The role of ICT as a partner in Architectural Design Education

Sevil Sariyildiz and Peter van der Veer

Delft University of Technology, Faculties of Architecture and Civil Engineering, the Netherlands

Abstract: Design education in general is analyzed and the existing tools in the design process are explained. The design education in the past as well as the design education for the future is mentioned. The influence of new technologies on the design and the impact of Information and Communication Technology (ICT) use in the education are clarified. Finally the future perspectives of an architectural education and the preparation of future professionals to the practice is worked out. Further speculations about the role of ICT in the education and practice is done. The form and the infrastructure of ICT education for architects are discussed.

Keywords: ICT, Architectural Design, Architectural Education, Knowledge Integration Tools, Decision Support Tools, Design Tool, Internet, JAVA, Collaborative Design

1. Introduction

When we look at the history of design education in headlines, we see that designing is never handled as an isolated theme during the Middle Ages in the process of design. It was always a part of the construction process. In the Middle Ages the form of an architectural object was never considered apart from the technical aspects of the design. The builders of the large projects were mainly not architects but craftsmen. They were the practicing people who started as an apprentice, became supervisor of the workmen, then the foreman and finally the building master. Those people needed to have years of practical experience to become a building master.

It is always interesting to know how the historical monumental buildings such as French cathedrals being built and designed simply because these buildings were built along a period of hundreds of years, even some of them were 400 years long under construction. This implies that there was no one designer who gave the form to these buildings, these buildings were designed and constructed by various craftsman, technicians and artists.

This craftsmanship which we see in the past, left its place to a new craftsmanship, namely the electronic machine in our times. The machine took partially the place of these craftsmen. Buildings are not anymore labor work but by means of computers the information is directly sent to the robots to build it. We see such realization of the buildings in Japan that where there is even no labor work on the building site. The machine is controlling all the robots and the instruction is being sent from a distance to the robots and these robots are doing the whole construction of the building.

In this example, the computer technology was used to enhance the productivity and efficiency of the building process as

primary objective. The danger is that the limitations of the building machines and processes can dictate the architectural design process. What we should search for is a much wider approach, an approach to create complete new methods of designing. In this case the accent should be put on the new design methodologies and techniques. In the future both cases could merge in a system where the building process is automated and the machines are so advanced and flexible that they form no limitations in the design process of our building environment.

The buildings are becoming more and more complex. Not only in their volume but also in their infrastructure and their use. [VeSa97] Therefore the building process itself is a multi-actor, many-discipline and multi-interest process. The actors in this process are the architect, the principals, the consultants, the authority, and the contractor etc.. Disciplines that have to be integrated in building design are such; construction, electricity engineering, sewer engineering, acoustic sciences, geotechniques, and construction management, building economy, environmental engineering. Therefore, building design is characterised by teamwork between various partners such as architects, designers and various experts from special fields like building physics, construction, material science or installation. Having in mind this reality, we do not have the illusion that the architect should be a superman that posses all the knowledge of the different disciplines that are involved in the building process.

In our times the professional education to become an architect takes only few years. There is an enormous time limitation to learn each discipline of the building. The student can only aim to have overall view of the disciplines which are involved in the building process, knowledge and understanding of some fields and the skills in others during the education period. If this is the case for the future, in which way the architects should be educated to deal with these new challenges?. It is expected form an architect that he/she have overview in all these aspects, and this can be only possible by the developments of ICT when it is used in a efficient and better way. Therefore, it is the responsibility of the scientific education institutions to educate the future architects who will have these abilities and qualities.

Then the question arises: What is the most efficient way of teaching and learning to become a building master in this limited time of the recent architectural education system at the universities?

Up to the recent research in the Netherlands which is done by the Council of Science and Technology, who brought report in february 1998, it is clearly emphisized that there is an enormous demand for the informatics people. This report called "De structurele behoefte aan informatici" (The structural demand on informatics people). But not only in the form of pure computer scientists as we thought, but especially for the people of various disciplines who are better educated in the field of informatics. That’s why the universities should pay extra attention to the informatics education.

2. The form of design education with respect to the ICT technology

When the computers introduced to the architecture education, the reflection of the building practice could be seen very clearly. The use of ICT tools within the architectural offices came much later than in any other engineering discipline. Very first CAD programmes like AutoCAD were developed for the mechanical engineers. Later the other 2D programmes were introduced. The development of the first 3D programmes was realised at early 60’s. But the real commercial introduction of the 3D programmes was done with the faster Personal Computer (PC) development in the 90’s. This has to do with the huge new use of PC’s at the architectural offices. The initial 3D programmes were running only on workstations and generally with operating system as Unix. They were more expensive than the PC’s and for that reason their use was limited to some medium size enterprises, architecture offices and private users.

When we look back to these historical developments of computer use in the education of architects, we realise that computers are used as a tool mainly for following purposes such as:

1- Information processing tool

2- Communication tool

3- Visualisation tool during the creative design process

They are mainly used into processes such as animation, simulation and the whole spectrum of visualisation. All these 3 category of computer use has the purpose of improving quality and efficiency of the building and its process..

By the developments of advanced 3D visualisation tools and the developments in the field of Virtual Reality (VR) techniques, we can state that there is enormous improvement comparing with the other subjects, in these above-mentioned fields (except the VR techniques for architectural use).

The question is now: what will be the next step of architectural education in computing? In which direction we will work for the further future developments? What will be the subjects in the architectural education for the future?

We can clearly say that the computers not any more only a tool for the architects but more than that, they are becoming a new medium besides the other existing ones within the architectural design process [SDC98]. Next to the use of any traditional tool, the computers are becoming a valuable media for designers and architects. Especially the widening of Internet opened the horizon that computers became more and more a medium and speed up this ongoing process. Today it is difficult to imagine an architectural practice and architecture office that is not making use of this new medium. It became inevitable essential and crucial tool and the internet as communication media for any successful office.

Actually, there is a growing need for tools that enables architects to cope with the increasing complexity in design and with the increasing need of efficient communication with many partners in the building process. Computers are very suitable for fulfilling these needs.

In the very near future, the computers will be even more than a medium, they will become a reliable partner [Schm97][McCu96]. How can they become a partner and what will be the role of this partner in the design process?. From this starting point we can add to those purposes referred above three more as 4th and 5th 6th category of tools to answer the question; namely the computers will be used as partner when they are put as:

4- Knowledge Integration tool

5- Decision Support tool

6- Design tool

Then we come to stage that there is a need to develop new methodologies and therefore techniques to realize the goal that the computers can be put into the whole building process as a reliable design tool also which offers the possibility to act as a reliable partner.

3. Future perspectives of an architectural education and the form

In the near future by the ongoing developments of ICT, we as designers and professionals who educate the designers on the field of Computing in general, need to think thoroughly and adapt ourselves to these rapid developments. Up to now, in most of the CAD education at the faculties of architecture, more attention is paid to the visualization uses above other aspects such as communication and information processing uses as it is mentioned above. We are now in the stage that the technological developments allows us to look forward and go a step further than only the present use of those tools in education.

It is necessary to start from the very first year on, to give education on the development of the tools, which is mentioned as category 4th, 5th and 6th. Namely to develop tools which one can integrate his/her specific knowledge to a computer model and to built up this model up to the specific needs. At one hand, the way, which is being done, has to be further developed and continued. The student must get the knowledge and ability to coop with the existing hardware, software and to use them as efficient as possible and to integrate the use of it in own design to reach better results. On the other hand the level of education must be push up to the higher level. To the level that the use of computer as a partner in knowledge integration and for a support environment during the design process.

If these developments will be left to the others than architects, the architects will face with the danger that they will be the *slave* of the tools and not the *boss*. Partially we face the same kind of problem at the moment with the commercial tools. None of the commercial CAD product supports the designer, as it should be. Each program has its advantages and less advantages or disadvantages. The user must have to learn the basic principles of CAD software to be able to use the needed program and take the advantages of each to use it in an efficient way. This basic knowledge should be given form the first year on to the architecture students.

4. An experiment: learning by doing & integrating the tools!

During the last couple of years there are many experiments done on collaborative design at the Faculty of Architecture in Delft. Prof.dr.Gerhard Schmitt introduced this collaborative design from ETH-Zurich and set-up by the authors in Delft. In this design studio, we introduced HTML, VRML and the software such as AutoCAD, 3D-Studio Max and PhotoShop to our students.

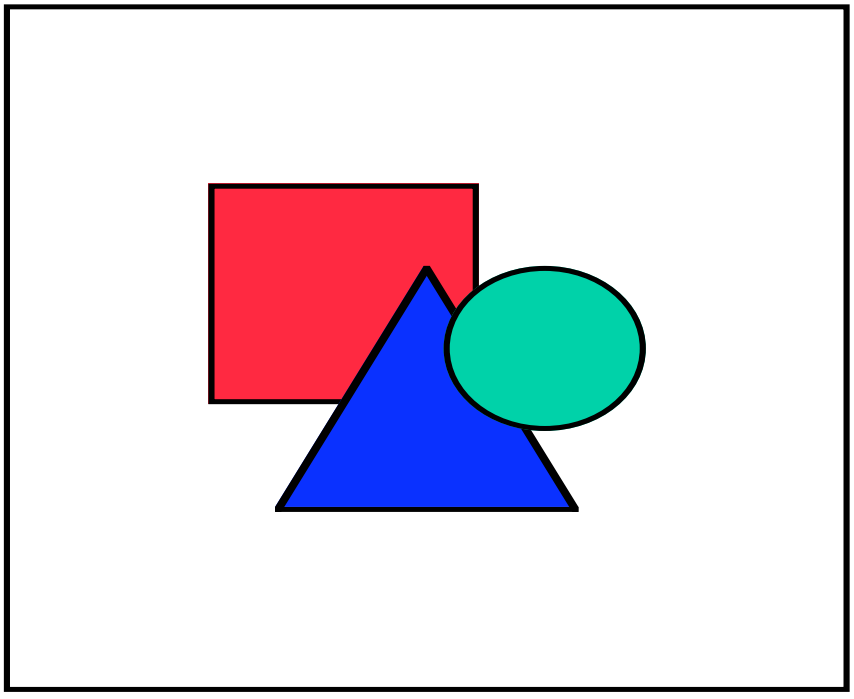

Figure 1. Front view of the house design on an island

The purpose was integrating the above-mentioned tools together in a design exercise. The students were asked to make

their own design following a certain program of requirements, (which was a house in this case). Then to discuss by means of video conferencing, about the various alternatives, which was produced by each individual student and to choose the best one to continue. The students and the teachers from various universities worldwide participated in this discussion and gave their opinion by means of video conferencing possibilities on computer via the Internet.

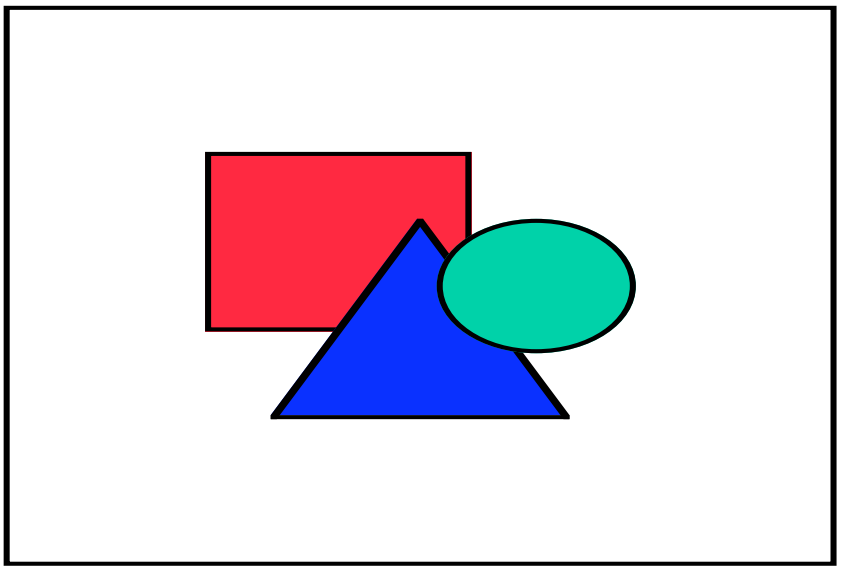

Figure 2. Perspective view of the same house

The goal was ***learning by doing!*** While the student was working for a design, he had to cope with various techniques and tools to simulate the design idea and use of new communication technology and the Internet.

5. The way to upgrade the level of ICT education for architecture students

As it is mentioned before, the computers can and are used as a tool for visualization, communication and information processing purposes in the architectural design process. Today we reached a stage where computers should be used as a design tool, a knowledge integration tool and a decision support tool that supports architects during the entire design process. This must be also worked out in the architects' education. Therefore there is a crucial need today to upgrade the knowledge of architects especially with regards to ICT knowledge.

To reach this goal there are 2 ways that should be followed at the different architecture faculties:

1 The non-informatics teachers, teachers from the other disciplines of architecture such as building technicians, interior specialists, urban planners, should be trained on the field of informatics applications for architects to upgrade their knowledge on Information and Communication Technology. They must be aware of the possibilities and impossibilities of the existing tools to be able to guide the students in the right way. There are still design teachers who do not have any knowledge about computing. That 's why they do not stimulate the students to come further on the field of informatics applications in the design process. On the other hand some of the teachers are so enthusiastic to see the results of computing that they can not see the real design quality of the student in order to judge it objectively.

When we can reach the point where the teacher himself can criticize the student work objectively, then we have also

reached the point where the student have the attitude to discuss openly the possibilities and the shortage of tools. She/ he will then be attributing for the improvement of the tools.

2 The second way, we state that the student must be able to develop his/her own application up to the certain needs in a limited way. The student must be able to discuss and to communicate with the software engineer to formulate the needed requirements. This is a very important attitude which students have to reach during their study. It is not meant that architecture student will become software engineer, but the future architect must be able to define his/ her own needs and requirements concerning the used informatics tools. The necessary knowledge should come from the architect to built up a computer system or a building model. Therefore the architect has to have certain level of informatics knowledge to reach that point of communication.

Therefore we implement for the first years architecture education to introduce programming languages as JAVA and the internet technology such as HTML,VRML etc. besides the existing applications like CAD software. On later years, the students should also get knowledge on the use of new Artificial Intelligence (AI) Techniques and get introduction about the techniques such as Neural Networks and Fuzzy Logic.

6. Why Java?

We believe that the developments of Java as a programming language will open new perspectives to architects. This is why during the very first year this programming language should be introduced besides the Internet techniques such as HTML, VRML.

Including programming languages such as Java in the first 2 years of basic architecture education bring with it many questions and doubts. For many colleagues teaching the existing CAD application is more than enough. In our opinion looking to the future and approaching architecture as a profession that need always to keep renewing itself, we state the following argument to this new need in architecture education. If we ask the question for the reason is to teach e.g. Java from the first 2 years of basic education in architecture, then we can state that;

Java is a programming language, which is developed especially for communication in Internet. That's why it has probably the most important character, which is hardware independence. (Although SUN tries to standardize the JAVA technology, still it is developed by private sector. Because of this reason the recent technologies such as Object technology and Agent technology adapted very efficiently and rapidly in Java.)

The advantages of the Java are;

- It allows large-scale enterprise modeling where the dilemmas such as the necessity of interfaces fall.
- Integration of software and the communication between these various software or parts of it. Within Java technology it is much efficient and easy to realize.
- In the future it will allow a much better platform of independent use of databases, although recently it is being used but in a limited way.
- Data exchange in Java at the moment is possible with Physical file format
- The basic structure of Java is object oriented, e.g. C++ is object oriented version of C, but Java is originally object oriented.
- Simple in use and easier to learn.
- Other than any programming languages, Java has its own 2D & 3D libraries available.

The reason why the architects should learn it can be summarized in the following;

- The new generation of architects will use Internet for communication in brood terms.
- Architects in the future must be able to make their own computer model up to their own needs
- Architects need to integrate the knowledge of other experts in their discipline, therefore there is a need for such knowledge as Java.
- The new generation of architects should learn at least one programming language.
- Up to the estimations Java will be the new generation programming language for the coming years.
- It is easier to learn than other programming languages

In the later years of the study the students should also get affinity with alternative use of computer techniques. To avoid a limited view of the possibilities of software one should pay attention to other fields of use of computer. Techniques like Artificial Intelligence (AI) , Neural Networks and Fuzzy Logic.

These AI techniques enables them to cope with uncertain data, to recognize patterns in large data sets and to perform automatic reasoning in complex design task, such as in case based reasoning.

Because in architecture communication plays such an important role, a programming language like JAVA is a suitable choice. Here we see that teaching programming is not an aim as such. It is, of course, closely related to the nature of the discipline.

In other sciences, like civil engineering, there is more need for tools that enables engineers to program their mathematical algorithms to find solutions for differential equations. In such an education we see a role for programming languages that are more suitable for those tasks.

7. Infrastructure for ICT education

FONT SIZE=2>

Many universities in the USA already had chosen the model where the student should have her/his own laptop computer. In some of the European universities and also here in the Netherlands we have chosen the same model. This way is chosen purely because of the physical space shortage and the economical weighing such as personal and maintenance costs. The development shows that in the near future, the communication on Internet will be wireless the same as the wireless telephone. The mobility is the essential item in this choice. The development of Dynamic IP number makes this choice easier and applicable.

No matters in which place, the student can get instructions form her/his teachers wherever and whenever it is needed. The distance learning instructions are the other judgement for the future developments. According to some researches on distance learning, it is clear that the present generation of students prefer the personal contact with the other students or teachers. Some of the subjects can be partially learned by this teachware but the temporary student chooses still the face to face contact with the teachers up to the research. Even though, at the student flats of Delft University, each flat is connected to Internet for a very low price which is included in the flat rent.

We are planning to make it possible, to get for each 500 first year student a mobile computer. Besides that, to have an advanced education laboratory for students and for instructions whenever it is necessary including advanced input and output devices. Further we are developing "distance learning projects", and attempting to integrate the ICT education in the 5 graduation directions. Those are building technology, Architectural design, Building management, Social Housing and Urban Design. Although it is not an easy to realize it up to the huge number of students we have, (3000 students in total at the Faculty of Architecture), we are working on it step by step.

8. Conclusions

- As in the architectural practice, the education at the universities is changing by the influence of ICT technology.
- The faculties who give architectural education must adapt themselves up to these developments and must be aware of the danger that the architect profession can be partially lost or taken away by others in long term.
- To prevent this, the level of education must be on a higher level on the field of ICT
- The existing visualization tools are at the end of their limits, now we come to a new phase of ICT applications for architects and building engineers.
- The education must be directed more to the level that the student use the ICT tools for knowledge integration and the decision support environment to use the computers as a reliable design tool.
- The student must be able to develop her/his own tools up to certain level for own needs, besides getting insight and knowledge about the existing ICT tools.
- Ongoing developments of Internet technology requires other way of design management and communication (data and partners communication) in the building process.
- Collaborative design, interactive way of communication in the design process will be the future of the building practice.
- This will result that the architects can not be educated as a national architects but must be prepared as mondial architects.

9. References

[McCu96] McCULLOUGH, M., "*Abstracting Craft: The Practiced Digital Hand*" MIT Press, Cambridge, Massachusetts, 1996

[Schm97] SCHMITT, G., "Design Medium – Design Object" In: Junge R. (ed.), "*CAAD futures 1997*" (Proceedings of the 7th International Conference on CAAD Futures held in Munich, Germany, August 4-6, 1997, Kluwer Academic Publishers, Dordrecht, 1997

[VeSa97] VEER, P. van der and SARIYILDIZ, I.S., "Integrated Building Design Decision Support Systems", in: *Proc. Applications of Artificial Intelligence in Engineering*, AIENG 97, July 6-9, Capri, Italy

[VSSD96] VÖLKER H., SARIYILDIZ S., SCHWENCK, M. and DURMISEVIC, S., "The next generation of Architecture within Computer Science", in: *Proceedings of the 6th Conference of the European Full-scale Modelling Association (EFA)*, Vienna, Austria, Sept. 1996

[SDC98] SARIYILDIZ, S., DURMISEVIC, S. and CIFTCIOGLU, O., "Integrating pattern grammar and wavelets in architectural design", in: *The Sixth International Conference in Central Europe On Computer Graphics and Visualization 98*, February 9-13, 1998, Plzen, Czech Republic

[AWT98] *AWT Advies, De structurele behoefte aan informatici*, Adviesraad voor het Wetenschap- en Technologiebeleid, february 1998