CAD-techniques in architecture and building design, a realistic (over)view

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0. INTRODUCTION

Giving an overview on CAD-techniques in architecture and building design might seem a bit superfluous.
Every mentioned subject will be worked out in this conference in much more detail than is possible in the context of this very first paper.
Nevertheless it will be useful to sketch a framework. It gives an opportunity to participants to compare, and will help to judge the different influences of the conclusions in the right context.
For the authors it might mean that they can fill in their own place, and that their introductions can be short so there will be more time available for in depth explanations.
It must be stated that CAAD-Futures theme is at the design part of the building process as mentioned in its announcement "it takes stock of current developments in CAAD and attempts to anticipate the direction of future developments and their relevance to and impact on architectural practice and education, the building industry and the quality of the built environment".
Following this the framework of this paper is not a copy of the building process.
It is formed around the following topics:

1. Applications today
   1.1. general application
   1.2. CAAD-aids
2. Research today
   2.1. graphics and visualisation
   2.2. reference models
   2.3. Al and knowledge engineering
   2.4. design tools
3. Conclusion

1. APPLICATIONS TODAY

1.2 General applications

Although developments in the use of computer applications are proceeding rapidly it is a general knowledge that the professions of architecture and building engineering are under pressure, due to macro-economic problems.
Combined with the average size of firms in this field, all applications seem to be used on a very small scale.
The general aids include wordprocessing; DBMS-software; draughting systems; spread sheets; all kinds of statistical and mathematical programs; facility management systems and visualisation software.
These tools are available on the widest range of hardware. Hopefully they are bought as the first step to a more comprehensive automation plan.
Even these plans however are often insufficient. The limitations of hardware and software are reached quickly and then disappointment ensues. Although consulting specialists are usually considered too expensive, their accumulated knowledge and experience can be used quite effectively.
All the afore mentioned tools are used in the office for only three reasons: saving time, increasing efficiency and to achieve higher accuracy and quality.
Of course the ultimate goal is to put the firm in its best financial position. Now these tools do exist for these goals, but they are all designed in the traditional way of working.
It is thought that using them will lead to a higher degree of integration. In fact, this is not true. Due to the available tools automation works out to be very fragmented or segmented.
Economical success does occur, but always in the extension of some special task.

1.2 CAAD-tools

The main difference between CAD- and draughting-systems is mostly indicated with the ability if it is possible to connect alpha numerical data to graphical entities or not.
This is a very clear distinction, however even in the poorest draughting environment some low level communication will be possible.
Being able to make a connection as mentioned, it might be a useful extension but does not have a relation to the 'design' problem itself.

Until now results have been very modest. We are only entering the very first step of the developments. Many case studies presented in conferences illustrate the complexity of this subject.
The main bottle necks are

- the amount of data to be handled in combinations with the state of the art in algorithmic approaches and the processing speed available
- no normalized model of the designprocess is available, if possible any way
- the ability to handle soft parameters and not well defined problems. In fact a gap is shown between technicians, artists, psychologists and linguistic specialists.

The stand in need of architect and building engineers is

- to build model of a building in true three dimensions to the accuracy that the design process in its specific phase demands, and the possibility to "play around" with it
- to be able to compare physical behaviour from different angles of incidence
- to act with the system so it is an intelligent cooperator - to test original requirements in an original way
- to test the results of decisions using then as planning systems during realization, performing all aspects of facility management.

Unfortunately today is not the future. A substantial difference exists between what architects is offered and what they really need.
In fact design tools that can be used in an architectural practice do not exist yet!

2 Research today

The stage of evolution in the CAAD-research is illustrated by the fact that chapters of this paragraphs are completely seperated.
The problem fields by themselves are extensive enough. Except for some rare small scale exception no integration between subproblems occurs. (Please note that "design" is the subject, not draughting, planning, construction or project and office administration).
The only general accepted starting point is that information must be presented graphically. Informatics and information technology is making this possible.
The needs of building engineers and architects have been mentioned already in paragraph 1.2.

2.1 Graphics and visualisation

The speciality of computer graphics and visualisation has always been dominated by the search for new algorithms that would generate more realistic images on the hardware available.
Photographic quality of a 3D-world is the ultimate goal.
Many new algorithmic approaches have been presented through the years (ray-tracing; wave-length based methods; radosity method) however, researchers are still looking for better and more accurate models.
Processing time to achieve results based on these theories in enormous.
Many hours, sometimes even days, are needed to generate complex images.
This problem will be solved in the near future due to two developments:

a. research will be succesfull in finding better, faster and more accurate algorithms
b. as big computers get cheaper, and cheap computers bigger, the wanted processing power will be available someday.

Anticipating to the second evolution will make sense.

For the parties concerned it will be a frustrating experience to find out someday that all the knowledge on smart techniques is put into firmware, and standard build into computers and terminals. The 2D-world is in this phase already.
A major problem is caused by the fact that researchers in the field of visualisation are only interested in the 3D-image. The models are seldom a result of a technical or psychical process.
The importance of a connection to general CAD-techniques is generaly underestimated.
Many tools in the field of visualisation therefore is not applicable. Besides this people only work on a one-way connection. The images are the result of some "cut and pasting" process. The other way around, that an image can be input of a technical process, is neglected.
More research has to be guided into this direction. Methods have to be invented which allow easy visual assesment and allows evaluation of design attributes of the model itself.

2.2 Reference models

Integration and communication are key words in all discussions that take place around the items in CAAD and its future application. The

construction industry is not so easy to guide as the computerworld is in following standards that are to be set by major industries.
The result of this is that at many places around the world researchers are active in creating and testing proto-type reference models that can be of value at all stages in the product life-cycle.
A danger that occurs in this respect is that existing procedures can form the base of a failure. It is essential to think about these questions in a very "lateral" way. It is obvious that even small scale models will take a gigantic amount of data.
In a reference model it must be possible to make spatial, time and logical relations. Besides these also the concept of value and of standards need to be added.
It means that a model will consist of seven dimensions.
The structure of the model will always be semantic.
It is necessary to agree on some form of standardisation concerning reference models. It can form the basic idea of communication between partners in the building process.
It has to be realized that this is not a pure technical problem.
Linguistic experts for instance are needed to help technicians to formulate in an un-ambigous way. And as it is to be expected that the model will posses some degree of intelligence, knowledge engineers and psychologists will be part of the team to.
Two main types of reference models can be recognized:
a. pragmatic models
b. academical models
Pragmatic models are structures around existing programs and can be called bottom-up developments. Academical programs have all the features of a top-down approach.
The two do not touch and are completely seperated developments. Also inside a. and b. no communication between models is possible. It is surprising how different and divergent conclusions can be when different specialists start thinking about the same phenomena.

2.3 Al and knowledge engineering

Of all topics that are favourite as conference themes artificial intelligence and knowledge engineering are most popular at this moment. This is understandable. It is the newest topic, more challenging than ever an item could be, and the subject is still in the very first beginning of its development. It can be predicted that knowledge based systems will

change the designers world drastically. The principal difference with the existing situation will be the transition from procedural approach to being able to manipulate data in descriptive form.
Knowledge engineering will enable us to manipulate soft parameters; factors as feeling, colour, pleasure and so.
There is a future in which computers don't need to act fully algorithmically; a user does not experience the computers behaviour as algorithmic. These techniques will help computers to act in a way that designers will understand.
Knowledge based systems provide new directions in CAAD. Nevertheless some remarks must be made.
Analysing workbooks, and conference proceedings it calls attention that research projects mostly are fixed on very narrow area's.
The issues on expert systems and related topics are sometimes presented concealed under not relevant professional knowledge. Every researcher invents his own model of the "design process". The importance and problems of data- and knowledge organisation are underestimated. Dealing with the so-called softparameters, in CAAD special relevant, is seldom mentioned. Science fails completely in analysing the design process or in tackling social behaviour of users. In this respect the specialism is still un-mature. There is an un-sufficient willingness to listen to specialists from social sciences.
Although it can be predicted that knowledge based systems will change many processes, it is not sure if it also will effect the design products themselves, or will improof design.

2.4 Design tools

The symbiosis of all the mentioned items can result in design tools.
Hardware technology is less and less on the critical parth of reaching it
- computers are getting more powerful
- chiptechnology improves, accuracy gets higher
- high frequencies
- decentralized configurations, networks
- 'hands' and 'feet' are improving
- bit mapped display technology, colour selfevident
- multi user/multi tasking available at almost all price ranges
- storing capacity gets cheap
- etcetera

A small example on the Intel chips illustrates this phenomenon:

	intel 8085	intel 8086	intel 80186
MIPS	.07	.03	.07
IPS/$	700	1.500	10.000

All these facts will continue in improving.

Besides the mentioned influences also software technology will improve.
Software engineering will be a profession itself. Logical zooming techniques will help in presenting only relevant data to a designer.
Real time use and simulation will be available.
Helped by user oriented languages there is a tendency from procedure oriented to model-oriented problemsolving. In fact this last development started already some years ago. Designers want to talk to their machine and want understandable answers that are relevant to their questions.
Computers will serve the 'Homo informaticus".

3. CONCLUSIONS

It has been argued that CAD-techniques in architecture and building design generally are in an acceleration.
Main threshold is the slow progress in knowledge based techniques and designing design tools.
In design philosophy there still is a contrast between fundamental thinking and practical application.
It is realized all over the field that without an adequate theory of design we will be quite unable to design systems for designers. We do not succeed in finding this theory. A conflict also can be found between the linguistic approach and the conceptual level of actions. An intermixture of relevant disciplines has to be stimulated. Psychologists in this respect will have a major influence in the design process of our future design systems.

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