New Professional Profiles for International Collaboration in Design and Construction

Hannu Penttilä [1], Dietrich Elger [2]
[1] Helsinki University of Technology, Department of Architecture, Finland, [2] KOOPX Architecture & Engineering, Germany
[1] hannu.penttila@hut.fi, [2] elger@koopx.de

Abstract. *This paper discusses the recent changes within the architectural profession: the growing demand for collaboration within design and construction and the recent transition to fully digitally enhanced design process.*
The aim of the paper is to stimulate the discussion within contemporary architectural profession. Profound discussions and re-evaluation is needed in the fields of design education, architecture related research as well as in current project practices. A proposed visionary profile of a collaboratively technical architectural education will be presented as the conclusion of the paper.
Keywords: *architectural profession; collaboration; communication; CAD; BIM.*

Communication processes and tools

"To get to know each other means to learn how to be alien for someone"

The citation of Christian Morgenstern describes impressively the imponderableness in relations between people of different business cultures. Due to globalization, the increasing volume of international business activities is fostering the need to be able to communicate over different cultures and languages and with new and unfamiliar disciplines.

In this context it has to be considered that to be acquainted with someone, means that you have to learn from someone. Besides the content of respective areas of expertise, diverse culture is first of all leading to the necessity to be ready and able to learn about new traditions and unknown conventions in an international context.

Architects have traditionally had a comprehensive understanding of building design and construction process. Despite the artistic design ideas, the architects have also been those project participants who find innovative solutions and alternative proposals for various design and construction related problems, and it is the architects who contribute and communicate design related problems in multi disciplinary teams of building professionals.

Contemporary design communication is stretching over various scales: discipline internal (own work), project-centered (cross-disciplinary teamwork) but also wider national and international collaborative skills are essential for contemporary architects. Anita Moum has recently described these various levels of professional architectural expertise, defining micro-level to be the internal and personal scale, meso-level to be the teamwork scale and macro level to be

the context to design aith the outside world (Moum, 2006). Moum also refers to a wide selection of architectural research literature in describing the main factors or tasks of the architectural domain specifying it to creative generation of design solutions, evaluation of design solutions, communication within the architectural design process and finally professional decision making.

Various technical working platforms and communication tools of our time require lots of technical skills, to simply manage the communication activities. The era of emailing, Internet, databases, videoconference et cetera, has spreaded design data so widely, that it is often very tedious to even try to integrate all this data and information, to compose and accumulate real and essential design knowledge within a project. Even if this collaboration and communication with pervasive technologies is technically enhanced and demanding, on the other hand it is also required as a normal necessity in contemporary net-based project management and place-independent design project cooperation.

Nevertheless, professional digital architectural design tools, such as CAD, have to be discussed with the wider context of the whole design process, all project related activities, interactions and communication within it, and above all, over various cross-disciplinary domains and various working scales.

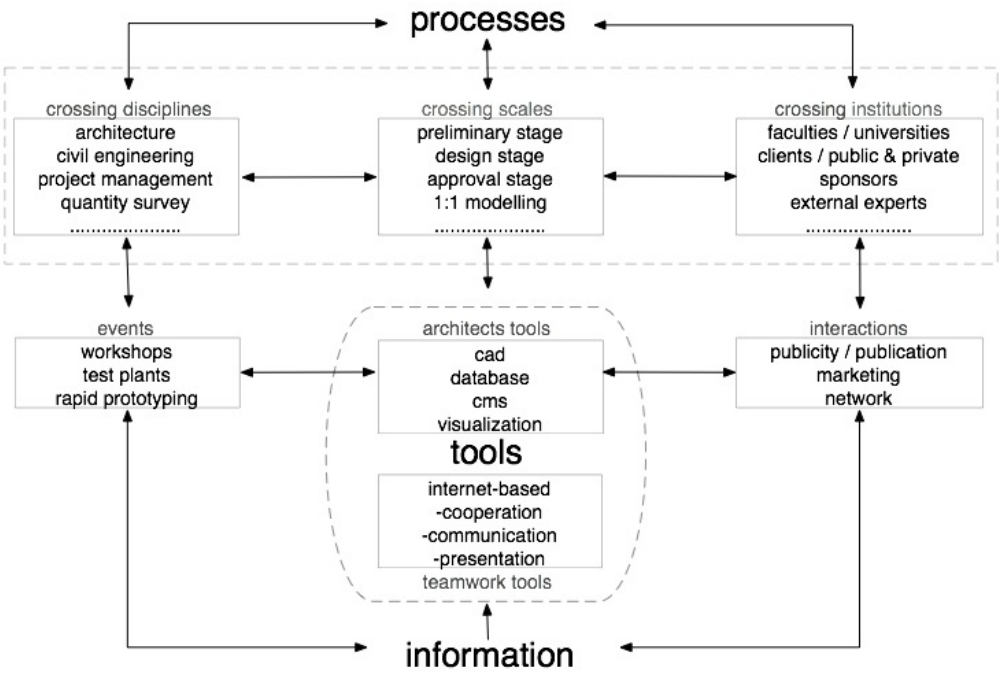
Computerization, changes and complexity

The architectural profession and design practice has faced a fundamental structural change during the last 20-30 years. Some of the professional changes have been clearly caused by ICT, such as the technical change from hand-made drawings to computerized digital drawings and furthermore the recent change towards model based design. ICT-related changes in the construction sector have been measured for instance by Olle Samuelson who has performed a series of IT-barometers in Scandinavia, first in 1998, a second one in 2000 and the latest in 2007 (Samuelson, 2007). The new barometer from Sweden reveals that computerization and information and communication technologies have already fully penetrated

	Micro level - personal	Meso level - team - project context	Macro level - environment - societal context
Generation of design solutions	CAD, innovative tools	Collaborative design	Environmental requirements and constraints
Communication within the design process	Integration of communicative tools	BIM, interoperability	Access to design information
Evaluation of design solutions	Regeneration of design proposals	Merged design models, consistency	Visualizations, BIM, simulations
Decision-making	Conviction	Project promotion	Comparison of design proposals

Table 1
Anita Moum has used this simple matrix framework to analyze the ICT-impacts on architectural profession. The matrix content presented here is by the authors. The matrix can also be useful in describing architectural profession and design related tasks in a wider context.

Figure 1
A schematic description of integrated design and planning concepts within architecture, showing digital tools and communication as an elementary and essential component of our modern profession (Elger & Russell, 2006).



the architecture, engineering and construction sector. For instance the volume of CAD-systems' use within the architects is currently over 90 %, and in fact this development occurred already in the early 2000's. Based on the barometer series, a trend from 2D-drawing towards 3D-design can be seen within designers. A recent Erabuild-report (Kiviniemi et al, 2008) documents that the volume of building information modelling BIM, meaning 3D-design plus approach towards comprehensive information modelling, has gained more importance during the last few years. The estimated volume of BIM is currently said to be as high as 10...20% within the architects and furthermore within the engineers and contractors around 10%. These ongoing changes towards digital design and construction are self-evident and irrevocable.

A positive reaction and even a political sign is, that also designers' professional organizations and institutions as well as other bodies in the construction field have noticed and reacted on these changes in the working environment, which are likely to expand with an accelerating pace in the near future (Bucher, 2003). The common vision of the architectural profession is changing towards a more collaborative, more multi-functional and definitely integrative directions. The professional profile of a contemporary architect can not be defined without ICT any more.

Despite tools and technology, also the widening spectrum of requirements posed by our surrounding society, has also accelerated these elementary changes within the architecture profession. Finally, these changes are currently re-forming the contemporary profile of the architectural profession.

Parallel to these professional changes, the growing complexity of the design domain and also contemporary buildings, demands that AEC-field professionals have to work with increasingly complex projects these days. The amount of various technical systems and equipment in buildings has been constantly growing during the last 50 years. In modern buildings the total share of technical systems of total building costs is 15...20 % and it reflects also the needed design work to accomplish the buildings. The more technical systems buildings have, the more discipline specific expertise is need, hence, the more collaboration and detail level coordination is needed in building projects – and furthermore, the more complex buildings will evolve.

The recently addressed importance of societal and environmental awareness contributes also with design and construction complexity. When buildings overall performance and material behaviour has to be regarded within the whole buildings' life cycle – also in connection with the environment and the society – the near future criteria to design buildings and evaluate building designs will surely be even more complex than today. For instance building information models, BIMs, may well be profitable data repositories in managing building's overall information about life-cycle sustainability related information (Häkkinen, 2008).

The architects are, above all, building information managers. Architects do not move concrete, stones nor steel, they merely move information about concrete, stones and steel. Their role as coordinators of building design as well as coordinators in the planning and realization processes is leading to the necessity, that they shall cope, control and coordinate all information about building. This means that for instance methodical systematics and toolboxes like building information modelling BIM, will help the architects to take over – again – the lost control of the entirety of building information and comprehensive design of the building itself.

Construction project conventions, business and efficiency

Since the 1990's economy-oriented leadership and business management have affected the expansion of the design management research domain. Changes in business processes as well as the important status of the architectural profession within construction has come out to a conclusion, that architectural design is a sector which has to be managed, and hence the field requires also leadership actions (Otter & Prins, 2002). There have been discussions about collaborative design in general design theory (civil and mechanical engineering and systems science) and collaboration has always been discussed within architecture as self-evident part of the profession. Design guidelines and requirements management, have emerged as relevant topics in building related information processes.

The objective in project conventions though, has most often been operative project or project data management and naturally project economy control. Building information modelling BIM aims to pragmatic project data integration via digital tools and controlled data exchange (Penttilä, 2007). A profound description about the BIM-systematics has just recently been published (Eastman et al, 2008). Another recently emerged concept, namingly virtual design and construction VDC, has extended BIM and virtual building environment discussion towards business, finance and project contexts (Kunz & Fischer, 2008). Virtual design and construction is currently

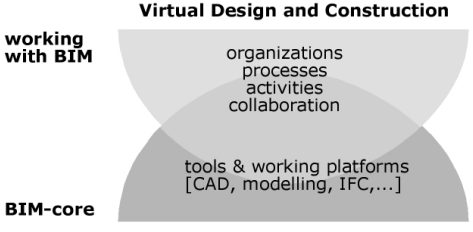


Figure 2
Building information modelling BIM is currently understood as an elementary basis or a working platform for design and construction related projects and collaboration.

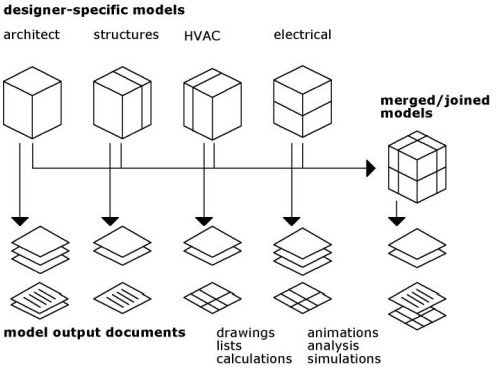


Figure 3
The concept of a merged model is elementary in model based design such as BIM. Designer specific models have to be merged in crucial project check-points to verify design integration and ensure project coordination.

understood to be an entirety of digital technical working platforms and tools, which also have a well defined functional framework of design and construction project (processes), actors, goals and tasks.

The traditional linear design and construction process has been transforming towards more interlaced, interleaved and concurrent process, where various design and construction tasks are developed simultaneously and with digital tools, but still with a coordinated integration. Traditionally hierarchical organizational structures within the AEC-field have also been developing towards project oriented team structures and networks, which respectively require more communication and coordination as an essential part of project work.

A mini case study – Changing project conventions

The content of building design has been structured formally for instance with systematical task-based methods. In a national Finnish design guideline documentation, the design project has traditionally been divided to project phases, which thereafter have been divided into tasks. Various discipline specific task lists – for instance architectural, structural and technical – which were first published in the mid 1990's, will be updated during 2008 to match the recent needs of changed modern project conventions and also to match the requirements of model based digital design construction conventions.

Essential additions to this task-based architectural design guide, will be a subset of project management and design control tasks, as well as a subset of coordinative tasks to integrate model based design. Especially when working with discipline specific design models, these models have to be merged and cross-checked in pre-defined project check-points. BIM-model coordination related tasks will suit well to the profile of the main designer, most often the architect, but the new emerged role of a model-coordinator has also to be included into project agreements and contracts, and also into project schedules, because model merging requires also time.

The importance of design and comprehensive understanding

The architects as main designers have to take care of the overall design quality of the buildings. Despite the fact that this total quality management fits naturally to architects who are traditionally comprehensive design project coordinators, it is also a professional responsibility issue to aim at the quality. The importance of compendious entireties is likely to become even more important in the future of our economy-driven construction, where professional and enlightened project owners and customers are also willing to invest on quality and management.

Hierarchical decision making may be efficient in fulfilling the process needs and quantitative requirements, but efficiency may quite obviously fail when applied to design quality related issues, says Yehuda Kalay (Kalay, 2006). Efficiency and quality – both desirable features in a design process – are difficult to measure with the same scale. Kalay is also skeptical about BIM, because when it solves the project communication and enhances efficiency, it does it with the cost of quality, he says. The possible negative impacts of controlled and centralized project data management, such as BIM, have in fact not been discussed too widely in recent scientific literature. Of those few critical approaches, Chrabin et al describe

a single building model paradigm as a constrained and constructon centered view on design (Chrabin et al 2003). Both Kalay and Chrabin claim more variety in selecting and using architectural design tools, to gain more flexibility and design freedom in defining the architecturally important project content.

Buildings are important parts in the wide-stretching environmental network and the buildings will constitute an information network themselves as well. As architects we do know which parts of the buildings are important, how often the parts are used, and as architects, we can make precise statements about the construction and running costs of the buildings throughout their whole life cycles. Virtual building models will in the future be used for documentation of the sustainability of the buildings – not only to generate colorful images, as most often is done so far. Comprehensive digital building models will be the first versions for development and realization towards real buildable buildings, and in the future these both, the virtual model and the real one, will be linked to each other, to support the use, the living and in the buildings. Virtual buildings are essential and profound means for contemporary architects to manage the complicity and the diversity of buildings and the totality of the buildings.

Conclusions – Architectural education directions

It is obvious that in the framework of architectural design education, which is always oriented towards the future markets, training in communication and cooperative skills needs special attention today. In Europe there are altogether some 120 000 architectural students and 5000...7000 full time teachers in around 200 European architecture schools. Student exchange programs such as European Union's Erasmus which has administered altogether 1,4 million students (not only architecture) from over 30 countries since 1987.

A widely noted fact is, that architectural students extend their expertise during the studies by visiting foreign architecture schools and attending their international programs. In several European schools the percentage of foreign students is remarkably high, even 20...30% of all students, which has forced the schools to target their traditional education more towards international courses, which respectively means more collaboration and integration between various cultures.

The challenges of collaborative design doesn't only occur in managing and organizing the design courses, but it is also a threat for educational quality. Various international course participants do very often have different skill levels and premises based on their own cultures and experiences, meaning that joint international collaborative courses should put more emphasis on course pre-qualification in the future. The management of information and the work spanning over different disciplines must be seriously established in the curricula of the educational institutions.

Diverse multi-disciplinary understanding and knowledge about various factors of design and construction will be essential in the near future architectural design profile. While design and building related information seems constantly to spread into smaller and smaller details, at the same time with the distribution to various scattered locations, a unifying and comprehensive vision about future buildings and environment is crucially needed. Large professional building owners and property managers have always addressed the importance of a holistic vision and understanding of buildings, a vision which very well suits with an architectural profile.

Most university level architecture schools do already have professorships or at least faculty posts in digital design, but there are still also several schools without any resources in modern collaborative digital design.

Although model based design will not replace basic design requirements and needs such as drawing, desktop publishing, calculating, presentational and communicative skills, model based design in it's widest meaning – and performed with various

modelling methods – will become the core of the digital design process. The digital design curriculum during the architectural studies, needs to be part of an integrated educational system, where analogical and digital methods enriches and support each other.

What we need in our constantly evolving complex world, is powerful and competitive architectural education. We may also even need more credits points for both the bachelor and the master studies, to show our students that professional associations and institutions are able to face the changing challenges within the architectural profession.

Extensions to contemporary architectural profile

A few new roles have been noticed to emerge within the contemporary architectural design practice. Despite the traditional and highly valued and still strong role of an architectural designer managing design content, the emerged role of a design project leader and coordinator and the more technical role of an ICT-manager are constantly growing and coming more and more essential for our profession in the future (Penttilä 2006). The ability to work with distributed project partners and scattered information and the ability to manage and delegate design work and at the same time with a true approach in design quality related issues, are profound skills to modern architects.

As a conclusionary argument, modern design work can not be managed without computational tools and methods any more. Hence, widely managed ICT tools and skills are as essential these days as drawing and presentational skills used to be, and ICT skills, such as management and communicative skills, have to be considered as additional extensions to those traditionally highly valued and profound architectural design skills.

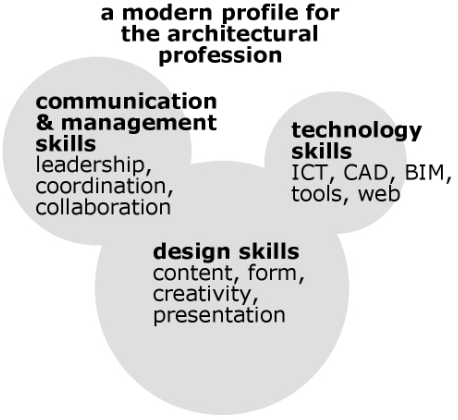


Figure 4
A 'slightly tortured Mickey Mouse diagram' represents the contemporary modern profile for the architectural profession. Traditional architectural design skills – design content creation & modification – are the true and solid basis for the profession, but enhanced with management skills and technical skills.

References

Bucher, C. (ed.): 2003, Architect's Profile – Professional Practise, reference document, ACE, Architect's Council of Europe, Internet, accessed 10.5.2006: http://www.ace-cae.org/Public/content/EN/pos/pro/prof001.html.

Chrabin, A. M., Szewczyk, J. and Neuckermans, H.: 2003, A Critical Evaluation of Early Stages Software in its Capacity of Coping with Contextual Issues, Local values in a networked design world - Added value of computer-aided architectural design, M. Stellingwerff and J. Verbeke (eds.), (2004) DUP Science - Delft University Press.

Eastman, C., Teicholz, P., Sacks, R. and Liston, K.: 2008, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, John Wiley & Sons, Hoboken, New Jersey.

Elger, D. and Russell, P.: 2006, **Crisis? What crisis? Ap**proaching information space: New dimensions in the field of architecture, International Journal of Architectural Computing, 4(I).

Häkkinen, T.: 2008, Sustainable building and BIM, presentation at RTS rakennusfoorumi, accessed on 13.5.2008, http://www.rakennustieto.fi/index/rakennustieto/rakennusfoorumit/esitykset.html.

Kalay, Y. E.: 2006, The impact of information technology on design methods, products and practices, Design

Studies, 27(3), pp. 225-422.
Kiviniemi, A., Tarandi, V., Karlshöj, J., Bell, H. and Karud, O. J.: 2008, Erabuild 2008: Review of the Development and Implementation of IFC-compatible BIM, Sintef, Norway.
Kunz, J. and Fischer, M.: 2008, Virtual Design and Construction: Themes, Case Studies and Implementation Suggestions, CIFE working paper WP 97, Stanford University.
Moum, A.: 2006, A framework for exploring the ICT impact on the architectural design process, ITcon, 11, Special Issue The Effects of CAD on Building Form and Design Quality , pp. 409-425, http://www.itcon.org/2006/30.
den Otter, A. and Prins, M.: 2002, Design Management Within the Digital Design Team, ECAM special issue, 9(3), July 2002, pp. 162-173.
Penttilä, H.: 2007, Early Architectural Design and BIM, Computer Aided Architectural Design Futures, Proceedings of the 12th International Conference on Computer Aided Architectural Design Futures, Sydney (Australia), 11–13 July, pp. 291-302.
Samuelson, O.: 2007, The IT-barometer - a decade's development of IT use in the Swedish construction sector, CIB 24th W78 Conference, Maribor Slovenia 26-29.6.2007.