

A National Strategy for CAAD and IT-Implementation in the Construction Industry

- Proposal from a seminar of experienced researchers, developers and practitioners of CAD.

Author: Professor Jonas af Klercker, Computer Aided Architectural Design, Lund University and Institute of Technology, Sweden. Box 118, SE-22100 LUND, Sweden; phone: +46 46 222 72 46; fax: +46 46 13 83 58; e-mail: jonas.af_klercker@caad.lth.se

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Summary

The objective of this paper is to present a strategy for implementation of CAD and IT in the construction and building management^{#1} industry in Sweden. The interest is in how to make the best use of the limited resources in a small country or region, cooperating internationally and at the same time avoiding to be totally dominated by the great international actors in the market of information technology.

In Sweden representatives from the construction and building management industry have put forward a research and development program called: "IT-Bygg^{#2} 2002 - Implementation". It aims at making IT the vehicle for decreasing the building costs and at the same time getting better quality and efficiency out of the industry.

The presented strategy is based on a seminar with some of the most experienced researchers, developers and practitioners of CAD in Sweden. The activities were recorded and annotated, analyzed and put together afterwards.

The proposal in brief is that object oriented distributed CAD is to be used in the long perspective. It will need to be based on international standards such as STEP and it will take at least another 5 years to get established.

Meanwhile something temporary has to be used. Pragmatically a "de facto standard" on formats has to be accepted and implemented. To support new users of IT all software in use in the country will be analyzed, described and published for a national platform for IT-communication within the construction industry.

Finally the question is discussed "How can architect schools then contribute to IT being implemented within the housing sector at a regional or national level?" Some ideas are presented: Creating the good example, better support for the customer, sharing the holistic concept of the project with all actors, taking part in an integrated education process and international collaboration like AVOCAAD and ECAADE.

Background

People engaged in the development of CAAD have claimed the use of computers and IT to be a turning point where architects have the possibility to choose their new roles in the construction process. Now as this turning point is passed it is late but there is still time for action.

All around the world there seems to be a tendency of decrease in significance of the role of the architect in the construction process. The blame of this is usually put on a lot of circumstances which are more or less connected to the increasing complexity of the process. But it is also due to the attitudes of the architects themselves. The role of the "master" is to be differentiated into a lot of roles, which cannot be played by one single person alone. Customers need several roles of expertise and they do not expect the traditional architect to be able to play them all. Actually architects as well as other actors in the process are offered to choose roles and develop their competence accordingly.

The construction industry in Sweden has for a long time been used by politicians as an economical tool for getting more money into the market in bad times. Also the right to a high housing standard has been a political goal. According to the argumentation in the daily press and TV the construction industry in trouble therefore always seems to start acting by looking for governmental subsidies.

IT-Bygg (1990-96)

On the initiative of some enthusiastic researchers, developers and practitioners within this industry a national research and development program, IT-Bygg was started in 1990 - then with 2/3 governmental money and 1/3 from the Swedish Construction Industry Development Funds. The goal of the program was to create joint environments for research and development for the construction industry at the three Technical Universities of Sweden with schools of architecture and engineering in Göteborg, Lund and Stockholm. This was also achieved at the end of the program in 1996 but it demands a following program to make use of these efforts.

IT-Bygg 2002 (1997-2002)

A group of representatives from the different actors of the construction and building management industry has put forward a document "IT-Bygg - 2002 - Implementation". Five areas of interest are pointed out, each to be acted upon within the fields of research, development and implementation. The areas are:

1. Communication and provision of knowledge
2. Human - machine interface

3. Product- process- and computer models
4. Classification and standards
5. Implementation and changed forms for action

The document is primarily aimed to be used when convincing the companies of the industry to participate and contribute economically to the program. It is therefore quite brief. "Implementation" is a key word and focuses on the overall objective and it means that the program should work close to the practical needs of the industry. Research should support the longer perspective and development the shorter. Briefly the areas are to cover the following:

1. Communication and provision of knowledge

In this area electronic trade, shared databases and document handling are focused. Research should investigate and systemize information activities and documents and find methods to combine computer generated with other information. Development projects are to be based on the research and study the solutions of communication between the actors in the construction and building management process.

2. Human - machine interface

Studies of how computer systems are used and how they function in their practical environment is to be a base in this area. Prototype systems are to be developed, tested and evaluated. A recognized problem is how to get an overview of the huge amount of information of various kinds to be able to find what you are looking for.

3. Product- process- and computer models

Research in this area should be based on international cooperation. The program should focus on modeling of processes for construction and building management also in early phases. Further development of product modeling for different purposes should aim at influencing the processes in the direction of better quality and more productivity. Evaluation of the use of model oriented systems has already started.

4. Classification and standards

This area is of basic importance to create frameworks of concepts, classifications and standards for making interfaces between actors and different computer systems. Cooperation within international as well as national organizations is to be continued.

5. Implementation and changed forms for action

A renewal of the action methods in the construction and building management process is a clear goal. In practice it means that a lot of questions of administrative and legal art have to find new solutions. Studies of how to conduct changes of structure, working methods etc in commercial and educational organisations is to be

used to exemplify and guide the implementation process. Special interest will be taken in the development of new forms for collaboration of various actors supported by IT. Even other fields of business and other countries will be considered to find examples.

International Perspective

Referring to reports from Swedish Technical attachés^{#3} the construction industry in many countries as in Sweden is rather slow when it comes to cope with development as such and taking an interest in IT especially. There does not seem to be any natural "engine". Trying to establish a national project is an alternative to letting the market powers have their go. Hopefully this example can be of interest to other regions or smaller nations for their own development. In the UK for instance the Department of Environment has delivered a plan, DoE Implementation plan 1996-2001 which is a parallel to the IT-Bygg 2002.

Special Comment from an Architect's Point of View

As in other countries in the industrialised world architects in Sweden have lost too much influence to be able to run this kind of program. It demands the full engagement of the economic powers of the business to even suggest such an operation. This will mean the great construction and material producing companies. It is quite obvious that the main interests of those actors will be very much taken for granted and that the weaker partners, the consultants etc. will have to fight intelligently for their areas of interest. Strangely enough the estate owning companies are economically powerful in terms of turnover but very passive in terms of acting. This harms the consultants as it also means weak clients.

An IT integrated building process demands new services that gives alert and creative actors space for action and initiative. This might be just the right thing for the architect's profession in the new era of information and communication. Implementation of IT ought to favour the architect's ambitions in sustaining the holistic concept etc.!

Seminar on the Future of Design and Product Modeling

To analyse the impact of the IT-Bygg 2002 program on *design and product modeling* the author of this paper was asked to host a seminar with some of the most experienced researchers, developers and practitioners of CAD in construction in Sweden.

Some 30 persons were invited personally and almost everyone took part. By way of

introduction each participant personally declared his special concern, then a group discussion took place which finally was summarised and made the base for a final discussion. The activities were recorded and annotated, analyzed and put together afterwards. It was then presented to the participants.

Some of the engaging problems in the sessions are put forward and discussed in this paper. They are then used to discuss some problems which must be crucial to the architects and the Architect Schools as actors in the future construction and building management process. Practically, these problems either lead to adaption to new rules or less work within the traditional sectors. Architects being unemployed or even unemployable are indications which have to be taken seriously by the schools.

Some of the questions and suggestions brought up at the seminar intimates change in attitudes, skills and knowledge to be taken into serious consideration.

What was Brought up at the Seminar.

Collaboration - the key to renewal of the construction industry.

Analysis#4 has pointed out that the construction industry is characterized by its fragmentation into a lot of actors usually representing different knowledge and even separate companies; working in adhoc project groups in a sequence of separate phases. The metaphor used is "A relay race with bad changeovers".

It was stated at the seminar that the total knowledge needed for a construction task long ago passed the limit of what is possible to keep in one person's head. All the same for instance the architect and the boss of the building site are doing their best to do just that. The advantage for the information keeper is that he has to be present personally when the information is needed. The serious disadvantage is what happens if he cannot.

If we cannot rely on the "one person model" we have to collaborate. Sharing information is essential to collaboration. Information technology can be a fantastic tool for those who have to share information. But there are still many problems with insufficient user friendliness that computer specialists have to deal with.

A difficulty of another kind is our traditional way of looking at information as private property. How can holders and creators of information be convinced to let go of there privileged access to information? This is to a great extent a matter to be dealt with by social scientists.

Commercial competition versus collaborative development

For some reasons the frustrations of early users of CAD and IT have not been a popular issues to be studied by either researchers or the market. One severe reason

for user frustration is the use of computer "formats" and grade of user friendliness as tools in the commercial competition. It would be interesting to get an evaluation of what has been actually gained by these rather crude measures. A natural hypothesis was stated by some of the participants of the seminar - that the total market to be shared by the competitors would have been much larger with e.g. more generosity with formats.

From an academic point of view it is easy to find the weaknesses of the CAD market but what can actually be done to improve cooperation between rivals? Being neutral or support those you think might win? Being short of funding and therefore seriously tempted by anyone who offers you soft- or hardware free of charge - it is not easy to be neutral.

From another point of view, the MIT Media Lab, Nicholas Negroponte^{#5} sketches a promising future for the development of the digital media. More efforts are being put into making persons feel at home interfacing the machines even if they want to stay amateurs towards computers. Format trouble is going to be solved whether the computer industry likes it or not. There is already promising progress being made with for example Java and TCP-IP on the internet.

Keeping track of the international development

Sweden is a small country and the Construction and Building Management Industry is a small sector from the IT software producers' point of view. International cooperation is therefore crucial if the industry wants to have IT adapted to its own special conditions.

In the seminar there was a concern about how to be oriented in the international environment. Writing almost any academic paper demands that issues are related to what is being done at other universities. It is therefore a natural task for the universities to take the responsibility for keeping continuous updated information on the state of the art in the surrounding world.

The "slavery" of drawings

At the seminar an architect, who is in charge of the implementation of IT in one of the biggest consultant firms of architecture and constructions in Sweden, stated that "architects must be set free from the slavery of drawings". And he got support for that opinion!

The reasons can be summarised that using CAD for production of drawings is not taking advantage of CAD. The production of drawings would still rule the process keeping intelligent humans occupied by doing work which to a great extent easily could be automated. The time could be used to put more efforts into the design work.

"The problem with a set of architectural drawings, for example, as a symbolic picture or model of a building is that they present an inadequate means for the rigorous testing of the form against the requirements of the programme or context; they are a

model of what the proposed building will look like, how it will be disposed three dimensionally in space, but not how it will behave....." #6

The quotation from Philip Steadman is another argument against overestimating the role of drawings, but it also states a warning ! If we use the CAAD modelling tools the same way as we would use drawings we are not very much better off !! Educating students of architecture at the CAAD lab in Lund we have found that there has to be a change of mentality. Students are taught to present their projects in the form of drawings for everyone to see and make his own opinion. They have to be taught more about communication and how to create messages and tell stories.

Information technology in the design process.

To the advanced IT user the concept of computer aided design might feel a bit ancient, but to the majority of the construction industry it still means something - mostly 2D computer drawing. At the seminar there was a lot of discussion about different aspects of information handling etc. It has to be stressed though that object-(product-) modeling is a narrow key part of IT in the design process which is the basis for the following phases. The need for a certain amount of communication tools for exchange of information etc. within the design work could be incorporated into the concept of CAD. It also seems a waste of manpower to state a new concept when CAD has finally been established.

Collaboration in the design phase must mean that more actors are being involved in the design work - evaluating consequences, suggesting new solutions, negotiating to create compromises etc. There is a misunderstanding by architects as well as engineers that architects are the only actors who are expected to be creative. There is a difference in methods of problem solving. Engineers often want to have a fixed framework and rules within which they solve the problem. Architects often start when everything is uncertain and nothing is decided trying to stretch the limits to be able to use the solution in their imagination. Architects often summarize their method in the concept of "sketching".

If the design process is going to make use of collaboration and more integrated work more actors will have to learn how to sketch. As architects disagree whether to use computers for sketching or not, it might have to be both ways.

Design and product modeling

Like most industrial fields the construction industry has engaged in making use of product model technology to create the next generation of CAD-tools. When all information, geometrical as well as properties, about a building part is connected to the same object in the database the possibilities to use that information intelligently is beyond our imagination. The work on standards for product models is done on an international level and as such it takes time.

Väino Tarrandi, researcher at KTH who is taking part in some commissions on

standards and classification, estimated that it will take at least some 5 years before there is a product model standard for practical use. He suggested that meanwhile something temporary has to be used. Pragmatically a "de facto standard" on formats for communication has to be accepted and implemented. This was also concluded by the seminar. A serious question though is if it is possible to claim "regional" requests on the worldwide acting computer industry.

It was also stated that there is quite a lot of useful software on the market, but it is only used to a very small extent. The marketing done by the companies gives little overview and guiding for new buyers. There used to be a magazine now and then making a market overview. All software in use in the country should be analyzed, described and published for a national platform for IT-communication within the construction industry.

Summary - a strategy for CAD and IT implementation

The proposal in brief is that object oriented distributed CAD is the solution in the long perspective and will be the assumption in all research. It will need to be based on international standards such as STEP and it will take at least another 5 years to get this established. International collaboration has to increase at all levels of the program.

Meanwhile something interim has to be used. Pragmatically, a "de facto standard" on formats for communication has to be accepted and implemented.

All software in use and marketed in the country should be analyzed, described and published for a national platform for IT-communication within the Construction and Building Management Industry industry.

How can architect schools then contribute to IT being implemented within the building sector at a regional or national level?

Discussion

The good example

Launching the IT-Bygg 2002, Implementation Program must be seen as a strong recommendation from the construction and building management industry to all concerned including the architect schools to take part and adapt its activities to the new situation.

An architectural competition is generally a demand for new ideas. Customers expect architects to be in the lead of development in their area of knowledge. Some architects have also tried to be in the front of development of CAD even if the majority has rejected it. It is natural that architects are eager to create the good example - to be in the lead.

Being used to and rather enjoying working with problems which start with all uncertainties, architects should be the first to engage enthusiastically in the implementation process.

Architect schools should be leading the way by engaging in research, changing the curriculum and developing courses to prepare architects for taking an active part in implementing IT in the construction and building management process.

Adopting an IT-strategy has been many organisations' starting point to implement IT. Since recently many Swedish companies have their own IT strategies. For instance, how many Architect Schools have an IT strategy?

Better support for clients

It was stated earlier that the clients, the estate owners, are rather passive in their relation to development of the building process. Studies of the building management process indicate that it is in this area of interest the real profits of an IT integrated building process can be made.

Traditionally, the architect acts as the client's "good man". But architects seem to slip away from this role into something else - more related to their own ideals than the client's actual needs.

A lot of research by architects during the last decades has studied how to support the end-user of buildings. At some instances the end-user's interest was put in opposition to the estate owner's. The question was then who is the real client? Maybe this is why a gap in confidence has grown and the architect no longer even knows what the client's needs are. Now is the time that Architects should engage in research to find out how to support their clients.

Sharing the design concept and the holistic view

Traditionally architects develop the concept of the building and transfer it into the creation of the house. As drawings are weak as communication means for concepts it has not been obvious to the other actors by just reading the drawings. Research on work environment has shown that by knowing more about the final product industry workers get more motivated and make a better job. By sharing the concept of the building with the rest of the actors in the process the architect might contribute to improve motivation and work engagement. With visualisation supported by computer techniques it is possible to make conceptual messages accessible.

Architects also claim that a part of the professional role is to be the only one who keeps the holistic view of a project. As more persons and professions are to be involved in managing the process it must be crucial that almost everyone shares the holistic view.

Implementation of IT is a huge challenge to the educators of architects and engineers.

There was a time when CAD was just another drawing board which did not at all affect the architect's aged traditions of work method. Now, having more experience, we imagine that the new technique offers possibilities which will change many of our ingrained options.

So far education of CAD for people in practice has been something between two days and a week. It has been offered by the dealer of the software and as such naturally focused on the most urgent commands. In a study done by some doctorate students at the CAAD lab in Lund some years ago it was obvious that this was disastrous in at least two ways. The operators of the CAD system at the office were anxiously limited in what to do with the system. To a large extent they were preoccupied by making plan drawings as they had been taught to do when the system was installed. This also meant that they were losing their identity as qualified architects or engineers which is an embarrassing wastefulness.

To make the full use of IT in the construction process will mean using a lot of different software for different tasks. There will be plenty of opportunities to teach "key pressing and mouse clicking" for a long period of time. But taking experience so far seriously we have to perceive that this still has to be the smaller part.

The real challenge is to make a lot of skeptical professionals convinced and willing to develop skills in reigning a powerful media into a personal assistant. The focus on drawings has to be shifted back to the model which is a better base for design and communication. Such a shift demands a change of attitudes starting at the schools. It will have the same need for support by theoretical clarifications and methodology as other subjects already taught at architect and engineering schools.

The number of researchers within the field of IT in the Construction and Building Management sector is limited. It is therefore important to use this resource in an effective way.

More collaboration with engineers, even in education.

Donald Schön^{#7} has described how the traditional way of teaching design also can be used for education of any other practitioner. Every architect reading his examples will smile with recognition of how this actually worked - at least once or twice. Briefly it means that students are being coached through the design task by an experienced teacher who brings problems to the surface for reflection and discussion. Within the Architect schools there ought to be a knowledge of this educational method which could be used for a broader group of students.

At CIFE at Stanford University^{#8} among other places education has been given to practitioners from different fields of interest. Offering an educational platform for consultants from different professions to try each others tasks and methods could definitely be of interest for the construction industry.

International joint ventures for Architect Schools.

At the seminar it was stated that Swedish industry has an advantage before most other countries - we talk with each other over the phase and professional boundaries. In Sweden the number of researchers and educators in CAAD and CAD in the construction industry are easily counted. So we will have to start talking with our colleagues outside the country.

Beside some exchange of students within European programs so far there is not very much contact between Swedish and other architect schools generally. All the same the educational conditions for CAAD have been strikingly alike.

In Sweden we are discussing a cooperation between the CAAD labs of Göteborg, Lund and Stockholm to develop a joint course package for a collaborative educational project to meet the predicted needs. It would certainly be interesting to discuss making a broader base for it on Scandinavian or even European level.

This paper is a kind of test to see if conditions in other countries are similar enough for us to share experiences and use each others good examples.

Building networks such as AVOCAAD is a good example of what an Architect school can do to create a forum where especially those belonging to small firms or organisations have a chance to keep in touch with what happens.

1 In Sweden from a recycling point of view the whole process "from plan to demolition and reuse" has to be considered.

2 Bygg is used for building as well as construction.

3 Report at a seminar at the Swedish council for Building research in may 1997.

4 "IT-Bygg - 2002 - Implementation", draft.

5 Negroponte, N.P., "Being Digital", First Vintage Books edition, New York 1996, ISBN 0-679-76837-8

6 Stedman, P. The evolution of Designs, Cambridge University press 1979, ISBN 0 521 22303 4.

7 Schön, D. A., (1987). Educating the reflective practitioner. San Fransisco , ISBN 1.55542-220-9

8 <http://www-leland.stanford.edu/group/CIFE/index.html>