

Managing the Changes within the Architectural Practice

The Effects of Information and Communication Technology (ICT)

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The architectural working environment has changed during the last 30 years more than ever before. Most of the changes have been related with information and communication technologies (ICT). Architectural working methods and tools have changed profoundly, when CAD has replaced more traditional methods and tools. Communicative working environment and document management within design & construction has also been changed to digital, meaning email and project webs. Completing a traditional architectural profile of the 20th century, a drawer-designer, contemporary communicating and managing skills plus mastering ICT are needed today to operate modern architectural practise properly.

The objective of this study is to create a change-oriented understanding of the contemporary architectural profession concentrating on architectural information management. The first phase, a literature study, will be followed by interviews and case-studies, to examine three hypothetically different periods of time:

- *1980-85 the era before CAD, the last days of hand-drawing*
- *1993-98 the era of digital drawing, the expansion of architectural CAD*
- *2000-05 the rise of integrated and pervasive web-supported digital design.*

The study will propose new aspects to be included in the modern architectural profile, namely project coordination, collaborative team-work, design information integration and profound digital content management.

Keywords: *architectural profession; design practice; architectural ICT; change management*

Introduction - Architectural working environment is changing

The seminal features of architectural profession in the western society has faced remarkable and thorough changes during the last few decades (Figure 1). Extensive changes have altered the social environment the architect works in, while also the architectural "working table" has turned into digital. Most of

the recent changes concerning pragmatic architectural practise have been caused principally by digital information and communication technologies (ICT). These changes are widely present in the whole AEC-field (architecture, engineering & construction), and even wider in the whole western society, where almost all kinds of official activities have been gradually transformed into digital. Computing and net-penetration for instance in Nordic countries is

comprehensive 85-95% (Nordic, 2002).

The architectural working methods have changed drastically during the last few decades because of CAD, design integration, project document management, collaborative team-work through the web and e-mail (Kalay, 2004). Design communication is currently considered to be an inevitable domain of modern architects. The changes have concerned very profoundly the tools the architects use but also the working methods. CAD-systems have become the main tool for the architects during the 1990s. Product data modelling or building information modelling (BIM) has also been developed to become an integrated future framework for the AEC-field information management.

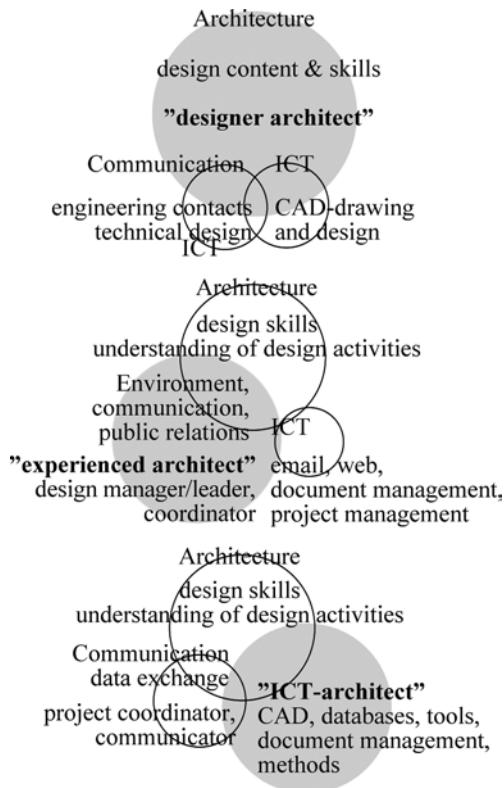


Figure 1
Contemporary roles of the architectural profession. Despite skillfull designers – traditional architects – project managers & leaders (Bucher 2003) and technology-oriented ICT-specialists are also needed in contemporary design and construction.

Despite the tools, technology and communication, also the organizational and legal context of architecture has been changing, when for instance customer related issues, tight requirements for design content and design tasks have developed more complex and multidimensional by nature. Project design tasks have been evolving towards more complicated nature. Design content is currently also guided by numerous official regulations. Environmental aspects have also gained more importance in current design practice and in current construction chain.

The changes within the architectural profession- and even more so in the construction process- have recently been particularly economical. A novel area of architectural design management, which has appeared around 1990s, is very likely to gain more importance in the near future (Otter & Prins, 2002).

The meaning of the architectural profession

Architects have throughout the ages managed the essential core information in building processes. Currently this is done extensively with ICT, mainly with CAD and with the support of document management systems. To ensure a smooth and effective design and construction chain later in the process, the initial architectural design data definition during the first project phases needs to be carried out correctly. This involves drawing and modelling design components properly, and after that distributing the data to all participants fluently avoiding unnecessary overlapping and redundancy in the later design and actual construction implementation.

All the design tasks and actions the architect performs have obviously to fit well into the contemporary frameworks of AEC-field. The majority of the building costs are defined in the earliest programming and planning phases and also during the design phases. Hence, all the project planning and design efforts which can be enhanced, are highly important and very cost-effective. The actual building costs will then be realized during the on-site construction phase, when the costs can not be influenced that much any more.

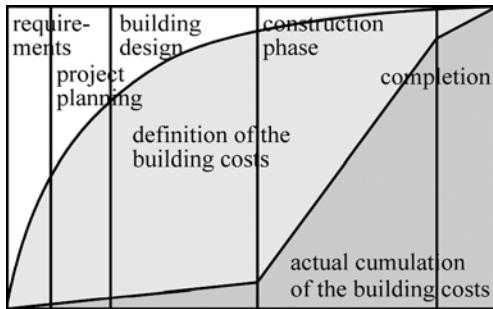


Figure 2
The building costs are defined in the very early phases of a design-construction chain, the definition and design phases, whereas the costs are realized later in the construction phase.

Modern ICT can supply tools and methods for a designer to manage design coordination. And it is not just a question of tools, but design management requires also proper project leading and management skills.

Objectives, hypothesis, methods and focusing of the study

The objective of this study is to create a change-oriented framework of the contemporary architectural profession, which is focusing especially on the role of ICT within the professional practice. This framework will then be used in managing and mastering the changes and their effects on architectural design, on working practice and on architectural information management. According to change-guru Kotter, it is essential to lead and manage the changes and desired change effects (Kotter, 1996).

The applicable objective of this study, based on understanding the changes, is to document pragmatic guidelines for modern architectural practice.

The focus is on architectural practice, but the chain of construction process has to be considered to justify the perspective.

A literature survey in the area of architectural ICT, changes within it and design practice will be documented to form the foundation for further work. Since ICT-based changes seem to have been remarkable during the recent decades, a *hypothetical framework* of recent changes within the architectural practice is created.

I Early 1980s (1980-85)

- the last days of hand-drawing – the era before CAD

Design drawings were drawn traditionally to paper and transparencies. Paper copies were distributed to project teams with traditional mail and couriers. Communication was done in weekly face-to-face design meetings and with telephones, mobile phones were not present yet. The introduction of a telefax was dramatic for designers. Despite traditional mail, drawings and other documents could be distributed also via phone lines, and much quicker than with mail.

II Mid 1990s (1993-98)

- the expansion of architectural CAD – the era of the digital drawing appearance

The shift from hand drawing to CAD-drawing was started. Paper prints of CAD-drawings were still distributed to project teams with traditional mail and couriers. Copy shops were transferred to printing shops. After the invention of world wide web in 1993 web-based communication started to expand, but it had not achieved very large volume yet in mid-1990s.

III Beginning of the 2000s (2000-05)

- the rise of integrated and pervasive web-supported digital design
- the importance of communication and economy
- 2D-drawing became the main design method
- the advent of building information modelling

Drawings were produced with enhanced CAD-systems with extended drawing automation. Drawings were distributed to project teams with email and more and more via project document banks. Web had dramatically changed the communication environment. Not only email, but also various collaborative working and communicating platforms transferred design work to virtual. Organizations started also changing their activities towards virtual services, virtual support and virtual products. Design work

was also done with more constant pace, instead of earlier phases and staggered design cycles. The experiences from building information modelling (BIM) and product modelling encouraged the AEC-field to develop CAD-drawings towards integrated virtual building information management. Printing shops (originally copy shops) transferred themselves to document management providers.

Next research steps

Quantitative data will be collected from mentioned three case periods, such as the number of architects, salary levels, work-load and design content definitions. In-depth Delphi-interviews will be carried out within Finnish architects and construction field professionals, to clarify the recent evolution of the architectural profession and also the ICT-based changes. Data will be essential for later qualitative evaluation, validation and concluding summary of this study.

Pre-results from a literature study

Literature concerning *traditional architecture* and *architectural design*, such as project presentations and design content descriptions are almost exhaustively studied and published. Contemporary architecture and trends are also exceptionally well presented in architectural magazines.

Another scientifically well covered area is the field of *architectural ICT*, which is mainly studied from technology-oriented and user perspectives. The essence and importance of architectural CAD in all respects, data management, digital drawing, visualization and modelling, as well as numerous web-based collaboration techniques are well documented within the research community, such as in Cumincad index database (Cerovsek & Martens, 2004).

ICT-based changes concerning the construction sector have also been documented in several local and national surveys and barometers during the last 10-15 years (Rivard 2000). The surveys have mainly pointed out and measured noticed changes within various fields of ICT. Figures about construction field

computing volume, the use of CAD and the distribution and content of web-based communication are available. One major result from these surveys is, that information and communication technology has in general been adopted and also gained a significant role in design & construction during the 1990s (Howard, Kiviniemi, Samuelson, 2002).

One slightly surprising result based of literature is, that the pragmatic tasks the architects perform, the daily architectural practice, has not been too extensively studied though.

The domains of the changing working environment

As a reflection from the history of architectural practice, the traditional architectural working environment is described in a quotation by a Finnish architect Birger Brunila at 1910's (Korvenmaa, 1992):

"The architect is an artist who has to manage a large domain area; he has to be a constructor, a thinker, he represents the builder and project manager in technical and legal issues, he is the concierge of patron's wealth, and finally he also has to be a business-man."

Practising architects have throughout the ages needed wide understanding of the society with all of it's various aspects. The skills and knowledge of an all-round renaissance person has always been an ideal within the profession.

The increasing need to manage larger and larger domains of knowledge – also outside the actual architectural content, the design domain itself – has finally created an insufficiency problem within modern architects. It is difficult to manage all the information of whatever design project any more. Information technology may, though, help in managing large information contents and the managing task may therefore become possible, provided that information technology is mastered.

Numerous separate domains have to be considered in contemporary design work, such as the grown economical concern, deeper technical detail-

ing and stronger environmental concern.

Design and construction projects turnaround time has shortened during the last decades. The pace in project work has accelerated, possibly due to modern ICT which allows even simultaneous communication, and much quicker than earlier. Design work was also earlier performed in cycles, such as weekly design meetings, whereas work is currently proceeded more steadily and constantly in virtual environments. ICT has evidently made contemporary tight process schedules possible.

The working environment of the architects started evolving more public since 1950s when organizations and commercial companies, despite private persons, started also order architectural services. Since the social consciousness of the 1960s, architecture as part of public environment, has been considered public property.

The client requirements for design have also been enhanced during the recent decades. Design requirements currently include detailed economical guidelines, design quality control, strong needs for design modifiability and structured task lists. Customer consciousness of our time is also very strong. Although the importance of customer and client requirements has lately been addressed (Kiviniemi, 2005), nevertheless the requirements are currently not well implemented for instance in contemporary CAD-systems.

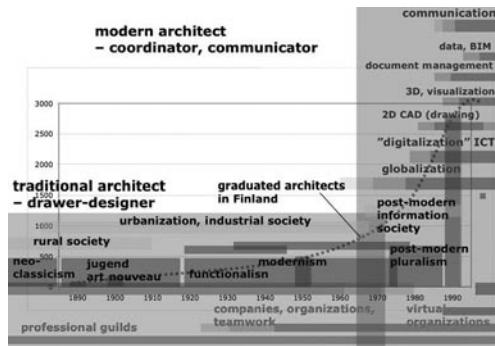
A modern architect has to be a communicator and a coordinator

Contemporary architects have to be active in communicating with the surrounding society. As is stated in a historic description of the architectural profession (Kostof, 1977):

“The primary task of the architect, then as now, is to communicate what proposed buildings should be and look like.”

The communicative environment of modern building projects is entirely based on daily phone, email and web-support. The architect operates virtually with other design teams, with clients and public authorities and during the construction phase actively with site managers. A major change within the previous decades is, that now all active design material – documents, drawings and all other data – is also virtually accessible via web whenever the design issues are discussed. Electronic document management systems (EDM), often also called project extranets or project webs, are the cornerstones of contemporary design and construction data management. The use of project webs has recently rapidly grown in Scandinavia (Howard, Kiviniemi and Samuelson, 2002). The rough volume of EDM-systems’ use in Nordic countries is currently around 50 %. Of architects roughly have 60 % earlier EDM experience, of project managers the figure is 20–40 % (Hjelt & Björk, 2006).

Open communication and systematic information exchange between the project participants are essential key-issues within contemporary construction projects, based on a customer and client study within Finnish construction field (Pekkanen, 2005). The most urgent alteration needs within contemporary construction process, addressed by the dissertation, are better control and adjustment of sub-projects, development of agreements and process responsibilities and enhancing project collaboration.



*Figure 3
Some essential megatrends and architectural styles & movements of the 20th century which have strongly affected the architectural profession.*

Design develops towards virtual drawing and integrated modelling

Large white drawing tables – traditional “altars” for architecture – have been replaced almost entirely with screens and keyboards and CAD-systems have become the main digital tool for the designers. Working without CAD is currently very uncommon in western architectural environments and design teamwork is hardly any more possible without digital drawings.

The nature and working methods in drawing have changed since the days of hand-drawing. Early sketching is currently done in well-structured layered documents, even if with fuzzy content in the beginning, still with a clear intention for later reuse.

The concept of digital drawing will surely keep on changing in the future. Earliest CAD-drawings reminded merely traditional sheets of paper, whereas digital drawings are currently rather “temporary output sets” from CAD-systems. Contemporary CAD-tools have to be fine-tuned, well mastered and professionally maintained to produce accurate documents with certain detailed appearance to the paper. Final output is also often done virtually and remotely in printing shops, meaning that the creators’ touch to the final documents is rather vague. CAD-systems are effective in automating and generating the drawing production. Drawing components, such as walls, doors, windows, furniture and drawing labels, are most often produced [semi] automatically.

Producing drawings will not vanish from building design but the concept of digital drawing has already now been proven very different than its traditional predecessor.

Architects are often in their design work relying on the support of spatial 3D-modelling, even if they are producing digital 2D-documents. The nature of design content has evolved towards more spatial character. Spatial design is even more helpful for the customers and other project participants, when the final design product has become much more realistic already during earliest design stages. In drawing-oriented design process of the 1990s – often the

active practice – 3D-modelling has really been more like a spatial reference, rather than the final aim of the design work.

The scientific foundations to manage design and architectural data in computerized form were created 40 years ago (Sutherland 1963/2003, Negroponte 1970). The foundations and finally also practical applications of a more comprehensive methodology to manage all building related data, building information modelling (BIM) or product modelling, were strengthened during 1980s and 1990s (Björk & Penttilä 1989, Eastman 1999). International efforts by the IAI-initiative to promote AEC-field information exchange and neutral IFC-format have also been noticeable during the last 5-10 years (Tarandi, 2003).

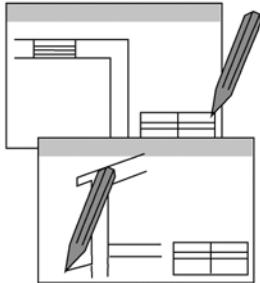
Building information modelling experiences in Finland.

Design by modelling is currently characterized by wide enthusiasm and positive expectations in Finland. Several research programs have been realized to further develop modelling, mainly with active support by national technology fund Tekes (Penttilä, 2005). Recent Pro IT -initiative (2003-06) has concentrated in distributing modelling methods and knowledge to design & construction practice. Data modelling has recently been tested in a handful of pilot projects. Model based methods have been applied to design & construction process so far mainly concerning design integration, cost estimation, designing-to-build activities and so far mainly new constructions.

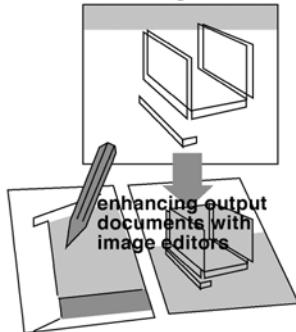
One key objective in promoting model-based methods has been publishing pragmatic modelling guidelines for the construction sector to adapt their activities and processes towards modelling oriented construction (Pro IT 2006). Strategic aim has been addressed by major national players, namely constructors YIT and Skanska and Senaatti properties, the state-owned FM-operator, who all have publicly announced to develop model based working methods and processes.

Finnish experiences underline the importance

Drawing and draughting with CAD (2D)



Visual 3D-modelling with CAD



Product model based data management

Modifying and analyzing product model data with applications

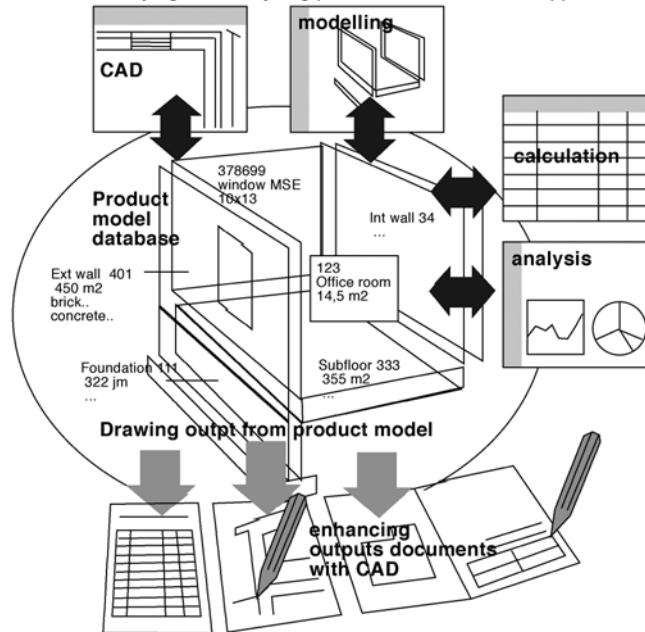


Figure 4
2D-drawing and 3D visual modelling are transition phases between traditional hand-drawing and integrated building information modelling.

of early project phases in decision making. Although modelling has proven to be some more time consuming than drawing based methods, the future value of properly modelled design information is still high, hence, modelling is advisable – it just has to be adapted to current processes.

Model based design concerns also administrative and legal issues. Even more conservatively oriented design & construction process participants are adapting their own procedures and activities to model based framework.

The evolution towards more integrated and model oriented framework is continuous and it will obviously take years before it may gain a wider penetration within the whole sector. Model based activities will not replace traditional processes, whereas, they will offer alternatives – more integrated and digitally better supported framework for future design and construction.

Architectural design environment summary

An evolution has changed drawings from hand-drawn papers to digital documents where elementary CAD-components are now digital lines. The change towards more complicated conceptual components – design objects such as walls and windows – has also been evident for years. Contemporary research likes to call these components & methods “smart”, “intelligent” or “advanced”.

Paper based traditional design environment

- + quick, cheap and easy to produce
- complicated and non-effective in design changes
- “ancient” in digital design collaboration

CAD-drawing based environment

- + well accepted and adopted in contemporary design-construction chain
- + cost-effective in drawing production

Table 1
Analysis of design environment changes.

- drawings contain lots of duplicate information
 - rather complicated to manage design changes
 - paper copies are still needed
 - communicative tools are needed to support design
- Product model based environment
- + fits well to life-cycle long information management
 - + cost-effective in design data management
 - AEC-field is not administratively ready for quick and profound changes
 - paper copies are still produced and needed
 - communicative tools are very essential to support design

Conclusions

The overall changes concerning the architectural design environment have not been fully responded within educative nor administrative sectors. New domain topics, such as *design communication, coordination and management* have to be included to modern framework of architectural practice. Active role in communication, in collaboration and in team-leading and coordinated actions are needed with clients, project participants and various fields of the surrounding society – and architects have prominently a central role within this.

Modern digital architectural environment is dominated with computer-aided design tools, not to forget project webs and databases. The continuously expanding and altering domain of *architectural ICT* has to be included as a profound technical and also communicative basis for contemporary architectural working environment.

One of the most challenging issue in utilizing advanced ICT-methods, such as building product modelling, is how to maintain design quality within the changes (Kalay 2006). Data management is often done by economical reasons only, and economy does not always respect design quality nor richness issues. Cornerstones of classical architectural virtues, such as beauty, usability and flexibility as well as de-

sign creativity, should also be taken into consideration when developing architectural ICT in its various contemporary forms.

In adopting the novel roles of architects, modern pedagogic methods such as continuing education, learning by doing, collaborative teamwork have also to be acquired to professional profiles of modern architects. Especially IT-related issues are renewed these days so quickly, that learning has to be continuing and also a normal condition architectural practice. The architectural profession will in the future be in constant change.

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