is you have a meaningful word for you, not for Google, for Google it is only an index, and then you have this list again, it is just a list. The meaning is, you say I can use that. Just by getting things into the same screen, Google says this must be a meaningful context. So, therefore they are out of meaning. Which is not the case in any other model.

Just by using it you insert certain stabilities, but you do not have to talk about processes. That is great because you get out of modeling and it is working because it gets pre-specific. So if you have full access to all the data and if you have continuous co-existence with this data you don't need any model - you are super adaptive to anything and it will work and you don't even know why.

To integrate that, you have two streams of independent data and how they correlate, nobody knows. The first stream is the keywords and the other is the sorted list of documents and there is no connection between, except how the users behave.

**PH Are you testing something like that here as well in the architectural field?**

LH We are just setting it up, to bring that to buildings and environments, this is a kind of theory working. So this is only words and documents and it has a lot to do with content management and so on. But, search in a radical sense. If you think about it radically you have these kinds of self-organizing maps. These pictures and data landscapes are conceptual pictures about concepts before they get real. (showing book called urban data mining and a poster of about 5 meters long with floor plans that are with a visual search)

If you have to connect everything with everything, in principle you have an infinite design space. Then your personal design and your sequence of things is just a point in this infinite design space, therefore you can always look around where you currently are. My work, the whole experience I did, is this point in this design space. It is not specific which kind of 'neighborhood' you have, but you know your principle neighbors and if you get interested, the whole thing changes a little because of the information and then you get more specific about what is going on. Therefore you can see 'friends' without knowing why, this is just because you are thinking in the infinity of data interlinking. Why this is working, is the observation of Markoff, and this is how Google works, you have to think in infinite dimensions. Take 20 or 30 dimensions and that is enough. If you are pragmatic in the dimensionality it is working. Think in infinity and the pre-specificity of models and you operate on abstract idealistic dimensionality which is precise. In my understanding these kinds of things will change drastically the way we work, the same way how Google changed drastically the way we use computers.



PH In your opinion the tools are going to a certain direction and developing, but how are the architects able to cope with this complexity?

LH Well, the tools are not complex, they are complicated. It is not complexity, it is not really complicated, it is an overwhelming amount. Nobody is able to deal with that. What industry is doing is the question of power, money, engineering concentration and certain regulations. The tools should work like that, point. And still, they struggle a lot. Because they get too slow and so on. For the building industry, especially for the architects, they do not have any chance I think, to cope with this massive amount of information with this speed. I think this set-up is not right. You see with Google and Wikipedia, that this is not the question. The question is not complexity or the amount of calculation or the amount of tools. The question is abstraction.

I want to do this building and I have to calculate the weight and huge amount of things and you always need a certain overview and you need abstraction. Therefore my strong belief is that to look at Google not as a silly indexing machine, but as the most abstract usage of computers we have. Mobile phones are the same thing, we orchestrate and organize our social behavior in cities and we have been able to change that drastically very quickly. It is not a question of models, it is a question of abstraction.

What you see is with Google is writing a word and get a text. So, it is not complicated. Mobile phone, talking, we are still talking, but to all people, with anybody on the planet. It is 5 out of 7 billion people who have mobile phones. So, in Google, the whole thing is to write a word and get a whole text around that word, and to do that with buildings and to that with pictures and to get the whole information around this certain picture. The question is, is the list appropriate?

The idea is, this building is connected to any other building. This power plug is connected to any other power plug in the world. The same with the processes. My building process is a kind of an object and I can take one segment of the building process and compare it to any other building process and then I can take the next step. This means you are pre-specific. Then it is easy. It is the talking, the writing, it is building, it is the building itself, it is the building construction and so on. It is the matter of taking the next step in this milieu that will change the game. Our work and how we interact and how we communicate how we design, how we choose materials is connected. Now it is connected semantically next the pictures are coming.

PH I guess this would lead to improved learning and process. Now in the creative process you are not really learning from anybody else because processes are very protected. But, then you could actually start to share the knowledge of process much better, which would of course increase our capabilities in design.

LH Currently there is no way to make processes explicit and that is a problem. You can draw and you have this abstraction and you have books and didactical things and so on. From these didactics you write certain software. People describe how they work and their work

will change if they are connected.

PH You cannot actually ever see the process now, you can only get their interpretation of the process.

LH But, that is not reflected in these tools. If you simply record all the steps in your process, then you are fine. Then this gets explicit. We just made this experiment here in Zurich. We made a whole building, structures and so on into a code and with this code you are able to reconstruct the building. You can improve that, but it is working. You don't need to talk about problems anymore. We know how to behave to prevent us from problems. If you put it to the radical this is a kind of design without problems.

PH What I love about this is that, reading about creativity process there is a lot of talk about the tacit knowledge and intuition and all these ethereal concepts and somehow I sense a belief that we cannot write that or code that. By recording different creative processes we can see what is actually going on.

LH You don't have to ask the question, that is the interesting thing. I believe that all these Turing machines and computer intelligence are old fashioned. Computer doesn't care about creativity, it is boosting creativity. Google is exactly what computers are able to do and leaving the things to you that you are able to do. If you try to make creativity explicit, again it is a question Google is not interested in.

PH Does it collapse the profession of 'my style and my way of doing things'?

LH It is much more from a style to a brand. It is not about the object any longer, it is more about the brand and families of objects that you are creating, and challenging and fighting other brands. Same with buildings I think, so Koolhaas or Hadid they are big, which is an interesting phenomena. They are brands. So, it is not the individual building, it is the brand and architecture of these brands coupled to certain persons. Industrial designers are coupled to a certain companies. This is how design currently has to be looked at. It is much more marketing, brand making and a kind of economic challenging of other brands. 'Commercial' itself will change with that. The brand has to be started, it is embryonic, you have to care for it and have hundreds of artifacts and different channels of communication and you need a certain economic value to this.

PH This will create a very different design and architecture scene that we are educated to until now

LH If you look at a very abstract thing and the tradition up to the end of 19th century we were working in architecture and spatial articulations. In the 20th century it is very obvious to make time capsules, they are living organisms and they have their own time - buildings and design objects.

## ANNEX 5

### Short biographies: Ole Scheeren, Winy Maas, Dietmar Eberle

**Ole Scheeren** (1971 DE), principal of Büro Ole Scheeren with offices in Beijing and Hong Kong, visiting professor at Hong Kong University. He is former partner and director of Office for Metropolitan Architecture and responsible for the office's work across Asia. He led the design and realization of the China Central Television Station CCTV and the Television Cultural Centre TVCC in Beijing. Other projects include MahaNakhon, The Interlace, The Scotts Tower, as well as the Taipei Performing Arts Center. Scheeren directed OMA's work for Prada and was the project director and lead designer the Prada Epicenters in New York and Los Angeles. Through Studio Ole Scheeren, he is also exploring nonarchitectural projects, such as Archipelago Cinema, a floating auditorium first conceived in the Andaman Sea of Thailand. Currently he is working on a series of projects, including Angkasa Raya in Kuala Lumpur, a large-scale urban development in Singapore, and the new headquarters for Guardian Auction in Beijing.

**Winy Maas** (1959 NL) is one of the directors of MVRDV, known for projects such as the Expo 2000 and the vision for greater Paris, Grand Paris Plus Petit. He is a professor at and director of The Why Factory, a research institute for the future city, at the Delft University of Technology. He is also former professor at Berlage Institute and Massachusetts Institute of Technology, Ohio State and Yale University. He is member of the research board of Berlage Institute Rotterdam and supervisor of the Bjarvika urban development in Oslo. Current projects include large scale masterplans for Almere (NL) and Bordeaux (FR), a bank headquarter building in Oslo (NO) and various housing and office projects in Western Europe, USA and Asia. With both MVRDV and The Why Factory he has published a series of research projects.

**Dietmar Eberle** (1952 AT), principal of Baumschlager Eberle with offices in Lochau, Vaduz, Vienna, Hong Kong, St. Gallen, Zurich, Berlin and Hanoi. He is a professor at and former dean of the faculty of architecture ETH Zurich. He is also former professor at Technical University in Hannover Germany, Technical University in Vienna Austria, University for Arts and Industrial Design in Linz Austria, Syracuse University in New York USA and Technical University in Darmstadt Germany. Recent major projects include Vienna International Airport extension, WHO/UNAIDS in Geneva and several high rises in Beijing.

## **ANNEX 6**

### **Excerpts from interviews with designers and architects 2010-2011**

#### **First set of interviews (September - October 2010)**

##### **Interview design consultant (UK)**

**23 October 2010**

**Via Skype**

##### **Pirjo Haikola (PH)**

##### **Design consultant (1A)**

PH Can you describe your typical process, if there can be said to be one?

1A There are different teams for different things, there is an internal consultancy team dealing with the client and then there is a wider project team that includes your client and maybe external partners and experts, so there are different levels of team involvement. In terms of typical process it can be quite different. First thing we do is make the brief, we normally get a very abstract brief and then we try to define what the issue is, so we write the brief for our clients because they don't know what the issue is. That for us as consultants is the most creative part of it. Creating a process and reframing the issue, whatever it is. Our job is really to facilitate other peoples' creativity. In this beginning phase we usually work with the smaller internal team. Sometimes both client and us both try to rewrite the brief. Sometimes we have experts to help also.

What kind of client you have has a big influence on what kind of process you work with, as we work with research, design, marketing and development. The amount of collaboration also depends on the client, the Asian clients typically wants us to make the brief and says see you in two months. Others want more collaboration in developing it. There is no one process for us.

But we have abstracted it like this.

Generally you would first have a kind of a scoping phase, where we try to define the brief and then we do some research. The research can be internal or expert led, like sociologist etc. or you go do some research on people somewhere in different countries. When you get the results back you try to understand these different inputs. Sometimes our internal team does this and tries to synthesize it to the client, Sometimes we do it a bit with the client usually in a workshop situation. Sometimes experts participate.

After this it can go two ways, it can be this o recommendation from us. Othertimes they want us actually to facilitate their design where we throw workshop where different parts of the company are there. Marketing, design, sales etc. They can be quite disparate parts of companies. Engaging them into the creative process, because when it comes to taking those ideas into practice they feel like they are part of the process and they know where they come from. That can sometimes be the key to getting the ideas anywhere in the first place. The ideas is not the difficult part, it is actually getting them through the organization.

It is a challenge. In organizational problems it is usually the people and it is usually very very analytically led, so if you are working for r&d or marketing department everything is kind of metrics. How do you measure everything, before you even come up with an idea? It is very very difficult to be intuitive. What I am trying to do is to give a structure and process to creativity within an organization.

The interesting thing is that most people in these companies are used to doing like workshops and brainstorming, everyone knows how that works.

(about companies that don't have designers)

The idea that you have to work intuitively and having something you can talk about early in the process, even if it is rough and the value of that and the value of having design and taking time to work on the details, because often that reveals what it is that they want in the first place and you can't get that from 100 word description. That is the most tricky when there are no designers involved.

**PH What are the challenges with different disciplines and parts of the company?**

1A I think it is mostly understanding what the different issues are from different perspectives and trying to at least... It doesn't matter if you don't address issues directly it is more about giving people place to be heard in that situation so that you don't ignore some concerns that they have. To give them kind of a venue and put it down on the record somewhere and they are quite happy with that.

**PH What kind of tools do you use in your work?**

1A We spend a lot of time in workshop design, it is quite a big part of and those kind of facilitation tools to harness people's creativity. So for example when we look at clients product range or something like that, we might as an abstract version. We might look at that through different spheres of knowledge, so looking at it from kind technology point of view of what might drive change in a certain time span or looking at it from trends, or what governments might be doing, what are their customers or users going to be thinking about in different times. Discreet channels that you can structure concept generation around and having different inputs into those. There could be a piece of research into each of those which could be from experts, it could be from going and doing research on people in different countries. Often it is about finding a common format they can all understand, so it is kind of about structuring it.

(information overload)

Having a more of a hypothesis that more of inductive method works well. Information overload is a problem for people these days, so you can start with a subject and then even before you have done any research you have to come up with some kind of taxonomy of what you think that subject is all about, before you even go near the computer

Information overload is a problem for people because they've got so many metrics and so much information or so many reports and knowledge management is usually crap and

so before we do any research so first before searching for information we try to find the people who might have it and try to work with them to synthesize that way that we can communicate their kind of technical geek things for the rest of the company - helping with knowledge transfer.

**Interview Senior architect (NL/DE)**

**22 September 2010 Rotterdam**

**Pirjo Haikola (PH)**

**Senior architect (1B)**

PH What kind of problems/challenges have you experienced in 'team' design in general? (related to management, personality types that are involved, the different disciplines involved, team that is split in different locations, or something else)

1B It is interesting to involve people and brainstorm (advisers, structure etc.), but frustrating because where different aspect are brought in they are not interesting for all. People lose interest when it doesn't involve their area and they end up losing a lot of time as well. Sometimes people rather avoid the meetings.

With experts and advisers you need to filter out a lot of information that you don't need and see the relevant ones. If you have less experience this can be difficult.

But, you meet the same experts over and over again so you learn how to deal with them.

With clients can be more difficult. In the beginning you work with concepts and general ideas not details. But discussing concepts is something you have to learn and it is maybe new to them and sometimes discussion remains on the tangible level.

For example sticking to the needed m2 instead of getting the general concept clear.

Un-experienced people look at details easily, what they already know, instead of discussing on abstract level.

PH What kind of problems/challenges have you experienced related specifically to generating and developing ideas in a team.

1B Models seem to be easiest way to communicate, as they are easier to read for everyone.

Physical models especially. It is good is modify them on the spot, cut and change. But, quickly adjusting a physical model is quite difficult. It is a lot easier on 3D if someone is doing it, but can be very also irritating without being able to touch it yourself.

Also changing drawings on the spot in the meetings is good, but if there are people outside of architecture, depends on their skills if it can work.

It helps if someone is there to make sketches (like when someone is drawing a crime suspect. A nose needs to be little bigger, and chin smaller...)

In a brainstorm, if the group exceeds a certain size, only few can comment.

And if boss is there and says something, others tend to agree - it is not equal brainstorm.

Skills around criticizing evolve quicker than producing - negative part is easier. Positive

constructive critique is hard. When there are more people in brainstorming all easily start criticizing and ideas are stunned in the beginning before they have a chance to evolve.

In a bigger team you need to be very visual and have clear alternatives and variations. Hierarchy between people is also needed.

Teams do not necessarily bring in new ideas in two it can be more effective...can agree on directions. More people is good for developing ideas further.

In design meetings often all the people sketch and you gather sketches after.

But, design meetings are messy and terms come up (like this one that is like spaghetti and that is a blob etc.). Everyone works in different way and makes notes and drawings.

Information tends to get lost during and after meetings.

**PH What has helped to 'innovate' the most? What techniques work best?**

1B In architecture the ways of doing a more the same all the time, not so much innovation in materials or other things (sure some offices are more focused on that). The creative part is more about the form and spatial arrangement.

Public buildings and how public opinion supported or didn't them is interesting and those discussions can be quite dreadful.

### **Interview Senior Product designer (FI)**

**29 September 2010 Helsinki**

**(translated from Finnish)**

**Pirjo Haikola (PH)**

**Product designer (1C)**

**PH Can you explain your process and some tools you use in designing?**

1C We recently tried Six Sigma. It is a tool set put together in the end of 80's for companies' quality control and it has taken a big role in it. Since then it has been expanded and it has a lot of followers, but it is more for developing the quality for existing products. Then there is something called Design For Six Sigma and there the observation is that you cannot improve quality endlessly, because at some point the product itself is at fault and you have to design the whole thing again. So, DFSS is a tool set where you do certain things and then something meaningful is supposed to happen. It is a set of tools and thinking models. If you look at it in a 'loose' way it makes a lot of sense. In this recent product design project we tried to proceed with it.

It begins by collecting users voice exactly like it is said. What do the people think and you always note exactly what they said and who they were. In the next phase you start to look at the needs from the users and you do some interpretation. In between these phases you try to validate with the users if you understood them correctly. Then you start to prioritize

these needs and see what kind of user groups and segments begin to form and then you validate again if you understood correctly. Then you start to look for solutions for the most important needs, so the point is to translate users voice into engineers voice. Then there is this UFD tool where you try to create a situation where everyone understand which needs you are trying to meet and what kind of solutions you could find. Then you take competitors products and you check how competitors products respond to your need map and you compare your ideas to the needs, and of course you try to find a profile which is different from others. If someone (competitor) is strong somewhere, you try to be strong somewhere else. Then we make even a bigger table where you have all the product qualities, and competitors products, and your own products, and those needs and then you start to look at the existing products and different concepts and what is the best. Then you group the needs according to the CANON thinking, where you have needs that have to be met. Like cars always need to have breaks, but no one would make purchasing decisions according to that quality. The you have things according to which you make comparisons, like in a car the speed or fuel consumption. And then you have elements which surprise the users like 'wow this is really cool'. And then the needs and functionalities are categorized this way. Then you create a concept that contains this whole thing. So, user group, product segment, needs that have been met, the way they are being met and the product with all its qualities and then you add the technical solutions and price and then you validate one more time with the users that the result is what they wanted and then you make it.

The DFSS does not differ that much from what we have done before, but because it is a known and branded system it gives credibility and structure and it makes it difficult to question. It makes it (designing) a bit heavy the first time and probably the second time it would not be so heavy. Another thing that is difficult for people when you start to use tables and matrixes is to see the content inside the matrix. Quite often we were searching for that. I wasn't leading the project, but participated, and often we went tool first, like ' here we have this matrix we need to fill' and it so somehow so strong, the structure. When you look at the 'poster' when the whole thing is printed you only see the structure and you need to go close to look at what the content is. Communicating and implementing this thing leaves a lot wanting still, but it is understandable as it comes from engineering and more serious design tasks like airplanes or weapon systems.

The good things I saw in it is that unfortunately still very often designers and architects think that they have done a design and it is great, but damn there are so many restrictions that limits making it and then they think how to push for example this fork through the system, where in the end the limitations just amputate everything out and nothing is left. There two crimes happen. First, designers in that case are unable to make the kind of proposal and structure which in itself would have the kind of evidence that says 'this is what people want' and it is meaningful. There this kind of structured recording users voice and documenting the whole thing is very impressive, because you can say this is here because it is what people want. So you can make foundations for the design, which is as powerful as economic or engineering analyzes. The second crime that happens in that designers process is that you have designed the product in a vacuum and you haven't taken into account the process that is behind it, where it comes from and what is it related to, but you just design the fork



and not the systems what it is part of and then you wonder when you try to put it in that system and it does not fit. I think especially these days you should first understand the system you are designing for, whether it is sales, environment, or in architecture some more complicated structure and then modify the system, which is actually the design work. The design comes out of the system in a bottom up way.

I think it is a delicious idea that something developed slowly from engineering and process industry could offer some answers to designers - even when in the beginning all designers are horrified and they don't want to go anywhere near something like that because it seems too much like design by numbers. But using it as one part of design work could bring a lot of clarity. Otherwise it is easily just a mess and it is so hard to justify why you did what you did.

**PH What is the team configuration in the process?**

1C So, in principle the design team, sometimes we have had a research team, but it has remained somehow separate. So (related to the six sigma project) We worked on it in a project group and we had gathered all the necessary people. In the beginning of the project it is pretty much the product manager (tuotepaallikko), head designer, and of course the project leader. That triplet is very relevant in consumer products.

**PH How do you deal with outside experts?**

1C We try to keep a relevant number. In the beginning it does not make sense to have everyone in when there is yet nothing to comment on, but as soon as you start to have something for technical solutions we take them in to the project team. Towards the end the amount of people grows.

**PH Can you outline some team related problems?**

1C Suunto has a matrix organization. One basic starting point is that each discipline has their development needs and desires. So for example some are really fed up with the fact that the structure of the devices is really bad and they would like to improve it so they can make better products and how they could develop their own work. And in mechanic design is something because they would like to develop and do things differently and then these plans, strategies and agendas are not necessarily compatible in regard to that product development project and this is often a matter of time perspective that we can get the products out fast. So, each of these design and development disciplines want to do their best, whether it is hard ware design, software design, sales or anything else and then you would need to pull all of them together in a way that is meaningful for the company, so that is quite often the challenge. Because sometimes some people say that 'I am not getting into this, this is awful, because we cannot do our job right.' This is the starting point of basic conflicts. Project leader is the one who tries to solve the situation and is between the rock

and the hard place, because he/she tries to get all the design team disciplines excited and into it and at the same time the leadership of the company tries to push that when which product gets on the market. Often this end up being simplified as you want to get the product out fast and you cannot do the foundations well.

Once I have also been leading a bigger conclave where we were thinking about this and we eventually ended up with a solution that each one tells they point of view a bit and then we were able to do a little bit longer roadmap where we can see that we don't take this thing now, but we take this first and see in a rational way and we can proceed. I thought it was a great result that we were able to make this kind of solution.

**PH How do you share information?**

1C The concrete sharing of information happens on networks drives and we have also started to use Sharepoint. It is a kind of a group work space where you can put thing and it works kind of ok. But companies always complain that information does not move, this is like a basic thing. The problem is not someone cannot find a specific document, it is knowing that it exists in the first place, but this is more a practical thing. Then another thing I want to emphasize is the 'speech in the corridors'. When there are some seeds of information and a group of people make conclusions from it and then they develop somekind of theory about how things are. And they don't spread the seeds of information forward, but they speak their own theory and this influences other people further. The you can get pretty extreme scenarios and they can be very motivation killing versions about the reality. I have seen very radical examples of this where especially if some people have a tendency to be very negative and already disappointed and they get some seeds of information and then they make some kind of catastrophic scenario and then they keep talking about that - it can be very paralyzing. After even taking about the whole thing can be difficult because first you have to get everyone over the 'this is not going to work' mode. I think this is really important. Keeping everyone informed that everyone knows the whole truth, at all times. I think this is more important than the actual knowledge management.

**PH Do you see differences between disciplines?**

1C In many disciplines and work environments and especially engineering the thought model is that you have the starting point and demands and then you design according to the demands, so it is kind of a one way stream. And if there is something missing from the beginning you cannot do the next phase. This is very difficult to arrange these days. And when you add the risk management on top of this, like 'this is nice idea, but it is a bit risky'. The very often the risk management solution is a parallel track. Most of the time the main track is the safe one and the parallel track is the experimental one. And then you see how it goes, if you could at some point change them. Eventually you can have more alternatives. So, this is the main model from engineering. This is still a bit narrow model, a bit stiff way to do it, but it gives a little bit of flexibility. In many cases the situation is that in more difficult things you would need to go from both ends (beginning criteria and solution ideas), to see

where you can find a connection that could work. Getting this thought process to people, controlling it and most importantly measuring and guaranteeing it is really difficult. And getting the trust that we will actually achieve something like this. It is a bit like, we would need to do something for those people that is meaningful for the company, this seem like it is not going to work. But if you take just those people try this and then again back and forth looking for that connection point. This is a very natural approach to designers. Sketch and test and realize what is wrong and then you make the next concept. This thought model is very difficult to understand. I don't propose that any bigger project to be done like this, but sub-parts or pockets. The people with wider perspective that can think like this should be leading these projects, that 'even if we don't know this part, let's go with this idea so we can proceed'. Formalizing this is a little difficult.

Then product development is always depended on people. Perhaps the social skills are more important than the procedures, so that the roles and communication skills have been chosen right. So that someone too good in performing is not in a certain spot or someone too optimistic in another or too narrow minded in some other, but they all need to be in a certain spot and balance each other. If someone is in a wrong spot it can paralyze the whole thing. It has to be in a balance and everyone needs an opposite force.

### **Interview Urban Designer (P)**

**18 October 2010, Aveiro**

**Pirjo Haikola (PH)**

**Urban designer (1D)**

PH Who is involved in the process and what challenges are there between people and disciplines?

1D Public participation has quite big role on this creative process, but usually, despite of the fact that it should start to appear in the beginning, you see the effective participation almost at the end. Usually the public participation is based on public presentations with sessions, people explaining the works and hearing the questions. Also having personal meetings in a certain periods you receive people that book with you when they have specific questions. And by written as well. These are the three ways public participation appear.

Usually in the first phase of the work you work in a very lonely situation. You are just surrounded by technicians, colleagues. I have been these latest years supervising the works and I have a team that works with me and the political inputs usually come later and as a reaction to the public participation.

More peripheral team includes people from economical areas, sociological areas, demography. Sometimes you have difficulties to include these disciplines in the creative process because some of them have training designed mainly to describe and to analyze. This happens a lot with geographers and sociologists. To move from the analysis to ideas to proposals. There are always few members that although included, are less participative.

Then you have more cohesive group that has more participation, architects and landscape architects developing the form and the shape.

**PH What things do you look at, are there any tools?**

1D I have been developing a system of approach that includes usually the evolution of the site. It is based on the concept of urban form. Based on that approach I start to analyze the site. It has to do with the recent evolution, as much as I have to go back, I don't have a fixed period to analyze. From that I try to understand what has to do with what in the field. It has to do with spaces that are apparently not so well organized and not so well connected. So, in a way it has to do with putting things apart, to put them together again. The background, the history is important and the functional organization of the place as well. This gives you a frame of what kind of place are you dealing with and I have and what I want to achieve. What I want to achieve is to leave out some urban features that are not so interesting or important in my point of view, because they didn't produce enough critical material to be included in the urban form and urban structure. This is an example of what I do with the history of the place, I erase a few things or I bring others to the front. Also in functional terms I try to combine the size of the area, a kind of self-supporting system. Bases on the previous form try to see what is missing in terms of functions. 10 years in the future is usually our horizon.

**PH What are the typical problems in the process?**

1D One typical problem is that you are getting tools for a problem but in the end the problem is not the same and you created the whole artillery to do something. Other things that can happen is that you as an educated person have a certain view to a place, a goal and a perspective and sometimes it is so difficult to communicate, or peoples' expectations are totally opposite. Of course one cannot say that peoples expectations are wrong, but from your academic point of view and your professional experience you see it so obviously what is missing and what should be, and people want the opposite.

**PH What tensions are there between the disciplines?**

1D It is difficult to find a good civil engineer. Their training is usually made for infrastructures taken out of the urban context. Sometimes you suggest things and there is a resistance to new solutions - but is more matter of finding the right personal profile. With political side, either there is silence, or there is a political agenda. Sometimes reactions are totally strange.

**PH Do you use any specific tools?**

1D There are no pre-established tool. There are things that have to do with quantitative issues, the amount of schools you have to have for certain amount of people for example. You have here and there good practices you can learn from. You have technical tools and best practices and you combine them with and certain approaches you learn theoretically,

mainly in school.

PH Could you describe the process?

1D In the urban design projects that I have been involved in, have been always connected with urban planning, designing an urban plan. It is not designing project connected directly with construction, it is the previous step. You have to anticipate conflicts, needs that are related to the urban space that you are dealing with and usually I have been dealing with the broader scale, which is not confined to a small urban public space, but with a structure of an urban area. What is not very creative is the steps you follow, since it a process pretty much established by law.

You get a problem from the municipality and then you shape it. Then I get a feedback. Then there is the first open public discussion where people really speak about them as a community. There are not yet any solutions to discuss, it is only about expectations. Then there is a phase that tends to be mixed with analysis and starting to have ideas here and there. But, not just ideas, but also inputs that arrive in between. (From municipality) 'We have this idea of making this project some years ago we would like to include', or there could be European money to something we would like to include, or other things. Then there is the point you close the analysis. You have experts from the outside that evaluate the work you did and then you start to work on the proposal you are more focused on the proposal. Then you have the validation from the political side when the plan is ready. Ok, let's open the discussion.

Then there is the public discussion, the public session. By law people it is mandatory to have these proposals on-line for public so people can check it there and after a certain period you have to do an evaluation. You have to submit a report to municipality. This was the public discussion we had. This many questions, for these ones we say yes, for these ones we say no, these one we have nothing against so strongly that we say no, so they can also be possible. From that we close the process of discussion and then the political part validates again the work. So, there is the technical proposal, there is the public participation, and there is a combination on both. Ok, let's approve and then it is voted by the local parliament and then it is published and starts to be a law.

## **Second set of interviews with project architects**

**November 2010, Rotterdam**

**(Using cards with tool groups)**

**Pirjo Haikola (PH)**

**Architect (2A)**

...

2A Process tools in a way I have used. Internally self-made ones - kind of steering mechanisms. Standard thing is for project control and planning and these kinds of things. Things developed here, basic excel based calculators, which you could say are tools. They are efficient and maybe not standard management tools, but work very well for organization here at least.

It is still one of the ideas we have here to line out standard steps in the design process. In this company, but probably in many other companies, there is a big brain drain because you have a company culture in which things work and when people understand the steps they are about to leave again. It makes sense simply to write the steps down and use them as a handbook.

Somehow it exists here in the collective memory. There are also rough sketches for it and rough first list, but it does not exist yet as an elaborated functioning tool, it is half there. For project management there is a up-dated system for managing planning, which is related with management of staff, to working hours, and simply holidays and these kinds of things. Project budgets as well. In a small competition it is slightly more oversee able and becomes more complicated with ten years for urbanism. Those tools we developed ourselves here which work I think really well and which we use to monitor the process during different stages. There are also mini plannings per projects which are really practical, and then there is the overall planning of the office which is more managing budgets and staffing than the project plannings do.

I think this starts to make more and more sense as creative process is under a lot of pressure. Budgets have become more and more tight, rates higher and higher, so it becomes just complicated to still work with a decent team and to deliver decent output. You can become efficient and indeed not only towards the client but internally. When you can see for example in the analysis phase, 'ok it is pretty short, so we can only do these things'...it helps you prioritize and it forces decisions so it is a good thing.

To set, I always call them mini sprints in between deadlines, is really valuable. Because it is a standard thing you see in many architecture firms and presumably everywhere else in the creative industry where all the pressure comes towards the end. It is the deadline moment and I am questioning if it is really needed. To have these tools, to have more grip of the process, makes it much more efficient. I don't know dfss, I will look it up.

...

Open source. Of course I know more as an internet tool. Wikipedia is one of the most successful ones, which is highly interesting and things become more and more complete. I think it is interesting to relate it to sort of creative commons on how to share design knowledge. I would be open to it. I think the 'give away your ideas' article which we had in AA was really interesting in that sense. On one hand it is complicated for the office on the other it is also stimulating. Good perhaps to see KM3 telephone book of concepts essay. The question is, how to bring it to a next level, or to the next step?

...

HFA we use a lot. If that is really a design tool is questionable, some yes. I think that in the discussions we are having now, that through Rhino you can connect to grasshopper and

scripting tools and the potential design function they could have, could accelerate that and expand. And then the question is, what other parameters you could connect it to? Those are new steps and new questions we see in design process.

...

#### On-line forums and groups

Highly interesting, but not very effective yet, since it is part of the twitter culture with too light comments that are not really constructive and useful content wise. Can be very valuable. I don't know if in that sense I am experienced enough to be day to day user, but, if you have a question and you visit one of these sites and some better sites are very useful. For design not. Also the open source I would say is quite close to it.

AR is interesting but I have never been...I simply don't like the gaming industry. I am not too much involved in sci-fi and these kinds of things. Although it is highly interesting it is not directly my thing. Maybe you can compare it Revit ...you know the design of the pixelated rock with geometry on one hand which is combined with the repetition and reality of office building. Like that we could step by step through the design process test all these elements like brick beams and façade patters etc. so that would be the application or the level I would see to use it here.

#### Tool Concepts and directions

Process Navigator Like a contractors plan? Of course you have systems like smart ftps. The risk is that it creates bureaucracy, making things counterproductive again. It is interesting, but the good old 'write a small memo together with a small Pdf' is still the most efficient form now. So, I am deeply interested in your conclusions in that sense. A navigator... What you see often in the decision making process, is that when they become more political they line out this tree together with the phasing. I can imagine you do something like that. That is why I mentioned the contractors planning, but for the design process. A Dutch expression would be 'good planning is half of the work' but it is really true because, if you make a good tender, a good offer and it is part of the contract and you think about it really carefully before hand, it helps a lot. I can imagine that, from that, you distill this contractors planning and you manage quite precisely if you are on track, yes or no. It has to do more with experience still until now, so I can imagine it has to do with this standard protocol for process that can run parallel. It is sort of a dream here and it half exists.

Idea Contributor The question is why would they give it (input for projects)?

Question is, would it directly work for the creative industry? It would work for different professions, let' say for bigger electronic firms or chemical companies, because they do these competitions where they make a call 'please come up with your ideas in saving energy'.

It is what you mention as well, the credits and royalties. Then it is directly highly commercialized and if I imagine what kind of people would contribute to smaller firms like us, then you would be bombarded by advertisement I think. Really what will people get out of it? It I a question of inspiration and ownership really. How do you credit somebody did

he/she contribute 1% or?

Ownership of creativity, cloud sourcing, cloud thinking or cloud funding that you find in the internet are things that start to work. You can ask for money to wash your car. These kinds of things start to work but it is not really a big deal yet. I think it works for idealistic initiatives where the designer as the master brain does not exist yet. Ngos, public initiatives.

Or, maybe it is more the other way around. The cloud funding and these kinds of things. I see a lot of potential there that people do not contribute to the idea, but is more that the idea still comes from individual or small group and it uses new sources to raise funding for it. Designers and thinkers become developers themselves. Change the profession and change the process.

Small to Large, Research Scaler and Discipline Combinator

Scales...True, nothing to add. The famous phrase already from OMA I think, that by doing basic plans the buildings became better. And by not specializing and focusing on one scale, being a generalist, and working on several levels keeps you sharp. And by killing the classic organization tools and classical architectural tools and by merging these things and inventing new tools, overlays and combinations. But, that is also where is see potentials when you scratch to other disciplines. How architecture can learn from material engineers and nanotechnology? And on the other hand national planners and politicians? This is still from s to the xl, but when you really go to the extra extra small to the superlarge new fields than can be...

so, completely agree.

Semantic Referencer. I think it is interesting, because it stimulates and helps in terms of creative commons, since it is will show that almost everything has been done already. Design is becoming more and more a process of selling and you don't have to be obscure about your sources. By being confronted with the past and with the things that are there already, it stimulates improvement. By not having to invent things over and over again it becomes more acceptable for people. It is also more clear where the previous one stopped and where you can pick it up again and simply make it better, and the previous author can also be happy.

For my thesis project for development of the generic office I used first half a year to study in depth the history of the office. By having that as a reference I was able to formulate a hypothesis and by that indeed to generate something new again. At least the awareness of the status quo, lets call it like that.

But this one is highly interesting actually, because it is something I mentioned earlier in the



previous step we had. If you think about the design discipline, well it has been going on for decades but, you become this generalist and you hire experts for everything. We start to be more and more on the level where we don't understand what we are working with anymore. For example, in this whole sustainability debate, if you want to fundamentally enter that and really integrate that into the design process and come up with constructive and valuable answers you need to sit with Arup face to face 100% of the time. To be able to take steps and to some extent parameterize that, to turn that into scripting and incorporate that via Grasshopper to Rhino is where I see possibilities. Not only with sustainability, but many things, access ability, economics and so on. So many side specialisms, like mapping tools of cities and walking patterns and driving patterns. It looks fantastic, but what should I do with it? I should be able to integrate it directly. It is the interesting and complicated thing about design process that if you take them (other disciplines) seriously they are going to change things fundamentally. Because I want the information from the consultants to effect the main concept. It becomes this cloud or team of consultants and companies, and how to manage that process becomes more and more interesting.

**Pirjo Haikola (PH)**  
**Architect (2B)**

Existing tools.

2B HFA. Next to the pen very important... Spoken word is almost as important.

I find that more and more language and sketches, especially when you are talking to the clients, are becoming the tools to communicate directly. Of course you need images, but you always start sketching when you want to clarify more.

Serious games, I tried it, I worked with it. Personally I try to use game engines... To load your model into the game engine because it gives you more freedom to work around.

...

Open Source, if you are talking about the practice of open source software, yes, it is of course part of the process. It is also not something we are aware of. We just use the tools that we need. It is not something pursue actively at the moment.

Process tools. ...I am trying to see what are you...(explanation)

At the moment this is not part of our vocabulary. It is also hard to see. Maybe, I can see when you want to check your position when you talking about a product. It would be interesting to see how can you do this for example on an urban level? Is it you publish your plan and letting people react on it or?...How does it work. Could be interesting, I just don't know...how we could use it on an urban scale or on a building.

ISDSS I would say we are at the moment limited to simple GIS spatial planning tools. You use GIS to get information out of and put information in. But, I know that of course you can go much deeper and you can use these spatial tools for example to look at climate and at smaller scale what is the climate around your building. I know some of our advisers use it

but we don't use it ourselves. It is interesting, because this morning we had a discussion at the project table about four projects we just did. You saw that every time the client asked 'I want a green building, or I want a'...The question is always what is now green? Low energy consumption, is this really...? Low on energy but no social parameters...and that is something that in these spatial decision tools you can test, or design your urban spaces or also your buildings. How does it work if you make a flatter building, or a higher building etc.

...

MUVES I don't know it from the building experience. What you see now with on-line environments is that with an urban spatial plan, when you start selling houses, they create an online platform on Hives or on Facebook and use this to communicate how they do things...but we don't use it in our design practice. And of course we know it from the role playing games.

...

CSS, GSS. Software that assists in brainstorming. For example these interactive tables, also these Smartboards, that you see in all schools at the moment. They are of course really good tools. If you combine them with, this software, what is it called. You can couple a smart board to this software and people can join from anywhere and start sketching on your smart board.

It is interesting, it has to do with going back to the HFA tools. For example if you start to look at the latest development like Revit, where the idea is that at the certain moment, the model you have created is not going to be in your office but placed somewhere else and you work with more than one person. There you get this problem of project management and discussion when your client wants to change something and you don't allow it...How do you structure all these ideas people will have and all this information people will want to put in? Moderation of all this information, in these kinds of tools become really important. Hierarchy on moderation of comments. Like in Revit, certain person can be a leader of a certain task and if someone wants to change something he will have to approve it. How do you moderate this and who is going to moderate this?

These tools are the most important, but the least important, because you don't work with them, but they steer everything. And if they work really well, you will never notice them. And then they work actually. They can help a group work together better. When you have different companies and different ways of working, these tools could become really interesting.

Structuring of the decision making. If you have these paths clear for everybody. When you work with larger groups, it is of course more and more difficult. If you have this underlying management system that can steer people, it will of course always help. And help eliminate frustration.

...

PH New tools concepts and directions, how would you compare?

Tools like this already exist of course, Process Navigators. You describe it a bit more deeply. At the moment, at least I am not aware, that they would be this far developed. I don't know if it helps increase creativity. In the end it is a process navigator, it is more like a management tool than a creative tool. If you were to use it right, that is how it can help increase creativity. It will help you make decisions. If it is a tool that is accessible to all parties it of course then helps to structure the process probably. About creativity I don't know.

Idea Contributor. (long silence) It has of course something to do with...it reminds me of how people work in open source software. Where you work with different kind of copyrights and some people just do more, because they want to do more. Some kind of portal were you... It is almost going back to the first card we had. You have these groups in the Internet where you can post your questions and you get an answer, or not. If it is a very good working group you will get an answer.

It would be really interesting, what you say here, especially for details, materials and technology. Developing ideas, yes, but... On collaboration on a part of a project...I don't know. Would be interesting to try. But, it is an Ego thing then I think. Someone asks you a question, and as a designer you always think you have an answer. Maybe not always the best answer, but you always think you have a good answer.

But, of course we need input o new technologies, new materials.

What we find is that when we for example try to get something new in another country is already almost impossible. How can we for example get things to a new market. If you look at the Dutch market it is quite easy actually to get new materials, new technologies in. we are quite open, or we used to be, to try new materials and new techniques.

Developing ideas, collaboration, I see a big problem - Egos

Discipline Combinator is something that would be very interesting. Again referring to the presentations we had this morning, where you see that we as designers, or as architects, do a lot on intuition. We 'know' it should work like this and then we try to test it with the parties we work with. And we try to incorporate this knowledge in a really early stage, but still we see that there is a lot of intuition. If you somehow can communicate this, or get this info from other people on a question in a much earlier stage, even in first sketches... It is all about knowledge and there is so much actually that can influence your project. It goes from the urban design to the smallest detail on a house. Discipline Combinator, how can you make sure that if you have an approach that almost on a first sketch people can already react and say if you do like this is will work better...How can you in a very simple way communicate your first idea and your first intuition? How can you share this easily? How can you communicate something really simple, so people can react to it, is then the question. And I don't know yet how you can do this.

Semantic Referencer. You don't connect to the whole world, but you connect to the knowledge that for you is interesting. Actually you are limiting the input. If you can really, while discussing get this information and you know that it is interesting information - that is now of course the problem.

They tried it a little bit with the word clouds, but if you can get this on a higher level, it would be very interesting. But somehow it always needs a lot of input on the back. It needs input from you, but also a broad range of people. But, I see it will be there and it will be a design tool. It will be a discussion tool. If you have something that really works. Now, if you would try something like this there is always just too much clutter.

(general discussion)

What I really like is process of negotiation with everybody. That you get the best product possible and it doesn't stop until the building is really built, finished. As a whole process it is something I really like. What I lack is somehow the combination, and getting the right people at the right time and the right information at the right time.

There is so much knowledge out there and we work with hundreds of people but we still have a limited knowledge. They are really intelligent people, but there is so much going on... Sometimes you want to know about it. Not only getting the things you know, or your advisors know. And you always steer people because you have a question and they react because they know who you are. If you can somehow pose the question broader, to get other answers. Answers you didn't expect are sometimes the most interesting.

Actually it is really really nice, you came up with a different approach I would have thought of. It is also nice to think about these other elements, again, Some of them you thought of or tried or but then you just forget about them again...

**Pirjo Haikola (PH)**

**Architect (2C)**

Existing tools.

2C Process Tools, this we know. Not in terms of programs, but of course you always set up a kind of project management system. We work with a lot of web share programs to share production. We have Basecamp. It is always that one person sets up the structure, but not that there is necessarily a program.

It is funny because we see now for example with Breeam and with these certifications for sustainable buildings that they are all set in a kind of a matrix weighing system, which means that basically the management under layer starts to dominate your whole design process. Because you need to score points, and to be able to get these points you need to kind of prove that you have done these particular steps to get to the result.

**PH Do you feel it is limiting or?**

2C No, no, it enforces a lot more integrated design. Because a lot of points you can only get by integrated design, with insulation for example. I rather applaud this, it makes everything more clear. I don't know any particular program for it, but I do think it is a very strong trend at the moment, also for bigger more complicated projects. There is no way a single brain can, you know... You need a system that can cut it down and show you what happens when you change things and...

...

Open source. I know this but we don't use it.

Multi User Virtual Environments.

It is pretty interesting actually because this is what we are now doing with the... We are now learning to work in one model with all the advisors, everybody has to put their stuff in the model and it works quite well because it allows you to work in a kind of a virtual environment.

On-line Groups

We only use our own advisors. I don't think social networks or social media will be really helpful for really good advice. Good advice is something that is always worth money. In our line of work where we very much work with clients directly, I am not sure if you should be entirely open. Same for our website. We are now making a new website and we are limiting it and the amount of projects. For most of our clients we don't put the projects on the website because privacy reasons, so lot of villas we do are not on the web. We noticed with new clients that when they find out that we do a lot of really big villas we don't put on-line, they are first of all surprised because they check you out completely, and secondly they are charmed by the idea that we are discreet about it. The way you regulate openness is very important. And therefore I am not entirely pro-open source.

PH What is your process system?

2C When we do a pitch for a project we always do a very much integral approach. We always want to have all the engineers on board in the sketch design phase, structural, installations and if they want an art advisor or something else...the more information in the beginning the better. In every project we collect first as much information as possible. No tool, it depends on the project.

For private clients we have a now a system, which has grown kind of automatically. We ask them to give the parameters they want. Then we give them 10 references of projects we think are interesting and that are very diverse from like medieval churches to supermodel architecture. To hear from them where they see quality of space. We have two meetings where we don't talk about our design at all. First how you want to live and what we think is interesting architecture and we see a reaction. Then we make three designs, almost always three, that are really different from each other. But, all three designs that we are comfortable with to get their reaction and make them part of the process. If you present them with one design, they might like 80% of it, but not 100%, and you end up dragging the 20% with you and it destroys the whole project. When you offer them a variety of choices they feel more comfortable taking on an active role and be quite explicit about what they like and they can start to understand that it is always a matter of choice, there is never a 100%. There is always one of the three that appeals to them by far the most. And then afterwards we present a crude design based on it, sometimes there is another step of two designs. The same process we use for choosing materials etc. it gives them a feeling that they are welcome to step into the design process. With private clients it works really well.

But with clients like this it is a different case. (big project with multiple stakeholders) The people are not in charge of anything, they are only in charge of the money. They are just managing the new building. We are doing this big office building for x consultancy company of 12000 mq. There is probably a manager sitting at a manager meeting and 'yeah we are going to make a new building so who wants to be in charge of leading the process towards the new building?' and one guy is like 'oh yeah, fun, I like architecture' and then he of course doesn't know the whole shit storm he is going to have with the developer, the municipality, the engineer and so on. It happens always with these kinds of projects. In this kind of project it is very difficult to get their trust because they don't trust anybody. We just produce a shit load of options for them. We spent almost an entire year only on the sketch design.

So, we made like a million options and we ended up moving the building to an entirely different location. And then we started to research all different parameters that would affect the site and we came up with a whole variety of ways of organizing the program. Every option has a few parameters, this one is for example very nice in terms of building cost but difficult in terms of making good office space. This one is good in terms of making good office space but is something the municipality didn't want...

In this case the client is such a multi-headed monster. X wants to rent the building for 15 years so they feel they own it, but they don't because they are renting it. Developer is actually a conglomeration of three and together they made a combination and are fighting like mad over the cost and the profit all the time. But they need to park the building at the investor, which is probably like x, a real estate investor. So, the investor also wants to have something to say. And then there is the municipality, but actually two, because it is right on the in between of two municipalities and they all want to claim the address because it is such a big company.

So, these 5 parties all have the feeling that they are the most important on the table. It took a year to get everybody the feeling that they are getting something. Every week, every week we have a 3.5 hour meeting.

**PH** Do you find that you start to get lost in a complex process like this?

**2C** We have been pushing for a very German approach and production moments. Produce something, present and we go on.

In a way it would be really good if there was a software or something to organize that. I know for example that x did these two big buildings where they did the entire process with the developer and the contractor and also the maintenance. Design, build, construct, maintain, operate, it is interesting because it is the government saying these buildings are just too complex for us, we don't know how to do it. Managers know nothing about it... and are not trained to do it. And there is no school for clients. So nobody knows how to do it. Then this company said we are going to tender it, not only the design but also the construction of it and the operation of it. We are going to make a gigantic package and

tender the whole thing and they did it now for two buildings. They were really advanced with a lot of matrixes where you can decide on things and weigh down different variables, like make a corridor 10cm wider to allow you to clean it easier. We are crudely going there, but are too much from the stone age to do it, because the developer should be the one who knows.

Now they say we put in the contract that 30% of the façade should be open. Yeah, but why? Because it has to do with cost. But what do you mean cost? We reserve 500€ per mq for the façade. But, can you imagine we use a façade system where we ventilate...ah yeah... then the following is like. But how would you do that? They can't fit it in their spread sheet. And also reversely in the end when we design something, in the end the developer will look at the design and analyze the technical risk of the design and how much profit they will get out of it. In the end that is the only spread sheet that matters. And that spread sheet says 60m is good and 80m is not good. And this is probably the dumbest one of all. I think it is very intriguing when it comes to these kinds of processes where you hit kind of rock bottom market where you have to be very efficient and smart.

Tool Concepts, how would you compare or organize them?

In our case the idea contributor would be difficult one because ideas are our core business and that is where we are really good. And we are really good at having an overview of all the other parties. We are the ones who combine the ideas and give shape to them.

...

We are working on a housing system with a young developer team and there we said, look we would rather be part of the whole enterprise by not getting fees for design but getting cost payment and a royalty payment. This also leads to a structure that changes things dramatically. On one hand we are paid partly because they get the most profit out of it. Then they also hire other advisors, but we are in it also to sell as many houses as possible. It is in a way a kind of an idea contributor because for a lot of technical things we say we are not going to do it.

We are now also doing it with a boat design. A boat builder asked us to re-design two existing boats, yachts, and we are designing totally new boat. And we are doing the same there, we have a fee for our costs and we take royalties also. And then he asked us to also the art direction of the company and supervise the entire strategy for the company.

I see that this is a real market for us. Architecture is very strong in this, because you are trained to be a generalist. I really believe in it, but at the same time it is really about hierarchy. Ideas always have this air of being easy, but actually ideas are really hard.

...

Discipline Combinator ... And I always very much believe in combination of disciplines, for example we always work very closely with the structural engineer. It is very clear you need to combine them but also entangle them, because you have to say this is your group and this is where you take liability and this is my drawing this is where I take liability. That is another part where I would say that in the end it is also something about responsibility and this is

where it starts to become critical.

Idea Scaler

Interesting, but hard to nail down what it would be. I think many projects are still divided. Like we had a long discussion about the car park (in the big project mentioned earlier). We said you have basically two groups of people, people that come and work for you and you have visitors. People who work here all have lease cars so, why don't you lease one model and color? It would solve a lot of issues aesthetically, but for them it was a totally idiotic suggestion.

Clients are not ready to do the work. I think that is a big difference with product design and real estate. Here the money has been made purely on the transaction of the ground and the lease contract. Once they sign the lease contract, and the bank signs the money loan, the developer is done. He gets the cash flow, in between there he gets 20%...after that there is no incentive for him to make a better product. It is a real fundamental problem of real estate, especially in Holland because the whole real estate engine is driven by changing land value. So any piece of land without a building permit is 30-50€ per square meter and when there is a permit it is worth 300-500€. It is an insane difference. In this crisis and post crisis design condition, we are trying to make processes that are not the classical process, we are trying to make them into more incentive driven.

### **Interviews of functions and interactions of the concept Paper prototype with transparent tracing paper**

**October-November 2011, Rotterdam**

**Pirjo Haikola (PH)  
Architect (3A)**

PH What is the overall impression?

3A Would you also like to have it flat [the black square]. Yes, and ideally when you want to have a set...maybe I would accept it more if I would be able to turn it more like this way (more central) If this thing would be like this in front of the screen and things going up and things going down...it would be somehow more natural to me that it is more centered.

The other things is that, I like the funny shapes that are coming up, but if there is a document, I would prefer to see the document already. Or an icon, like a screenshot,

PH What information should there be in the files?

3A If I see this whole thing, I mean there is a lot of space around it. I would love to see the documents flying around somewhere. In the ideal case when I have to get structure into a project and I haven't been working on it for a while and I haven't done my administration right and I really have to clean up, the first thing I do is to put all the paper on a long desk



and try to find things. If that could happen and I could have a program that is automatically putting these random files that have never been stored correctly into order.

So, even if there would be a large cloud of documents right here (on the top left from the project tube) this thing is linking to it or the document is coming that would really help it would give me a kind of comfortable feeling that all the e-mails and all the agendas that I can see them somewhere there.

Then whether it is...for some documents it is preview of the first page could work if it is computer files maybe, I don't know, maybe the first image you see if you would open the file. Whether it is this stair you would see that already in a miniature version PH perhaps a zoom in from a document, if it is very big, or a long text file.

Then also for me, now it is a bit abstract, if you work with it for a while it is perhaps easier, but in the first place it is hard to grasp what is it. But if the documents are there, maybe it is even, you could have for different people you could also see a photo of a person. You could have these very formal projects where just the general description is there, but if you, if it would be possible to have for instance here the Arup logo put into the circle. That you see instantly and you can customize that or you can give a different color to this one or so... Now in a way it reminds me of induction heating stuff (laughter) and this black thing is quite harsh. To tweak it or leave it open so people can customize that. If I am for instance working on several projects and I know this black one is for this one project and I have a another one for another project. You are probably opening this kind of visualizations several times or have many open at the same time. (Note outside of interview: so in order to distinguish different project visualizations from each other, logos, faces or something is needed)

**PH Are the necessary objects and functions there?**

3A One important thing is that, in the phases is to fix deadlines, important things coming up. Like then we have to submit the building permission. The way it works is that when you are planning you say, ok, we need 8 weeks for this phase and then we work on the next phase, but once you are busy with it the deadlines which may be postponed or so or...they become crucial elements so.

Can you imagine that in this case this is our first deadline this circle but what if we had additional circles, maybe red ones. You have different points that are coming up.

Then it could be nice to indicate for that one that this deadline is actually something these guys are...it could also be for the whole team but (draws additional circles before the ending of the phase, different sizes)

It would also be nice to...ahm...I mean the phases and the dates should be able to shift and then one very practical things, vacations, Christmas, summer holidays, different kinds of breaks, which I could imagine for instance that they are somewhere on a different spot (indicates the x-plane) the question is whether or not the people are taking a vacation then, but you see that normal people are on vacation here and you see

PH Maybe if some stay working those tubes remain and other are 'cut' at that point.

3A I would say for the elements there are phases, vacations, people involved, maybe it is coming back in another question but, for me this would be really great if it would switch, I work with outlook, or any other environment people use, if it would be directly linked to that..instead of fixing who is in these meetings I want to be able to say for ...I am scheduling a certain meeting and these and these people from my contact list and automatically they get their place in this one.

Or vice versa.

yes. We need to plan a meeting but we take only these and these people for this meeting and you generate the meeting.

PH According to which parameters you need to search information?

3A I think what I am using most to find something is the name of the person the e-mail was sent to and then I am looking for the right...fishing among the timeframe, but actually what I am looking for is the fire escapes or the first network meeting or it is actually these topics or these keywords. Like hash tag in documents (twitter) that would be something I am now not use to but you would need to learn that you tag your documents, e-mails and documents and so on. It could be so great if I can switch on that one and I only see the escape staircases or coming up and I know everything that happened before 2009 I don't need to bother, somewhere after that my information would be.

If I am like that scanning the information one thing the program could then do is that I could stretch or shrink the time, it must be between 2009 and 2010 and I only want to see that and if the period is very long I would like to be able to squeeze that.

The other thing which could be really nice is if these symbols or if there would be somewhere next to it if I could already see, show me excel files and dwg files and pdfs, please arrange it for me, then I can see here we had several pdf and a dwg so if this is the right dwg then probably the pdfs around it would be good for me as well or that I could say please arrange it which drawings were done by Arup, this is in it already I guess.

Would also like to hide everything else when choosing a timeframe.

PH Which things are difficult to remember?

3A Easiest things to remember are deadlines, meetings - things in preparation, difficult things to remember are the one not directly related to either of those. Like you need to develop the floorplans further but you may not fix a deadline for that and then it is more difficult to see that I should have done that by now. So have things underlying thing, like to you have to fix this and this this week, but you should also continue writing or continue working on that and that.

PH Would you like to have reminders or see it somehow.

3A Yeah see it like a nagging thing on the back of your head but something you can also turn off.

...

This thing here next to it, so when I am doing something I can see parallel...nice thing would be that I am making this meeting and I see Peter is all alone left here, I forgot to invite him. I realize when I make these kind of meeting normally I get a certain pattern here.

...

(customizing colours)

Because then for me, when I have a larger project and I want to instantly be able to see.. in a building I might assign everything that has to do with facades blue and everything that has to do with the structure of the building yellow. But then it can be that in a different building I am working with different colors for different advisors, everything for mechanical installations is green and everything that has to do with structural engineering is white and even if I am there as an architect or there is a task that counts for everybody related to structure then these task documents get this color. So I would like to use the color as a simplified version of these tags. Because in different projects I would be able to dedicate that in different ways.

Of course things overlap so some things might have several colors, but for me that would be another way to sort out my project. I just realize right now, because I just did the financial overview for xx again, and I am getting this table from xx what is expected from income and spending and what we did until now and I click what we did in terms of salaries I get an excel sheet for every spending, but it took me quite a while to translate that to my excel sheet because that is of course working with education, research publications. I want to know how much time we spent on the last aedes workshop. Theirs is organized in a different way.

(about assigning with colors) it would be that I have my structure, or we agree with the team. But different parties in the project have a different structure.

PH How should the meetings be linked to other programs you use? But more specifically how to deal with overlapping meetings?

3A What we had in one or two occasions is that people used Doodle. You put online that you want to have a meeting in the coming three weeks and you can manually fix when you would be available and then this thing is telling if you want to have a meeting you have three options either it is ....It would be nice in this one if I say I want to have these here and I put the people in and I say two hour meeting it could be showing me here or it could be here or...it should show me day and the time of the day. So, I could say two hour meeting in the next two weeks. Would the program mail these people or...? Ideally you would share and agenda for that.

Either everyone is working with this program or you share outlook agenda or...I mean in

outlook you can already do that, compare different agendas and fit something in.

**PH File icons. You proposed a different color scheme. Would it then be enough to only have the urgent, red ones?**

3A I still think there should be the categories, to be approved, overdue, critical, less critical...maybe it could be done by linking, or how light they are or something like that. Maybe they are more or less transparent. Maybe you don't always need to see that. Difference between something that is planned, something that is in progress and something that is finished, but for the rest you could switch it on, show me all the urgencies. Blinking, or transparencies.

And in a way I would like to be able to switch it on a off. It is really irritating like on the laptop program which starts jumping. I want to be able to ignore my urgent deadlines. (laughter)

One thing about the files, I don't know if it fits here or not, I would for sure, and it is probably making things harder for you but, if this is something the other parties are also working with the I would like to connect this to a repository (Pirjo explanation that ideally all is in a cloud, hence that is the core idea)

**PH How about saving the file, seeing all versions or last save...to avoid clutter?**

3A I wouldn't mind the many icons if I have here..i'd rather have file arranged here, in this plane, more and more and more files, but if this file is a drawing that was saved her and here and here, and then it had another name here. And sometimes you can even see that now I split it I make a different drawing for the interior and exterior. So, I took this drawing and I made two different drawings. I think this would actually be really cool to see everything. I could still say, show me the latest version or show me everything.

Because I want to be able to go back. I see now that the emergency staircase doesn't work, when did it go wrong. There were some meetings what did we decide on this staircase. We said that we should have a capacity for 2000 visitors per evening, wait a minute now we have 2500. What did we draw at that time? I want to be able to link to that file.

(Pirjo, ideally then these have to be linked visually that you see this was one file saved many times and here it become another one, another line)

Here, this thing for me makes a really interesting jump because it is becoming the repository and a kind of backup and I have the whole project history.

**PH How about leaving comment in a file? How would you like to do that, see that?**

3A I would love to have is to open, say this is one drawing file, I am drawing it and it is fixed that I can change it but you can't, but what you can do is on a drawing or word file, you can see the file and you can put a transparent paper on top, just like this one, and write something on it and it remains that you could even go back in history and see that at this

point Peter put a foil on top saying, guys watch out this is only for 2000 people per evening, are you sure it will not be more later on?

Putting a kind of a foil on top, that would be really great. It could be super nice if I am working on something and I know rest of the weeks no meetings I have to adjust drawings (note Pirjo, these notes could be visible on top of the floating previews) tasks could be linked to that and then I collect these kinds of sheets and I put them on the screen. It would be very nice then to say I am taking this drawing and I want to see all these comments recently (so you collect all these notes) yes, then I see this one I have done, it is getting this thing (draws and x) could even write thanks peter this is done. I can see this one is still have to do. This one I don't know what he means so I need to send him an e-mail (Pirjo the program could also tell the person when he opens it ulf doesn't understand your comment, please check)

Actually peter is saying reduce staircases and x is saying we need an elevator. This is something where I could call them both, but it is becoming a problem and I am scheduling a meeting. Literally doing what we are doing now but as a digital version would be brilliant. The tasks, anything else?

I think I would, I mean already in outlook I can get an e-mail and follow up and it turn e-mail into a task. That is something. I would like to be able to turn all kinds of things into a task, these comments foils...

yeah, it would be nice to have some preset tasks like building permission. You are working on, or as a client, you work often for the same municipality you know, maybe I could even download it from the municipality...

(these are perhaps more the deadlines we spoke about earlier) yes, but it still including that before we have to finish some things, but task could include we have to schedule a meeting with so and so make a presentation etc. same for the building permission you have to make this calculation etc.

I am imagining these are a bit like deadlines...but that deadlines get a different meaning, things to do by that deadline you can give it a week actually you could say that this is a typical deadline, hand in a building permission, it is including several tasks, some are shorter some are longer

(drawing tubes attached to deadline circle) somebody has to do this ect. So deadline comes with tasks, some a very general, some are specific like schedule a meeting with a guy from municipality to check and it has to be two weeks before. In a way deadline could be a package of tasks.

One more thing is that tasks have relation to each other, I need to hand in the building permission so I need to make a drawing including the structure, so the structural engineer has to have it. So there is a relation he needs a sketch from the architect before...to be able to..so that is what planning programs for architects have, these kinds of relations.

(would you need to be able to link these tasks somehow? Ideally that moment is again a deadline of sending things around or it is a meeting.

But I think a typical standardized task is could look something like this... (draws arrows from

a task to another)

So the relation is important to show visually also

Yes, exactly, so when looking at it you realize.

Could be helpful to be able to have predefined tasks or to copy tasks.

**Pirjo Haikola (PH)**

**Architect (3B)**

PH What is the overall impression of the visualization?

3B I think it is abstract, but in the abstract way it is nice.

PH Are the objects sufficient, do you need more or?

Is there something you check a lot that is not here?

3B Things we check all the time is the brief.

PH So, here in the beginning of the first phase you probably need to have it, many files?

3B Yes, a lot of files. Also regulations can be related to brief but we check among other parties all the time lot, or add.

...

PH So, we would have to have the regulations somehow visible...?

3B Because this sometimes comes during the design process and add more regulations.

PH Are the regulations related to certain parts of the building, that you find out while working on a task?

3B Yes, it is related to parts, information about.. related to tasks.

PH Would you like to see regulations differently from other files?

3B Yeah, in a way task is, somehow I see it...you are searching for certain results. And the regulations is a shared file, knowledge to support your design task. Or general for the whole project. Or in a way it is a library, a shared library with certain parties.

PH What things are problematic to remember?

I think after each meeting the notes, and decisions you took, you check quite often.

Is there anything how you would like to see them differently than now? Now you have word files and e-mails....

3B In a project right now I am facing, we have a meeting and you e-mail to team members. I think the interface we are now using, the word file and the e-mail, it is kind of..because you communicate with the client, to write in a word file is not really efficient. In the e-mail you build up your communication and so in this way I found now I am facing a problem. So, now I write to consultant or other party about my question but if I can forward all those answers to my team member, but I have to get out to save or like..write comment or...

PH So, the problem is you have to keep going back and forth between word file and e-mail?

3B Yes, and sometimes I don't copy it because they are all saved in my e-mails. So that is what I found out, there is no easy way to save all...because now I have sometimes in an e-mail sometimes in someone's attached file.

PH Are these more related to comments on things or meetings or?

3B both

PH The discussion about something basically?

3B Either messing up the attachment or the e-mail. Things cannot be saved or recalled in a clean way. (discussion on the idea how the system would do this)

I think that could work, for example I open an autocad file and I have to e-mail the comments, but you don't see that in the file, you have to go back to the e-mail.

Here you would see the whole history of comments?

PH Yes

...(The use of colors)

3B You have to get used to. Like when you are an urban planner you already know for a long time green is park so...

PH Would you like to be able to customize them?

3B Yes, also to add new colors...

I am thinking what else could it be than color?...

Because circle for me now is..if we have really different people for example we really need to involve one person it can lead to very difficult shape, and its cute, but in a way I don't know if, because this happens only once so you get all different shapes. Is this shape really

necessary? Because the shape doesn't matter, what matters is who is there.  
To me to know who is involved these are the most clear but somehow circle can repeat quite often, is there an easier way...

**PH Like to copy the shape?**

3B Yeah, perhaps you have three lines and three colors (draws a shape with three concentric lines in different color, presume when the same groups meets often, works on the same files etc, to avoid repeating shapes in different color, could also be coaxial, when it is a continuous object)

So you know these people are always involved in this thing don't need to see three or five times. Also nice to see all together. An offset of three or more colors.

...(interface)

3B It reminds me of wiifit, you have a really clean table and you have many players and you can really click them and go into...I think that is nice, you don't want to see too many things going on here. In that platform you always see first the main player, the main user

**PH About the reminders, we spoke earlier about the e-mail. If you don't use e-mail so much, how would like this system to tell you about comments etc?**

3B Could pop-up, like Skype that you have so and so many messages...maybe it is not necessary. Or this interface should come up with then you check you sent a message and which file. That you receive automatically every time you go [in to the system].  
If you click on the message it takes you automatically...

**PH Scheduling meetings...conflicting agendas?**

3B I think it is really nice if you can see everybody's open schedule but in way that is not possible. I think sending an invitation here is more practical in reality and then just like a message you receive and you have to check. Would be good to see always....you invite three people and how many already accepted and then you have to either wait for the third one or...or go to that person to check.

**PH Perhaps you don't put it on one day, but you give more options? How do you do it usually?**

3B Normally we do like, we meet early this week or that week, would be good to have so they can choose two options and then people can react

**PH So, you create options and then you have meeting in waiting in a way?**

3B Would be cool to have this system and you don't need to reply by e-mail...wait and...

**PH File statuses? What do you want to see what do you want to know?**



In each phase I want to see the result. The pdf or the powerpoint...  
So people can go there and see what is the conclusion

I have always this folder 'lhide' (if I understood correctly) some things I don't use but I can't throw away.

PH What is in that folder?

3B You have like the old floor plan or old options. It is an interesting folder because you cannot delete it you want to keep it

PH If I understand..here you can see all the files, but this is more something like old files you would like to hide them. Outdated maybe?

3B Yes. During the design process you always work on the current and that kind of file I mention is also not from early presentation. It is just your work in progress

PH Here you see the blues are work in progress, would you like to give another color or something for the outdated?

3B Yes, because this you are still working on

It is active. Yes, but there are always not active files and it is not a library, it just crap you produced

PH Perhaps they need to change color when nobody touched it for certain time it turns grey for example?

3B If this system can create a function to sort it this out...not just saving double daily or something but save only today. That is also a design problem you always have in the end, because you finish here and you need to clean all these files. Like in the phase you don't have an option yet, so you create maybe 20 options but those things are interesting you don't want to throw them away and maybe you want to use them in other projects. Still after you finish a project and you have to clean up all the old files is always a problem. So I wonder if during you save everything and these files can already go somewhere? Sort it out in a way that it has another 'folder' and with certain files you carry on until you finish

PH You could see here perhaps a line that is a continuation of a file and maybe here you have some disconnected attempts they were not leading anywhere but they were just tries. You can see this one was stopped, but this was continued for a long time, so you can tell we should keep this one.

3B Yeah, I would also like to see them (the disconnected ones) in a place which I know after I finish this project I can keep them. This means they have a certain value.

You are searching still totally different ideas, not so related to the result but I would like to see them still after that project is stopped.

Higher priority files...experimentation...

This also gives the files status, this is about the project this is others, supportive, references,

**PH** Could you maybe categorize different roles of files? That might help me make these...

3B Because in our office we have always this...folders for files in different formats...you have presentations, documents (like minutes etc), besides this we have like image and 3D. In images we have diagrams, references, photoshop...so it is mainly 2D and 3D...

Looking through your diagram also I was just wondering how this file can be in those folders...

**PH** The tasks? What do you need to know about the task?

3B Normally if we discuss the tasks we write some briefs. It is more like you send a clear task division and then you send out to everybody, so they know ok you are working on the lobby, you are working on the façade. It is time and brief and everybody's role. Sometimes also contain the results sometimes the products like the plans and...So this is the task and this is the final result we need to have, this type of drawing we need to have.

so as before, would you need to see the conclusion of a task (as in a phase)

yes, the conclusion of the task, but presentation also.

If we do as we just spoke about you could look for the last presentation file inside the task...

most interesting is also this is the pdf we send out to be checked either by the client or by the boss. Would then always be good to see the reactions. For example xx always writes in a pdf on the top or in the e-mail this page the option number xx. Would be nice to have these here.

## **ANNEX 7**

### **Excerpts from software prototype testing with project and senior architects 2012 (four architects, referred to in numbers)**

The texts are only edited to eliminate the biggest grammatical errors and shortened to present the most relevant parts of the discussions.

**Pirjo Haikola (PH)**

**Architect 1 (A1)**

**Interview 20 March 2012, Rotterdam**

PH Please rate how you experienced creating a new project and adding objects?

A1 Quite easy, 4.

PH In planning things, how do the functions match your needs?

A1 I think they match quite well, another 4

PH Please elaborate freely on this question based on what you did.

A1 I think, the main difficulty in the beginning, which I think once you work with the program might quite quickly disappear, is that the symbols here don't really speak for themselves. It is not completely intuitive because I need to hover through it and see the names to understand what that is. For me that would probably go quite quickly, but I was imagining now where the clients are quite involved it would be good to partly let them use this as well and show them parts of it and then they would really not be familiar with the program and then it could help to have it...that was one thing I was a bit stumbling with. I think the basic idea that at the beginning of a project you most of the time very quickly have to make a planning. You have to have an idea when do I work on something, when do others come in, so I think it can really be very helpful for that. It could be nice not to start with a completely blank surface, I see you already have weekends in it.

I think what I would want is not only rotate like this but I would want to be able to flip this plane so that it turns from this view into this view (the side view he indicates with his hands) or the top view. What I would really like to have is that this is linked to my agenda so that I can quite easily see on the side what other things I have planned.

Now my feeling is, if I could put some other things here that are not related to the project, to watch out I have something planned. That information can be on the background.

PH Please rate how you experienced navigating in the 3D space, finding objects and information in it?

A1 I find it - using the tools themselves... Quite difficult, 2. The idea is clear but if I want to

really look for something, zoom into that, I find quite difficult.

**PH Is it about the zoom or?**

A1 No it is about more the 3D aspect of it, I am not quite sure. It feels a bit like as if I am in a room with a lot of things and I still try to find the right way to go through it without bumping my head.

**PH Do you think it is the way it is implemented currently as it is still a dummy, or do you think it is a more fundamental problem of the 3D?**

A1 I feel that the general setting that there is, I understand you have this kind of timeline that goes from bottom left to top right as a general thing, but I think what would make me feel more comfortable if I had a simple button which when I click this I get this timeline view. If I click this I get the side or top. I can imagine in some of those you can navigate much quicker.

I can imagine, I mean, I am used to 3D programs but this is something for the people who are involved in the project but are not working with the 3D programs they might be struggling.

**PH Please explain your experience in viewing information in a 3D format, compared to file folders, lists, 2D diagrams etc. or the other view seen in the demo in the beginning.**

A1 I think, we are not talking about how to change the view, but the general set-up, but this set-up, in this kind of 3D 'tube'. I find that quite revealing, I think like this in a project you can quite easily identify areas where suddenly a lot of... there was a boom or there was a lot of files were produced, where you, or where you see more people were joining or when a person left so. And it is clear when you think of the different design stages, you know it starts with a few people at the beginning, you have some important meetings with a client and people join in and then you have a large team with a lot of reviews and so on. This is something when working on a project that I have in my mind and I think this visual fits quite well. It is an interesting model to see it like this. I think this can also help to remember that ok, now I am in this big 'belly' phase of this project, but I am busy with two other projects as well. If these two 'bellies' are at the same time I know that there is trouble ahead.

**PH Please elaborate freely if you have additional comments. Improvement suggestions, problems or potentials about the 3D view.**

A1 I have a little bit the idea...Because I can imagine that when it is a larger more complex project, if I imagine I am busy on a masterplan or a project within a masterplan, where there are multiple projects going on it would be good to be able to put more things next to each other. And in a larger office it would be super cool if you could turn on several projects, if you are busy with one project, but you can turn on other projects from the office to see where you might have a critical phase in the office because there is a lot of deadlines at the same time.

If I look at it as a tool which now is focused on different projects, if it could also help me support planning within an office it would be nice to pull some tasks out of this circle and put them more on the side or so, you could see that some Photoshop work is being done by some people in this project and then they jump to another project.

...

PH Please rate how you experienced searching information with the search box? Please imagine the potential of the search.

A1 If the problems like the AND and the comma would be solved differently, then I would say very easy, 5

PH Can you explain what tools do you use now to look for information and how?

A1 The search function of the finder (laugh), relying on my own way of storing things, which might or might not work, filing system of the office which goes by names and for the rest very often searching for things by date, e-mail and asking other people in the office (laughter).

PH Compared to the way you currently look for information about a project, how could this compare?

A1 If this works well, it would be much better, 5 I would say.

PH Regarding the different view options 3D, preview and list. Do you think they (have potential) to help in faster finding, retrieval and comparison of information?

A1 Yes, I mean they have big potentials for sure. I think that what would one thing that would be necessary is that at a certain moment when people start producing and sending a lot of files. I really like the preview function...of any file. You might need to just show a folder or like in Iphoto you have a folder and at a certain moment when I am sending 10 dwg drawings at the same moment, I don't want to have all the 10 drawings behind each other, maybe I can just identify the key drawing, in some projects I would take out the main floor plan in others I would use the main section, and that could be the main symbol I am seeing in the 3D and also in the list it would be nice to see just the folders, almost like the zip files and that it is possible to extent this folder

PH Basically what you are asking is when you have a moment of very big production to somehow compress it, visually and functionally?

A1 Yes.

PH Please rate how you experienced using the notes feature.

A1 very easy, 5

PH Please rate how you see the potential of the notes feature in project communication.

A1 5...This is really...(nodding)

PH Please elaborate freely on the notes feature. Problems, potentials, improvements.

A1 I think these notes it is a good idea you can move them but it is not very obvious that it is referring to a specific points, if the notes would have a more pointy corner...Would be nice to do something with colors so you can automatically...can link them to categories like urgent or...if you for instance you can identify that I can only see them, personal, some that remain in the office, that is one of the big problems from e-mail that suddenly you forward something that wasn't meant to...If there is a way only three steps: mine, internal and everybody. It could really help.

PH Compared to current folder system, how would you rate the different file options?

A1 Mmm which were the priorities again? Having different statuses is very good, 5. The groups which are currently there are not the ones I would use, I think. I would make a difference between files that are sent out and files which are only internal and files which are for instance sent out and are a part of an official document like building permission that was handed in. files which only circulate in the office for instance.

PH Compared to folder system?

A1 I think it would be an improvement, there is always a problem, how do you deal with the same drawing just going through stages and reaching a different status. If you could have something where you actually always work in the same file and lets me go back in time, but the name of the file is just 'floorplan second floor', but I don't add the date because it is automatic and then giving these statuses, it would be really helpful.

PH What is your opinion on the added features to files: the shape visualizes who has been working on what.

A1 it is...It can be useful, it could be a 4. It could be useful to see in this one that someone may not be able to know about something because the were outside of it...I think it is something I would not normally turn on, but in special situations I would need to check it.

PH Do you think that giving a 3D representation and a shape to a project provides a better overview of the project, that you are able to have in projects currently?

A1 Yes. for sure.

PH Do you think that it provides opportunity to gather information together better than tools that you currently use and therefore lessen the feeling of fragmentation?

A1 Yes, yes.

**PH Does the combination and visual give you extra insights?**

A1 The note function is something..it is a new feature. If I would start using it would give me a lot more information. You can easier and quicker communicate on certain files. So that is a pro. mmmm I think maybe it is more indirect, if I have a project and I get used to it and I have a good way of how project should work I might see when there were troubling phases and when it is worth going back to that phase and seeing the documents. Learning from the projects. If i would join a project a see difficult things in the project I might go to that point and see there was a lot of trouble so...would be good to know about that.

It is one thing to plan forward, but what happens in architecture very often is that you are joining a project, which is running and has a history and often not a very straight forward history. So this can really help getting familiar with a project. It would be a very crucial help. Because now what you do is you go through the phase documents which were there, either you just take the booklets that were handed in at a certain moment and you have next to that all these folders (physical) with the all the material and it is completely hopeless to go through that because you would not know what to look for.

**PH If you can imagine using this tool on a daily basis, how would it compare to your current way of working?**

A1 I would hope for this to nicely and comfortably work in the background. It could help setting a planning. It would be necessary if there is an easy way to drop files in here so I am not depended on everyone in the project to use this. I can find files much better and quicker and communicate about the files much better it is really annoying to save as pdf and add comments and send it around again and again. And if you only send the e-mail that in the floorplans there is still this funny corner and it should be different well, it is not connected to the file.

**PH To what extent does it fulfill the needed functions when working in a project with several people in a design project?**

A1 I think as a concept it fulfills it very well, 5, currently the 'hubbles' I see is the easy way of working with the 3D viewing and the connection with e-mail and integrate and download files. I would expect this program to replace the finder that I can very easily combine with my agenda and e-mail...

**PH Do you think that the 3D visualization is appealing, attractive or not? Negative positive aspects?**

A1 One thing which I don't like about it is that these lines in the background suggest endlessness, I want the project to be limited. I know it is such as mess, but I want to feel 'don't worry it is just this. This is the thing, there is a lot of stuff, but if you look at it from the

distance it is under control'. It would be nice to clearly mark the end when this project is finished and happy life can begin again.

That is the main thing: the visual should every way communicate calmness and clearness. I think that the symbols on the side are very much developed from their own aesthetic. For the rest, For the list for example, what is shown here looks too much like scripting it needs to be graphically adjusted, but for instance the notes preview I like very much. The whole interface is 'terughoudend', it is not loud, it is supportive and humble. It is not so much in the 3D, but in the other views you have that. If the whole interface is quite similar to finder, maybe things that on the in and are around it. That would for me...I don't want to have a feeling like, should I start to put my project in here or would it maybe corrupt files or make it more complicated, so it that sense if it looks very inviting, 'i don't break anything' .

**Pirjo Haikola (PH)**

**Architect 2 (A2)**

**Interview 16 April 2012, Beijing**

...

A2 This (project) is organized then...if you have a big project already going on for one year, is this showing everything? Because, then it would be really a trouble to find information. In one year you have maybe a thousand files and you should be able to find it in a nice way.

PH Besides the bugs we experienced, how did you experience adding objects and planning tasks from 1-5

A2 I think it is quite easy creating a project (4).

PH in planning things how do the functions provided now fulfill the need to plan a project?

A2 mmmm ... I would also like to have there the money, because we have lets say...when we are planning a project we put there a certain hourly rate for each participant, and then we estimate how much time does each person have time to participate in the project and then the participation is maybe only half of their time and they do another project another half of their time.

...

PH And then it could automatically calculate the budgets.

A2 Exactly and then ideally there should be a red alarm coming up when the project has used up all the money (laughter)

PH yes, like we have 20% of the budget left.

A2 Yes. It would be good, honestly!

...

A2 Ah, so you cannot edit the history.



PH Not really.

A2 It is in a way a legal report in that sense.

PH Yes, like you said before that sometimes you need to know who created a document and at what time, you can see that here.

...

A2 How do I know who is responsible for this? (file) can I click on this loop?

...

A2 So there is also an empty note for me to comment on this.

...so it makes it time wise ordered so you can see the whole conversation.

PH Exactly

A2 So notes alone you cannot open, you have to open the files?

PH You can...

A2 Ah, so then you can see whatever was commented and this is what was visible?

PH Yes, it opens what was visible in the selection so the views are synchronized between each other.

...

A2 This purple thing was a task assigned to somebody?

... So the SA and DA were working on it first...this might get a bit cluttered when it is a big project.

PH yes, it might.

A2 When people are close to each other or...then you can only have this view of one day like a section of the...

PH then you probably want to do something like this (moving the visible area into a very small slice)

A2 Ah! it is like a project tomography.

PH yeah, really slicing the project.

A2 that is cool, so then it expands, that is very cool.

...

A2 Can you find out from here if there was a submission from the architects to Arup in-between?

PH Well, what you can do is you can add these things called time marks, like here

'drawings submitted to client'

A2 Yes, that is good.

...

A2 actually what was mentioned earlier, when there is a big submission they (files) need to be packaged so you don't see them all at the same time, it is not just drawing submissions which have like 200 drawings in one go but also what we produce often is Indesign files as a book which has a huge amount of files linked to it and then you package it and the final product is actually a pdf...normally we do a pdf which is then printed, but then all the other files, which are the working files, they are somewhere, because people have worked on them but they don't actually need to be findable here in the project management program, but they need to be findable by the people who worked on them. So I am not sure if there is this kind of...there is still in the pc there is the explorer used in the server normally so you also find it through that right?

PH I am wondering how would you see that because I would hope that this would be used for is that you would actually be working from here that the files are here.

A2 Yeah, but if I would show you some of our...when you package them there are so many links, it just explodes the amount of information. I know that this would need to be kind of the replacement of the explorer that you find the files from here and this would be a very good way to find it because it organizes it better, but then it is just really, even in a small project the number of different smaller files which are made into one file product is a lot.

...

PH How would you rate the navigation and finding objects and information in it?

A2 If it works fine, it would be nice to walk through all these files and see them around you...I think it is relatively easy

PH Kind of in the middle (3)?

A2 Yeah.

PH How would you elaborate on the navigation?

A2 it is also difficult to imagine this now because it is a hypothetical project that doesn't have the logic in it. But for example I see here two things that are connected so there are two versions and it explains it and I would take the latest one. So it is kind of easy to understand the logic in it. Then I am still wondering, would there need to be a certain hierarchy between the different files, like this is just team internal versions of two design options, but the that is really a submission. The first submission with client comments coming in, then there is a second submission...So would there be some kind of..I see here was this kind of milestone thing. That is good because somehow the key points need to be highlighted.

PH would you like to see them more in the files also? One of the questions was that if the file statuses need to be customizable, now we have these certain colors, would you see that submission category might need it own color, or something?

A2 I think so..Like now the red color was critical. Is it critical to be excepting to be worked on?

PH Yes, someone still needs to work on it.

A2 Exactly. I think really the...we have a folder called official submittals which we create additionally to files in and files out the record of the key things because the project can last for years and if you have to look through the files you get crazy you don't remember the date or...you forget it after two years...like they key submission points.

...

PH What is your experience in viewing information in 3D format?

A2 I think it is...I like it. It is kind of nice to see this timeline going through, it is very much visualizing the project, like the progress of the project..mmm..I still couldn't quite get into, like can you turn the...oops what did I do? Can I turn this angle?

...

A2 Is there a way for me to personally locate the files in a certain way? That if I look for example from the front, that I would put some files on the left upper corner and some files on right lower corner?

PH That is not now possible.

A2 They come in automatically?

PH Yes. but, why would you see that as useful?

A2 I don't know....I am just thinking that if that is in the 3D you could also use the location of these files to organize them, so let's say - like always the client files are going to the lower left corner and you could actually follow it then here, aa, those are the ones which are related to client.

PH You wouldn't see that now? Because now files that are produced for instance by Arup you would see them here.

A2 So they are kind of closed in there, so it is kind of located towards...they are located by their producer?

PH Yes.

A2 Yeah...

...

A2 But the 3D is kind of, it is nice...I imagine there could be a lot of potential...I am just imagining like the minority report (laughter) in the next generation.

...

PH You don't find it problematic or difficult to see a project as a 3D?

A2 I think it is almost easier to see it in a 3D, like now especially after working with a very very long project, and now we are also in a phase where we try to assemble like certain project history. It is extremely difficult! It is horrible and if we would have had it in this format that would just like, whatever! (snaps fingers) a job of a couple of days. But now, I have to go through totally unorganized files from 2002 with folder names like 'photos' and it is just insane. I think that the 3D and the timeline is very useful.

...

PH In terms of the search, how does it compare to way you search now?  
Maybe you can explain the current way and then compare?

A2 At the moment if we need to find something, you have in your head that something happened around April 2008 so you go then to files in or files out of that time around, you probably tell the secretary, try to find that kind of file, mmm... You could have a little bit of an idea what was the name of it, but not full name, that is kind of the worst kind of scenario, but if it was important enough kind of file, then we have it in our official submittal, which is then organized by timeline and you can find it quite easily there, but if it is some kind of minor thing, those are more difficult to find, because there are just so many of them. Then we use a lot the search by file name, like lighting and it gives you...or you say 'TL5 tube' then it gives you from that certain folder, that certain area all the files that have the TL5 in the title, so that is very useful. The one thing we normally don't, actually I am wondering how important is the assignment to certain person, who produced that file... aaa...because at least, in our office it is also that the same file has been worked on with the, like drawing it is not always that it is from one person, I don't see that the assignment (relation) to a person is that important.

PH So alternatively you could have a visualization where you have the parties that are producing things?

A2 Yeah, it is more the parties and who gets what.

PH Compared to the way you currently look for information about a project, how would this compare?

A2 I think it would make it easier, I am also thinking, ok if there is then...you would of course need to keep everybody very disciplined about using this system in doing their files so that has to be the project record. In this system it actually, probably, happens quite easily, I mean we have always the problem of keeping people disciplined like naming their files and putting them in their right location. So it is just really painful. But if it is inside this system... like how actually..

PH For example you don't have to give it a date, because it puts it automatically...

...

A2 So, the notes are related to some people, so other people cannot read your notes?

PH This is a good question, because now, notes are visible for everybody.

A2 In a certain way that is actually good, because it improves the openness of the project, it improves that you share much more information directly...than if it goes like clients sends something to you and you spread it to the team and...and instead of these several steps it could go directly. In that sense it is nicer, we have also a kind of a simple way to do that at the moment, there is a, we have a team e-mail for each project so basically every person who is working in that team is getting the whole correspondence also between the client and everything. I mean in some of our newer projects, not in our older projects.

...

PH One other person said, they would like to have my personal notes, internal notes and visible for everybody. Would you see that would be a good way to control the visibility or is there some other way?

A2 It would be good if you have the choice of doing that because some projects are not confidential at all and they have a very democratic team system and the team leader is sharing everything basically...even model makers or who ever...It depends a bit on peoples personal leading style. Again there are projects that are more confidential and where you need to kind of control information that goes to everybody but everybody cannot be included in everything. Especially anything related to money issues, like peoples salary or... that has to be confidential

...

PH Please rate how you experienced using the notes feature.

A2 When it is really working it must be quite easy actually and writing these kinds of notes it is almost better than, at the moment even though the office is really small, we are writing e-mails to each other. So a note is a nicer way to for this kind of instant communication. We had an installation of office communicator which doesn't really work so...it is supposed to be like the Msn, like popping informal information exchange but somehow it just doesn't work yet.

A2 So this is actually somehow eliminating a bunch of programs? It definitely eliminates the attachments to e-mails, which is quite a big issue.

...

PH what systems do you use now for management and content management?

A2 For meetings we use outlook, I think on our office management level it is used but not in the everyday working level that much. That is still done by e-mail, because sharing the calendar thing is not so simple and then you share calendars with lots of people...It is partially also actually a generational issue, like how open the project is or how much the team is part of like creating the project and how it is managed, I see there is much more transparency now in new projects...

...

PH Ok most questions we have gone through... Do you think that giving a 3D representation and a shape to a project provides a better overview of the project, that you are able to have in projects currently?

A2 With the timeline it is actually a very nice way of seeing it and that the files are tending to locate where it has been produced so that makes also sense..I don't have better ideas now, but there might be much more richness in the 3D. Actually one thing, can you, if you are a manager of several projects, can you see the projects parallel?

...

PH If you can imagine using this tool on a daily basis, how would it compare to your current way of working?

A2 For the daily working it is a...because I am not purely a manager I am doing the design too, actually most of my time is spent with illustrator or Autocad or...so this is maybe 20% of your time, when you use it for finding the right files or checking when you need to have things done so for that I think it is very very helpful.

...

A2 Then for the team internal...there is kind of two layers almost there is like this layer which is architecture, engineering and client and then there is the team internal level so probably you should be able to switch from the team internal level to the whole project team level so what ever happens inside of this tube that is then the selection of what will be...inside here could be more files if it saves every single test file, but they are not all published into the whole project team.

It is probably best to keep this as the whole project management tool and not team internal management tool because of course in team internally you should be able to talk to each other...

...

PH Do you think that the 3D visualization is appealing, attractive or not? Negative positive aspects

A2 I think this was sufficient

PH What do you see as the biggest benefits?

A2 I really would appreciate the organization and that the files are findable and also that they are not copied several times on the server, because we have capacity problems, the servers are growing all the time, but it just cant catch up with how much garbage is on the server. It is still not solving the garbage problem, but at least it is keeping it organized... maybe because it will add the transparency maybe it will encourage people to be more organized, because then they cannot create that kind of chaos, so I think it could work very well .

PH Do you experience 'fragmentation' in the projects now and would this lessen that feeling?

A2 I think it would...yes...improve that fragmentation,  
In the beginning of x I was responsible of the studio design of a certain area, but I had no knowledge of what was going on in facade, or no knowledge what was going on lets say... well I knew acoustics, I knew interiors, of that area and the studios but for example facade was totally strange to me.

PH Would it be interesting to categorize parts of the building, like you can switch to an alternative 3D view instead of connecting things to parties and people, you would connect them to facade, interior, circulation, whatever?

A2 It would be very useful I think. It comes a little bit through the teams already that there is a facade designer, there is wind and snow designer, there is the structural designer and they are...that is what I meant if you had a little bit if you had the possibility of putting some files on the upper right hand corner and some lower left hand corner that you would choose them to be there that could be very helpful or it is some kind of filter that is selecting them...it could be implemented by the file naming that facade files always have facade in the name of F or...

A2 It would be great, but since building vary it is impossible to do it in the program itself but since the building parts...like in the x there was a division A, division B etc. you couldn't make that as a filter because that would just vary in each building...

...

PH Any further comments?

A2 I would be only worried about the visibility of information when it gets really complicated.

It would be really useful to have all the information in one place, but to be able to filter what to see.

**Pirjo Haikola (PH)**

**Architect 3 (A3)**

**Interview 22 March 2012, Porto**

A3 I could see myself using it. But then a lot of thins depend on the small things that we are not seeing now. I think the interface with the e-mail is essential because I am thinking for instance, materials we search. A lot of suppliers.

...

You have the concept that it integrates the people, the project ...project management integrated with the client. You make a contract where all the parties must have the same program and it works very well. But you always have things outside, material suppliers, town hall. Could you do something like...for instance, you have your normal e-mail system in the office, here we are small enough not to have personal e-mail addresses we have a central e-mail.

Let me think, could you...the program goes and searches in your e-mail files what is related to this project? That is my only comment, the rest seems great. It is an environment no?

...

PH How do the functions provided by Mneme match your needs in planning a new project?

A3 They match very well. You can think a lot of different categories, but then you start having so many variables that it is better stick to these ones and then you can always fit and adapt things you cannot guess now.

PH Customizability would be great, I guess is what you are saying?

A3 Yes, that is right.

...

PH Please explain your experience in viewing information in a 3D format.

A3 I like it but you know, using I might have a different answer, maybe you are bored of it because it doesn't add anything but...mmm..But it seems to be useful for orientation in a complex history. It seems to be. And graphically it seems that this spatial location together with the colors, be useful which is a...

PH Compared to the way you currently look for information about a project, how could this compare?

A3 Sometimes you have a memory which is, you never know how you will...it is the way we have memories about the world, you never know but you always associate it with something so you remember it. Sometimes you remember it because someone changed something they shouldn't have, or it was a file on my birthday. So having ways to look so it is by people, by date or by parties or by status...I know it was critical. These different associations are helpful.

PH Please rate how you see the potential of the notes feature in project communication.

A3 We usually do pdfs' where you can add things, you have in Autocad or other drafting programs auxiliary layers that you can create that we use. So, there are already systems of notes within the files. Before using this kind of system how can you comment? It is a matter of trying. Without using it is very difficult question. I wonder if we need that the note is pointing a certain point in the image. If you could see the notes outside as a database, but that they are inside and relating to things in the contents of the files, that would be the ideal.



**Pirjo Haikola (PH)**  
**Architect 4 (A4)**  
**Interview 16 March 2012, Rotterdam**

PH Please rate how you experienced creating a new project.

A4 Quite easy 4

PH How do the functions match your needs in planning a new project?

A4 Quite well, 4

...

PH Please rate how you experienced navigating in the 3D space.

A4 Quite easy, 4. But you need to know and get into it. You need to play for a couple of days and when you know it is quite easy to understand how to use it.

PH Please explain your experience in viewing information in a 3D format.

A4 It is quite nice to have this overview, because normally you have one platform and one software, so it in a way gives you the overview of all the information. I think it is quite nice. Something you normally don't experience. But for me the icons and the way it is composed together takes time to understand.

I can imagine this way of managing a project... is the user, are they comfortable in 3D? To me it is not difficult, because we know how they work, but does it add other extra value... I think no. The overview is nice.

Because for instance showing the file, I think that is great (is hovering over a file preview). In a way it is quite new invention. To include this information and previews. That has to be in this 3D that you can see this information. It is helpful for the overview and to combine different interface. But still I think it needs training before you can use it. It is like switching from a PC user to a Mac. The time to get used to this program is not short.

PH Please rate how you experienced searching information

A4 3, not easy, not very difficult.

PH Comparing to how you search information in projects now, how does this program compare?

A4 I think you can find more information. Because normally in Outlook you get title of the e-mail, in windows you get the file and you have to click everything. You have to go through and can't see the content.

PH So it would be a 4 or 5?

A4 5

PH Please rate how you experienced using the notes feature.

A4 Quite easy, 4

PH Please rate how you see the potential of the notes feature in project communication.

A4 I think it can be quite (pointing at number 5 on the paper) it is a five? Yes.

PH Could you please elaborate?

A4 Because you can put a note right on top of a file. That is something you cannot do now. From that point of view it is really good. Of course you sometimes do a pdf, but that is more like extra work, so you cannot do it on the same file you are working on. To exchange it is really an improvement.

PH Compared to current folder system, how would you rate the different file options?

A4 I think very useful.

PH So it is a five?

A4 Yes.

PH So you don't see much problem replacing the folders?

A4 No, because in a way it combines the Outlook and folders.

PH What is your opinion on the added features to files: the shape visualizes who has been working on what?

A4 it is needed, but in the visualization when you have everything on looks quite complex. Now when you turn everything on it looks like a big machine! Of course that it is when you are really running a project, but when you see it, it is like wow!

PH Do you think that giving a 3D representation and a shape to a project provides a better overview of the project

A4 Yes.

PH Do you think that it provides opportunity to gather information together better than tools that you currently use and therefore lessen the feeling of fragmentation?

A4 Yes.

PH Additional information you can get from this software compared to now?

A4 Overview, statuses of things going on and the history.

When you are following a project sometimes it you need to check back and all these files you don't know what happened before or ...if you don't see a link to certain decision so in that sense this overview attached to files which gives you really... which things you agreed...it stays there but it is easy to get back to.

PH To what extent does it fulfill the needed functions when working in a project.

A4 Quite well, 4

PH Do you think that the 3D visualization is appealing, attractive or not? Negative positive aspects?

A4 Interesting in a way that it looks like a machine. When you see everything you can see how complex it is.

PH Is it a positive or a negative comment?

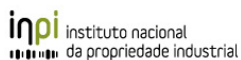
A4 Positive, because it helps you understand how complex the project is.

PH Do you think that the interface in general is appealing, attractive or not? Negative, positive aspects?

A4 It is quite nice. I like the colors... the reminders.

## ANNEX 8

### Provisional patent certificate 17 Jan 2012



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Nº	CÓDIGO	DATA E HORA DE RECEPÇÃO	MODALIDADE	PROCESSO RELACIONADO
20121000004443	0198	2012/01/17-14:16:16	PAT	

### PEDIDO DE PATENTE, MODELO DE UTILIDADE OU DE TOPOGRAFIA DE PRODUTOS SEMICONDUTORES

<b>1 REQUERENTE</b>
<b>Código</b> Nacionalidade PORTUGUESA <b>Nome</b> UNIVERSIDADE DE AVEIRO <b>Endereço</b> UATEC, ED. DA REITORA 3º PISO, CAMPUS UNIVERSITÁRIO DE SANTIAGO <b>Localidade</b> AVEIRO <b>Código Postal</b> 3810-193 <b>Telefone -</b> <b>Telemóvel</b> <b>Fax</b> <b>E-mail</b> MAIL@RCF.PT <b>Actividade (CAE)</b> <b>NIF</b> 501461108
<b>Tipo de Representação</b> Agente Oficial da Propriedade Industrial ou Procurador Autorizado <b>Nome</b> ELSA MARIA MARTINS BARREIROS AMARAL CANHÃO <b>Código</b> 79 <b>Exclusivo para este acto?</b> NÃO
<b>2 MODALIDADE / TIPO DE PEDIDO</b>
Modalidade: PEDIDO PROVISÓRIO DE PATENTE Realização de pesquisa pelo INPI: SIM
<b>3 EPÍGRAFE OU TÍTULO</b>
HYPERVERSUALIZATION PROCESS TOOL FOR ARCHITECTURE
<b>4 RESUMO</b>
<b>5 FIGURAS</b>
<b>6 INVENTORES</b>
<b>Nome</b> JOÃO ANTÓNIO DE ALMEIDA MOTA <b>Nacionalidade</b> PORTUGUESA <b>Endereço</b> AV. INFANTE D. HENRIQUE, 80 PRAIA DA BARRA <b>Localidade</b> GAFANHA DA NAZARÉ <b>Código Postal</b> 3830-750 <b>Telefone -</b> <b>E-mail</b> MAIL@RCF.PT <b>NIF</b> 151377006
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NIF 271185350

**7 REIVINDICAÇÃO DE PRIORIDADE**

**8 DOCUMENTOS ANEXOS**

DOCUMENTO DO PEDIDO PROVISÓRIO DE PATENTE (Novo PPP em nome de Universidade de Aveiro.pdf)

**9 OBSERVAÇÕES**

Nacionalidade do inventor Pirjo Annikki Haikola: Filandesa.

**10 TAXAS**

Taxa	Importância
PEDIDO PROVISÓRIO DE PATENTE	10,14 €
PESQUISA EM PEDIDO PROVISÓRIO DE PATENTE	20,28 €
Total:	30,42 €
Por Extenso:	TRINTA EUROS E QUARENTA E DOIS CÊNTIMOS

**11 PAGAMENTO**

Tipo de Pagamento	Débito em Conta
Banco	BANCO BPI
NIB	0010.0000.35135880002.97
Montante	30,42 €
Débito a partir de	16-02-2012

**12 ASSINATURA DO REQUERENTE OU MANDATÁRIO/REPRESENTANTE LEGAL**

**Assinatura/Nome** Elsa Maria Martins Barreiros Amaral Canhão  
**Nº B.I.** 10032204 **Data** 2012/01/17

**Atenção:** Os dados relativos ao nome e morada serão publicados no Boletim da Propriedade Industrial, de acordo com o previsto no Código da Propriedade Industrial, aprovado pelo Decreto-Lei n.º 36/2003, de 5 de Março, ficando também incluídos nas bases de dados de marcas e patentes disponibilizadas neste portal.

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**ANNEX 9**

**Conversion to international patent certificate 18 Jan 2013**

**PATENT COOPERATION TREATY**

From the RECEIVING OFFICE

To:  
 PEDRO ALVES MOREIRA  
 RUA DO PATROCÍNIO, 94  
 1399 - 019 LISBOA

**PCT**

NOTIFICATION OF THE INTERNATIONAL  
 APPLICATION NUMBER AND OF THE  
 INTERNATIONAL FILING DATE

(PCT Rule 20.2(c)) 30. JAN 2013

Date of mailing  
 (day/month/year) 28 JAN 2013 (28.01.2013)

Applicant's or agent's file reference		<b>IMPORTANT NOTIFICATION</b>	
International application No. PCT/PT2013/000003	International filing date (day/month/year) 17 JAN 2013 (17.01.2013)	Priority date (day/month/year) 17 JAN 2012 (17.01.2012)	
Applicant UNIVERSIDADE DE AVEIRO			
Title of the invention HYPERVISUALIZATION PROCESS TOOL FOR ARCHITECTURE			

1. The applicant is hereby notified that the international application has been accorded the international application number and the international filing date indicated above.

2. The applicant is further notified that the record copy of the international application:

was transmitted to the International Bureau on 28 JAN 2013 (28.01.2013)

has not yet been transmitted to the International Bureau for the reason indicated below and a copy of this notification has been sent to the International Bureau\*:

because the necessary national security clearance has not yet been obtained.

because (reason to be specified):

\* The International Bureau monitors the transmittal of the record copy by the receiving Office and will notify the applicant (with Form PCT/IB/301) of its receipt. Should the record copy not have been received by the expiration of 14 months from the priority date, the International Bureau will notify the applicant (Rule 22.1(c)).

Name and mailing address of the receiving Office INPI - Campo das Cebolas 1149-035 Lisboa - Portugal	Authorized officer Angela Canada
Facsimile No. +351.21.8883720	Telephone No. +351.21.8818100

Form PCT/RO/105 (July 2008)

**PATENT COOPERATION TREATY**

From the RECEIVING OFFICE

**PCT**

COMMUNICATION IN CASES FOR WHICH  
NO OTHER FORM IS APPLICABLE

To: PEDRO ALVES MOREIRA  RUA DO PATROCÍNIO, 94  1399 - 019 LISBOA		Date of mailing <i>(day/month/year)</i> 28 JAN 2013 (28.01.2013)
Applicant's or agent's file reference	<b>REPLY DUE</b> See paragraph 1 below	
International application No. PCT/PT2013/000003	International filing date <i>(day/month/year)</i> 17 JAN 2013 (17.01.2013)	
Applicant UNIVERSIDADE DE AVEIRO		

1.  REPLY DUE within   1   months/~~days~~ from the above date of mailing

NO REPLY DUE, however, see below \_\_\_\_\_

IMPORTANT COMMUNICATION

INFORMATION ONLY

2. COMMUNICATION:

The applicant is hereby invited to furnish a translation of the international application into Portuguese.

Name and mailing address of the receiving Office NPI-Instituto Nacional da Propriedade Industrial Campo das Cebolas, 1149-035 Lisboa - Portugal  Facsimile No. +351218883720	Authorized officer Angela Canada  Telephone No. +3518818100
--	--

## **ANNEX 10**

### **Summary of the invention**

The invention relates to computer implemented program for architectural or design project management comprising:

- providing a user interface for accessing and searching a project database,
- generating representations of objects, searched from the project database, in a 3D visualization field, wherein the axis of 3D field are defined by the user and said representations are based on at least one attribute of the objects;
- creating, in the visualization field, 3D representations of connections between objects, and
- providing access to the objects searched from the project database through the representations of said objects in the 3D visualization field.

In one aspect of the invention, accessing the database comprises creating projects.

In another aspect of the invention, accessing the database comprises defining information access levels for each user.

In a further aspect of the invention, accessing the database comprises creating and managing project phases, project tasks and project breaks.

In still another aspect of the invention, accessing the database comprises creating and managing parties, teams and people.

In a further aspect of the invention, accessing the database comprises at least one of: uploading, previewing, opening, saving, assigning/changing status and tracking changes in files.

In one aspect of the invention, accessing the database comprises creating and replying to notes attached to files or file previews.

In another aspect of the invention, accessing the database comprises creating meetings and accessing meeting related information.

In an aspect of the invention, database searching is based on semantic, temporal, spatial criteria or a combination thereof.

In an embodiment of the invention, one of the axis of the 3D field represents time.



In another embodiment of the invention, the connections between objects in the 3D visualization are represented by lines, shapes or forms.

The invention also relates to a computer readable medium comprising the above described computer implemented program.

The invention further relates to a computer system comprising:

- a database in which architectural or design project data are stored;
- a server connected to the database;
- at least one computer connected to the server, and
- at least one computer readable medium as described in claim 11, connected to the server and to the at least one computer.

## ANNEX 11

### Patent claims

1. A computer implemented program for architectural or design project management comprising:
  - providing a user interface for accessing and searching a project database,characterized in that it further comprises:
  - generating representations of objects, searched from the project database, in a 3D visualization field, wherein the axes of 3D field are defined by the user and said representations are based on at least one attribute of the objects;
  - creating, in the visualization field, 3D representations of connections between objects, and
  - providing access to the objects searched from the project database through the representations of said objects in the 3D visualization field.
2. The computer implemented program according to claim 1, characterized in that accessing the database comprises creating projects.
3. The computer implemented program according to claim 1, characterized in that accessing the database comprises defining information access levels for each user.
4. The computer implemented program according to claim 1, characterized in that accessing the database comprises creating and managing project phases, project tasks and project breaks.
5. The computer implemented program according to claim 1, characterized in that accessing the database comprises creating and managing parties, teams and people.
6. The computer implemented program according to claim 1, characterized in that accessing the database comprises at least one of: uploading, previewing, opening, saving, assigning/changing status and tracking changes in files.
7. The computer implemented program according to claim 1, characterized in that accessing the database comprises creating and replying to notes attached to files or file previews.
8. The computer implemented program according to claim 1, characterized in that

accessing the database comprises creating meetings and accessing meeting related information.

9. The computer implemented program according to claim 1, characterized in that database searching is based on semantic, temporal, spatial criteria or a combination thereof.
10. The computer implemented program according to claim 1, characterized in that one of the axes of the 3D visualization field represents time.
11. The computer implemented program according to claim 1, characterized in that the connections between objects in the 3D visualization are represented by lines, shapes or forms.
12. A computer readable medium characterized in that it comprises the computer implemented program as described in any of the preceding claims.
13. A computer system characterized in that it comprises:
  - a database in which architectural or design project data are stored;
  - a server connected to the database;
  - at least one computer connected to the server, and
  - at least one computer readable medium as described in claim 12, connected to the server and to the at least one computer.

## ANNEX 12

### Trademark certificates: *Mneme* and *Neem* note

**inpi** instituto nacional  
da propriedade industrial

## MARCA NACIONAL Nº 504271

### Síntese do Processo

Nº do Pedido	1000070944	<b>Mneme</b> MNEME Tipo de Sinal: MISTO
Data de Apresentação	17-09-2012	
Data do Pedido	17-09-2012	
Tipo de Modalidade	NÃO APLICÁVEL A ESTA MODALIDADE	
Fase Actual	REGISTO CONCEDIDO	
Data de Início da Fase	05-12-2012	
Data de Fim Previsto	---	
Situação de Taxas	TAXAS INTEGRALMENTE PAGAS	
Data de Início da Sit.	05-12-2012	
Data de Fim Previsto da Sit.	31-05-2022	
Taxas Pagas	1	
Taxas Devidas	0	
Data da Última DIU	---	
BPI 1ª Publicação	24-09-2012	
Data do Despacho	30-11-2012	
BPI do Despacho	05-12-2012	
Data de Início de Vigência	30-11-2012	
Data Limite de Vigência	---	
Titulares	UNIVERSIDADE DE AVEIRO	
Mandatário	---	
Classificação de Nice	09 35 37 42	
Processo em Tribunal	NÃO	
Tribunal	---	
Data de Envio	---	

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## Classificação de Nice

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### Edição 9

Classe	Produtos/Serviços
09	PROGRAMAS DE COMPUTADOR [SOFTWARE DESCARREGÁVEL].
35	COMPILAÇÃO DE DADOS NUMA BASE DE DADOS INFORMÁTICA; SISTEMATIZAÇÃO DE DADOS NUMA BASE DE DADOS INFORMÁTICA.
37	INFORMAÇÕES EM CONSTRUÇÃO.
42	DESIGN DE SOFTWARE; DESIGN DE SISTEMAS DE COMPUTADOR; DESENHO DE ARTES GRÁFICAS; DESIGN INDUSTRIAL; ARQUITETURA; ELABORAÇÃO DE PLANOS PARA CONSTRUÇÃO.



## MARCA NACIONAL Nº 504273

### Síntese do Processo

Nº do Pedido	1000070950
Data de Apresentação	17-09-2012
Data do Pedido	17-09-2012
Tipo de Modalidade	NÃO APLICÁVEL A ESTA MODALIDADE
Fase Actual	REGISTO CONCEDIDO
Data de Início da Fase	05-12-2012
Data de Fim Previsto	---
Situação de Taxas	TAXAS INTEGRALMENTE PAGAS
Data de Início da Sit.	05-12-2012
Data de Fim Previsto da Sit.	31-05-2022
Taxas Pagas	1
Taxas Devidas	0
Data da Última DIU	---
BPI 1ª Publicação	24-09-2012
Data do Despacho	30-11-2012
BPI do Despacho	05-12-2012
Data de Início de Vigência	30-11-2012
Data Limite de Vigência	---
Titulares	UNIVERSIDADE DE AVEIRO
Mandatário	---
Classificação de Nice	09 35 37 42
Processo em Tribunal	NÃO
Tribunal	---
Data de Envio	---

# Neem note

NEEM NOTE

Tipo de Sinal: MISTO

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## Classificação de Nice

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Edição 9

Classe	Produtos/Serviços
09	PROGRAMAS DE COMPUTADOR [SOFTWARE DESCARREGÁVEL].
35	COMPILAÇÃO DE DADOS NUMA BASE DE DADOS INFORMÁTICA; SISTEMATIZAÇÃO DE DADOS NUMA BASE DE DADOS INFORMÁTICA.
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## ANNEX 13

### Funding and collaboration partners

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Within the University of Aveiro the research institute of this project is ID+







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