

# The Next Generation of Architecture within Computer Science

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## Abstract

Technical inventions and developments have resulted in advantages and disadvantages for the well-being and prosperity of mankind. Advanced computer technology has brought in a lot of improvements in different fields, but some disadvantages as well. The developments in the field of computer science have also an inevitable influence on architecture, therefore we have to deal with chances and problems of computer application in the building process. How did the computer science influence the architecture till now, and what is going to be the future of architecture with this ongoing developments of computer science? In which way will these developments affect the position and the responsibility of an architect? In this paper we will discuss these questions and present our “vision of the future”.

## Introduction

*Information and Communication Technology (ICT)* has a great influence on behavior and functioning of human beings and therefore, in a more wider sense, at mankind and society as well. The development of the advanced computer techniques and technologies has also an influence on architecture. Computers are in common use in architectural offices, till now mostly for drawing purposes. The developments in fields like building technology and material sciences offer a lot of new possibilities for architecture with respect to the use of new materials, the application of new construction techniques, the buildability of designs, etc.

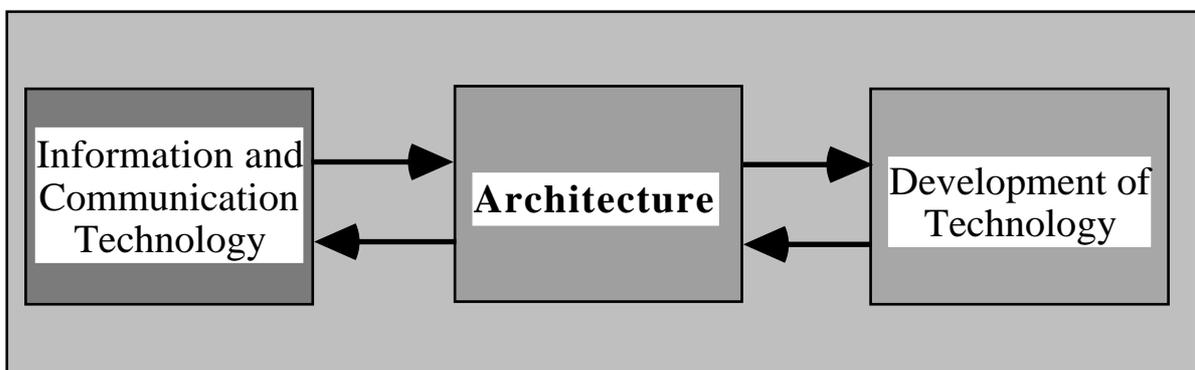


Fig. 1 The relation between architecture and technological developments.

These possibilities are applied in current architectural practice. Some architects go even further and initiate the development of new technologies. In this sense we can consider architecture a significant stimuli for future developments in these fields. Figure 1 illustrates this interaction between architecture and technological developments.

The subject that we decided to take into account is extremely broad and endless discussions could be held about it. Therefore we will try to concentrate more on the nearest future which is almost already knocking at our doors in search for the answers. At the beginning we will have a look at the development up to now.

### **The Way Ahead**

The only way to look into the future is to look back into the past in order to be able to answer a lot of questions, such as:

- Why computer modeling?
- Why architecture in combination with computer science?
- Is computer science essential for researching human space forms?
- Is computer science essential to handle complications in the field of building technology?

The answers to these questions are for the next generation. Architecture is a mixture of art (emotion), materialization and technology taking into consideration the human behavior and welfare. Since architecture is a product with a great tradition there is more reason to look into the past. Think about what the Greeks have done in the field of architecture, like the Agora houses, etc. What has come into existence in the Middle-ages? For instance the Gothic-style with influence of the Arab's pattern grammars. What was the communication system? The people themselves? Do not forget the Renaissance, neither the revival in the sixties etc. To design in the past was a very handy work. When an architect, in the seventies, started to develop a building, it was popular to start with a pencil and a piece of paper and draw the first ideas. In principle that is the same as in the Stone Age when a person used a little stick and a sand surface. But in our time, the building itself has become much more complex, not only in its function and form, but also in its infrastructure, communication technology, security, etc.

The variety of solutions, to construct and materialize buildings, is enormous. What are the reasons? In the seventies human brains have worked out a new architectural philosophy:

“A building is a part of the cosmos, That means that the inner space and the outer space are not in competition with each other but have to compensate each other.”

That means that the construction of the outer walls had to be open and light. The first consequence was a de-materialization process in the field of architecture. That means, in “use less more material”. The complexity grows! The next consequences were that buildings have “less more weights”, but also the role of the advisers and consultants became more important and relevant. One of the reasons was, for example, an acoustic problem that arose because the sounds from the outside entered easily through the light-weight walls and the inner climate-control was in disorder. By using light-weight walls and large glass surfaces the heat “gets” into the interior. The consequence was the development of a design with a complete climate-system taking a lot of energy and consuming more space. In the past the mass of bricks was the solution for this kind of problems. By this kind of complexities the architect needs a lot of consultants and advisers. Even the local authority (town-development, building-controllers, etc.), in his own organization, is much more complex than several years ago. It is hardly possible to handle this complexity as a single architect. Therefore, to design a well-balanced building communication is one of the most important things. A possible solution can be found in the use of suited software systems supporting the architect during the design process. The consequence is that not only the technical problems are easy to be solved but there are also possibilities to research the human-space models on a 3D computer system. In the next chapter we will deal with these possibilities and summarise current research concerning the application of ICT in the field of architectural design.

### **Current Research**

We generally consider architectural design as a process consisting of two main phases - conceptual design and materialization. Conceptual design includes a global design of forms and relations between different parts of the object to be designed. In the materialization step the forms are substituted by construction components and materials. A large variety of tasks has to be executed during the materialization phase. It includes dimensioning processes, determining the construction, materials and building details, considering building provisions, etc.

With respect to the importance we can state that materialization is the key issue in the architectural design process. Furthermore, it has above average importance for the whole building process. We have to consider these facts when discussing possibilities of computer support for architectural design.

It is common knowledge that a computer is very appropriate to check exact criteria and in the materialization phase data become more and more exact. So far materialization has been achieved through time-consuming procedure, according to traditional methods, which often fail the effectiveness and consistency and do not offer all the possibilities from which to select. The developments of methods by which three-dimensional materialization can be supported by means of computer science technology is largely unexplored territory. Therefore, it is quite logical that much effort is taken in current research projects and has to be taken in the future to achieve improvements for the materialization field. Current research in this field includes the following two important features:

- The development of design tools for the different materialization sub-processes;
- The integration of these tools into integrated design systems.

Both of them have to be taken into consideration to achieve fundamental advances. Generally, we assume a design methodology based on 3D representations for the whole design process despite some early steps as approached in [1]. Some examples for required design tools are:

- Tools for the generation and evaluation of design alternatives with respect to the selection of materials or constructions;
- Tools for the research of the spatial qualities of the design;
- Tools for the dimensioning processes;
- Databases for three-dimensional standard details including functions for the easy use of these details in design projects;
- Systems for the handling of building regulations and
- Decision support systems for the different kinds of materialization tasks providing knowledge of different specialities.

Besides the development of new tools there is also a need for improving the application environment of these tools. We have to avoid situations where limitations occur because of incompatible file formats and incompatible communication protocols or because of user interfaces that are not suited for the people working in the field of architectural design. This is the reason why

“integration” is a key feature. Instead of only developing design tools we also have to deal with their integration. We have to develop integrated software environments consisting of a framework and several design tools.

The software environment or framework realizes facilities for data and design management. New developed tools can be implemented according to these existing facilities avoiding the multiple implementation of generic functions. The integration of tools developed independently could be realised by using known tool coupling methods. With the services of the integrated environment, the developed tools and the integration of existing tools a system becomes available that supports the architect in a general way [2].

In this chapter we have shortly discussed possibilities offered by current information technology. We have made significant limitations by only taking into account the architectural design process and not the whole building process. Additionally, we have not looked into the future development of technology. In the next part we will overcome both limitations and extend our concerning field to the use of computer science technology in the whole building process.

### **Future Expectations**

It is obvious that in every day life the Information and Communication Technology (ICT) has a great influence on behavior and functioning of human beings and therefore, in a more wider sense, on mankind and society as well. It is almost impossible to keep pace with the incredibly rapid developments in the field of computer science. Computers are becoming cheaper and increasingly powerful, and technically, they can now exchange data via fibre optics cables at a rate of 1 billion bits (1 Gigabit) per second. Internet makes the world smaller and smaller, bringing scientists in very close contact with each other. Networks enables them to communicate night and day.

Today these networks, combined with fast computers, make it possible to simply exchange graphic data (drawings, photographs, films, etc.). This used to be almost impossible because of the size of graphic computer files. Until a few years ago one of the largest architects' firms, SOM (Skidmore, Owings and Merrill) sent drawings from their London-based agency to their Chicago office by means of a courier service; now they use Internet. Now, researchers may execute simulations by remote control, for instance, or hold a conference by video with colleagues abroad. What further developments may be in store for our subject area in the near future? What is going to be the future of the architecture with this ongoing of computer science development?

Early developments of computer science in the field of architecture involved 2-dimensional applications, the computer is replaced by the drawing table and tools and subsequently the significance of the third dimension became manifest. Nowadays, however, people are already speaking of a fourth dimension, interpreting it as time or as dynamics. And what, for instance, would a fifth, sixth or X-dimension represent [3]? In future we will perhaps speak of the fifth dimension, comprising the tangible qualities of the building materials around us. And one day a sixth dimension might be created, when it will be possible to establish direct communication with computers, because direct exchange between the computer and the human brain has been realised. The designers ideas' can then be processed by the computer directly, and we will no longer be hampered by obstacles such as screen and keyboard. This is mere speculation, and seems to be far-fetched, but just take your minds back 50 years ago, when nobody could even imagine that today everybody could be walking in the streets with a wireless telephone. Till now, we were dealing with data processing and the conversion of this knowledge into a computer model, which means dealing with the material world, for which the tools of computer science are highly appropriate. But what will happen to the immaterial world? Can we "teach" computers these immaterial values?

Scientists are still busy putting up the human intelligence into a computer model and trying to develop systems which can imitate the human intelligence, just think of the developments of the neural networks. If we look at human intelligence; intelligence is the ability of a person to think or reason. Humans have native intelligence and can build or improve upon it. Machines can have only limited intelligence. The most important aspect is the wisdom of a human being. A wise person is learned and experienced. Wisdom also implies common sense and good judgement. Computers may have limited forms of intelligence, but only humans can have wisdom. Nowadays the research is going on to make bio-chips to imitate human brain. We are not saying that it is impossible but we have still doubts about it. Human beings nowadays cannot even make a human cell, they are only busy in the manipulation of a cell. There is still a long way to go. That's why we should not be afraid that the machines will take our place! The development of advanced computer techniques and technologies surely influences architecture and that is almost inevitable. It will influence the very near future, as well as, on a future that lies "far ahead" of our time. Some architects have already decided to run parallel with technology, because they have realised that if they would ignore these developments, the technological culture might just go on without them, and no one likes the feeling of being "deserted" and "left behind". In future the influence of ICT will be both in the conceptual phase of a design (the form aspect) and the materialization (the technical aspect).

Naturally the processing information itself will be different as well. The architects are already designing the unusual spaces and concepts by the influence of the ICT. At the moment a school project has started in Den Bosch (Holland) an open form and a totally different concept than a traditional school building.

In today's urban environment we became very dependent upon information. With computers connected to a network we all realise that the world is coming into our room and we hardly have to step out of that room in order to gain information. We really feel as a citizen of the world, being able to exchange and obtain information and knowledge within few seconds. The fact that it will not be necessary to leave home, means that perhaps in the future the need for the office buildings might diminish or even disappear, thus, by means of further developments of the ICT, people will work and spend more time in general in their own homes. Just having this development in mind we can imagine what consequences it could have on the behavior patterns within the society and on architecture of the future as well.

If we look at the basic needs of a human being like eating, drinking, sleeping and social contact with other people, we can say that most of these needs can be fulfilled in so called "working home environment", but the last aspect and the need to have direct social contact to people will still happen outside the home. This will remind us of earlier periods of architecture and the Greek agoras. In future the social spaces will gain in importance in daily life where people come together. History is repeating itself, with some changes, however.

In Japan the urban planners and the architects are busy to solve the problems of a high population-density in the cities and also the negative aspects of the contemporary cities for the environment. It is a fact that in the 19th century 3% of the world population were living in the cities whereas in the 20th century already 15% of the population live there. According to estimations in the coming century 3 of the 4 people in the world will live in the cities [4]. Japanese started to develop a project in Tokyo which is called "Sky City 1000". The architect of it is *Shizuo Harada*. The aim of the project is to build a huge cut cone form of few buildings which is 2004 meter high. Within the building everything is planned which we have had in the normal cities in horizontal form. This time it will have an vertical form. This brings also other technical problems with it such as the velocity of the transport lifts and the influence of it for human health or the temperature problem. Because in 2000 meter height the temperature is about 13 degree lower than on 0 height and the water boils at 95 degree Celsius.

## Conclusions

The emergence of new technologies will affect our subject area; our way of living, our cities, our habits but this will create new challenges, new concepts, and new buildings in the 21st century. All in all, as architects and planners our responsibility will be to have both feet firmly on the ground, and to bear in mind that we are dealing with the well-being and the prosperity of mankind.

## References

- [1] Schwenck M.; Völker H. *Modeling the Architectural Design Process* [Report]. TU Delft: Faculty of Architecture, 1996.
- [2] Sariyildiz S.; Schwenck M., "Integrated Support Systems for Architectural Design", in: *Proceedings of the 3rd Conference on "Design and Decision Support Systems in Architecture and Urban Planning"*, Spa, 1996.
- [3] Sariyildiz S., *X-dimension in Building* [Inaugural Speech]. TU Delft: Faculty of Architecture, 1994.
- [4] "Sky City 1000: Een stad in de wolken", in: *EOS-Magazine "Wetenschap en Technologie voor de mens"*, (1995)12, pp. 6 - 14