ICCT Influence on Spatial Planning, Design and Construction Process

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Summary

The building sector already entered a new era during the last decades. Developments in ICCT (Information, Communication, and Computing Technology) have an impact throughout the entire life cycle of a building and the built environment. Through changes in daily life and culture as a social effect and through the economic behaviour, it will gradually influence spatial planning, the urban structure of the future, our cities, and our living environment. The buildings, the built environment, and architectural design itself will therefore evolve.

Developments in the field of advanced modelling techniques and methods influence how architects design and the design itself. Therefore, the gap between creative design, which is done by means of advanced modelling software with complex architectural forms, and the materialization and construction process of these complex designs, is getting bigger. Building technicians must be aware of the fact that this gap is growing rapidly as a result of the advanced modelling software and other smart/intelligent design tools and techniques. Furthermore, ICCT and Internet technology provide a closer link between participants in the building process, their activities, knowledge, and information. Collaboration and communication, such as collaborative engineering, will be the future of the building practice. This paper provides a vision on the influences of future ICCT developments in spatial planning and architecture in general, focuses on the influences on architectural design, and gives examples of existing buildings in the real world as well as the virtual one.

ICCT, spatial planning, advanced modelling software, collaborative engineering

1. Introduction

During the ages, every technical invention and development has resulted in advantages and disadvantages, which have influenced the well-being and prosperity of mankind. When we look back to medieval settlements, where they did not have water supply or electricity and where people lived in different conditions than in our days, we see that cities had a totally different scale. They were small and fortified with city-walls guarding against the enemies and city ports closed in the evening due to security reasons.[1] Streets were designed for coaches and therefore very narrow. Communication and social contacts between citizens were only verbal and places where people could take their water supply for the next day were the meeting places.[2] When electricity and water supply through pipes became a normal issue in daily life, social life and the physical living environment changed enormously. Then the telephone, later fax etc. were introduced in our life to connect the world. Now, the internet…

Gradually, due to technological developments and changes in culture and society, the security aspect (due to attackers) lost its meaning, and as a result these compact cities transformed into more open city-structures by the introduction of other transport means such as cars instead of coaches. One of the typical examples of a city where both the compact and more open structures are visible is Rothenburg ob den Tauber in Germany (figure 1).

Fig. 1 Panorama view of the city port, city walls, marketplace and the city map of the fortified city, Rothenburg ob den Tauber, Germany. Images from http://www.wolfgang-in-wuerzburg.de/rothenburg/inhalt.htm and http://www.rotabene.de/webcam/archiv.html

Technological inventions not only had an impact on how people worked and lived but also on the way of gathering and distributing knowledge. Finally, these technological developments had a fundamental influence on the behaviour of man and therefore on society. It changed our habits and, more gradually, our culture. In this way, the human being is continuously evolving. The infrastructure development is one of many examples illustrating these changes.

The reason for these phenomena is the technological inventions, especially the industrial revolution. Cities became larger due to the inventions of motor vehicles, trains, and planes. We are now talking about Mega-cities. According to scientific estimations, within thirty years, one third of the world population will be living in big metropolitan areas. Cities are becoming more and more concentration-points of employment with many new activities and jobs such as factories, universities, commercial companies, and cultural centres.

2. ICCT influences on building and creative design

Within the ongoing developments of ICCT, the role and daily work of the people who are involved in the design process are changing. Until now this process was divided into a few stages. When the architect designed the concept, this then went to the constructor to be worked out and materialized, and afterwards to the contractor to be built. There was also always the supervisor, the manager who led this process. We are now entering into a new stage where this process is not sequential anymore (co-operation), but more *network type,* which we call *information, communication and collaboration networking in the design process*.

Looking back at developments of ICCT in the building sector, we see that the computers were first put into practice as a *tool***,** as an instrument for achieving a specific result; either to produce a final drawing, an animation, a simulation, or an interactive visualisation. Nowadays computers have taken on a slightly different role within the architectural design process as a new *medium* besides the existing media. Especially the widespread use of the Internet and the developments of the Web have pushed the computer into the role of a medium.

In the very near future, we can expect another shift in the role of computers in the design and building process, namely, as a partner [3][4][5]. We are now at a stage in which ICCT allows us to develop new techniques and methodologies where the computer can be used as a *partner* by means of knowledge integration, decision support, and artificial intelligence. Decision support systems allow the computer to support the user through knowledge provided by experts or by the user. The computer can also be a partner when we teach it things it can reason with. It can even be a valuable and reliable friend when we let it solve problems that are not clearly defined, fuzzy, or uncertain. It can also assist us in generating shapes by processing information that influences the shape, supported by self-learning techniques. Here, artificial intelligence techniques such as fuzzy logic, genetic algorithms and neural networks play an important role.

2.1 ICCT impact on creative design

When we look at the role of the designer in the building process, we see that as a professional she has to deal with three main categories of sciences, sometimes called *alpha*, *beta,* and *gamma* sciences. Alpha sciences deal with the subjective world of beauty and moral, as expressed by the artistic, intuitive soul. Beta sciences bring in the objective world of facts and logic, represented by the rational mind. Gamma sciences consider the interest of the society and culture. The integration of these sciences makes the task of the designer more complex, but also extra-ordinary and unique. This means that the designer must have the skills to integrate the various disciplines of knowledge, involving besides the artistic form expression of the building also the dimensioning of the structure, building physics, applied mechanics, the calculation of structures, building materials and techniques, etc. The most famous designers, such as Santiago Calatrava, are the ones who have the ability to combine these various disciplines in their designs being architect and building engineer at the same time.

It is known that when computers were first introduced in the building sector, the initial applications mainly concerned administrative tasks. Gradually their functionality has been extended to support repetitive tasks; nowadays, software applications are becoming essential tools for *creative* design, for *materialization* (building technical aspects), and also for the *management* of the entire building process. Already, for many architects such as Peter Eisenman and Frank Gehry, the employment of computational programs is an instrumental, if indispensable, means, even if it holds no explanatory power over the results [6].

In respect to creative design, we see that spatial software developments for design aids developed in the last years have influence on the form finding and spatial design capabilities of creative designers (figure 2). The designing architects are more and more using 3D modelling software such as Maya.

To see the influences of new modelling software in design, last summer there has been an experimental workshop organised by the Netherlands Architecture Institute (NAI) in Rotterdam. Dutch designing architect Lars Spuybroek guided the students for the design context in collaboration with the staff of the chair Technical Design & Informatics at the Faculty of Architecture, Delft University of Technology. Our staff guided the students on the informatics aspects and within few days time the students were able to cope with various software including Maya in order to design a stadium. During this international design workshop, we experienced that the design tools offered to the designer have considerable impact on how the designer is stimulated by the possibilities of the 3D modelling software. It is a fact that the designer dares to design more complex forms and has more flexibility to do so. The outcome of the designs in the workshop was very extra-ordinary even futuristic concerning the form aspect.

As a result of developments in advanced modelling software, and its use for architectural design, the gap between what the architect or designer can envision on the one hand and what the building technician or product architect can materialize on the other hand is growing. Besides the Guggenheim Museum in Bilbao-Spain designed by Frank Gehry, the work of Dutch architect Lars Spuybroek, the Dutch Sweet-Water Pavilion in Sealand-Holland is a prime example illustrating this argument (figure 3). Designed using Maya, the shape of this design would be much more difficult to establish using traditional tools and methods of designing rather than using Maya or other advanced modelling software, for instance Catia. With such tools, the architect is provided with a richer form vocabulary and more flexibility to realize her spatial ideas on the computer. Design software has reached a point where it can stimulate the designer's creativity rather than impeding it as has been argued in opposition to the use of CAD software. We see more and more contemporary architects who have adopted advanced modelling software for their creative design, such as Peter Eisenman, Frank Gehry, Greg Lynn, Marcos Novak and Kas Oosterhuis.

Fig. 2 Design of an airship hangar by the student Remco Wilcke.

In the Sweet-Water Pavilion, we see clearly that the technical realisation of the building does not answer the requirements of the form. The structures, materials, detailing, building physics and installations techniques are far behind the expected quality. It is not only the lack of knowledge, but also the available technical possibilities and materials do not match with the form of the design. Each detail and each bearing structure is different from the other. To use existing, industrialised components is not possible in such buildings, and therefore, it is very difficult for the building technicians to build it. The building is now a few years old, but one can see that there are many problems concerning the building technical aspects, which are not easy to solve with the existing techniques.

The developments in the fields of building technology and building materials have not followed the advances in modelling software, so much so that they can no longer fulfil all the requirements and demands of the new architectural shapes. ICCT may play an important role in narrowing this gap. CAD/CAM already counts heavily in the realization of such buildings as the Guggenheim Museum. Electronic form information is transferred directly from the design model to computer-controlled manufacturing machines, as in the case of stone cutting for a curved wall. Unlike straight or even cylindrical surfaces, free-formed surfaces cannot be composed simply of standardized components; potentially each element may be of a different size. This strongly complicates the manufacturing process and causes astronomical costs. Numerically or computer-controlled equipment enables custom components to be produced at a lower cost. Connecting such equipment to the Internet so that these can be controlled directly from the design model further cuts cost. As custom manufacturing increasingly replaces standardized production, these costs will further decrease. Furthermore, custom production will become more accessible and common as electronic catalogues are extended to include information on custom manufacturing techniques, possibly allowing designers to check manufacturability and price in the design phase.

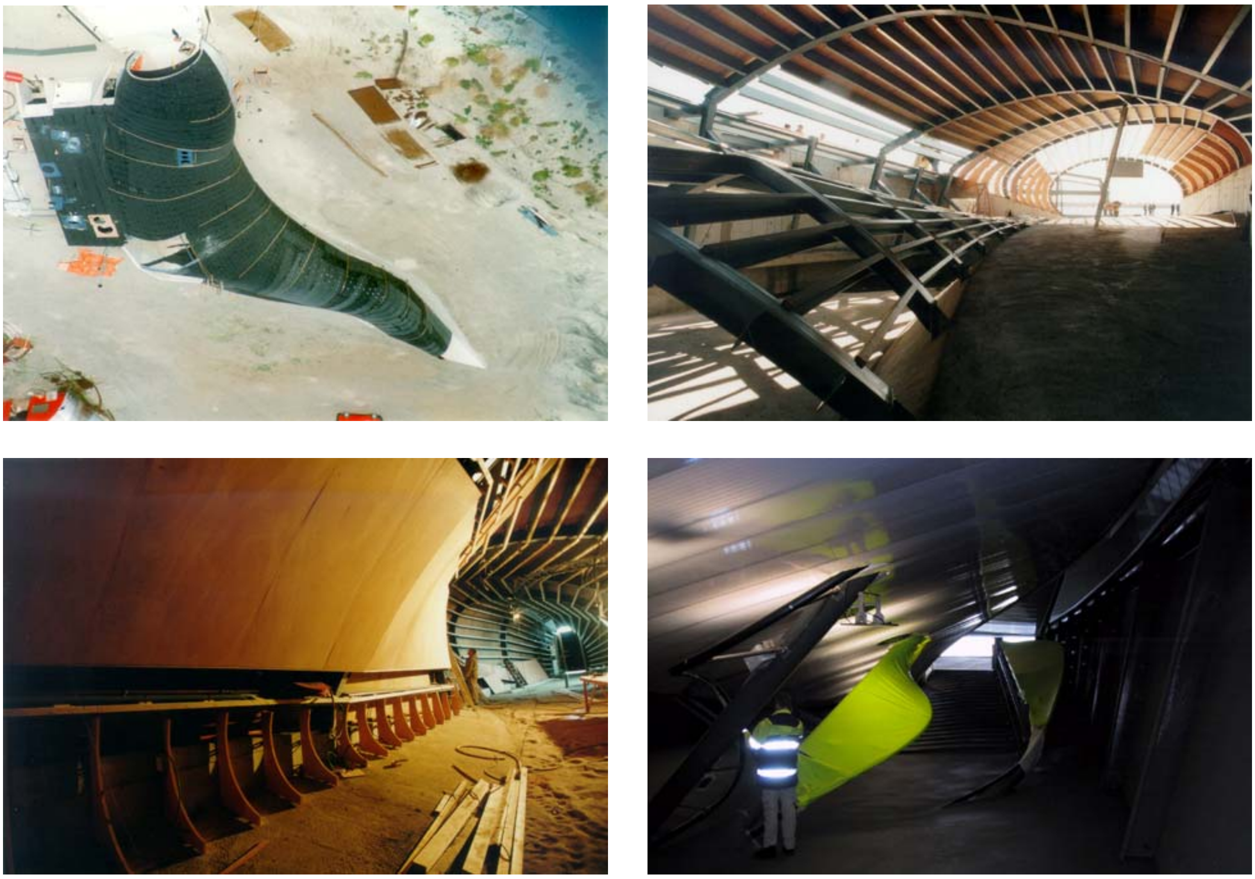

Fig. 3 Exterior, interior, and construction views of the Dutch Sweet-Water Pavilion in Sealand-Holland by architect Lars Spuybroek.

3. Conclusions

ICCT techniques have influence on spatial planning, architecture, and the whole building sector.

They cause transformations in society and culture by affecting the behaviour of each individual via social and economical means. The requirements and needs of the society are changing and this can be seen in our daily life through living conditions, recreation, transport, etc. This in turn results in changes to spatial planning.

The influence of ICCT can already be seen in architectural design. Designers can allow ideas and intuitions to take physical shape in ways that have not been possible before [6]. At the same time, technical developments in the building industry are lagging behind and alternative, innovative solutions have yet to be adopted. As a result of creative software tools, the gap between the designing architect and the building technician is getting bigger. The building technicians must be aware of the fact that this gap should be filled in by advancing the structural techniques and inventing new materials and techniques up to the requirements of the form of an architectural object.

The developments in *advanced form-finding* techniques by means of ICCT tools should be done in close *collaboration and communication* between the designers and building technicians, structural engineers, installation experts, etc.

The Internet technology provides a closer link between the participants in the building process, their activities, knowledge, and information. Collaboration and communication such as in collaborative engineering, using ICCT techniques will be the future of the building practice. Therefore it is necessary to set-up collaborative engineering studios among architects and building engineers, and to educate the young professionals with tools such as CAD-CAM, CAE, and with the internet based CSCW (Computer Supported Collaborative Work). The educational institutions should pay more attention and take more initiative to realise these objectives.

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