**Nordic Association for Architectural Research, Aarhus 27-29 April 2001**

# ARCHITECTURE TECHNOLOGY

## - virtual modelling gives a new dimension to an old technology

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Human beings have an absolutely amazing power to move, in their thoughts and at the speed of light, from one place to another. With the help of fantasy we can also move to places that do not yet exist. But it is not all that simple to take other people with us on the journey to these imaginary places, buildings and spaces. With words and pictures we can try to bring to life what we have seen, but we cannot be certain that everybody has the same mental picture of what is to be built and how it will be experienced. Considering this the drawing can be seen as a formidable invention. Today virtual modelling gives a new dimension to an old technology. The author describes here the background to the sector-wide programme "IT Construction and Real Estate 2002".

### The first drawings

In the book 'Arkitektur som kunskap' (*Architecture as Knowledge)*, Björn Linn tells us about the world's first building in chiselled stone, the step pyramid at Saqqara, south of Cairo. Here, in the Egyptian culture of five thousand years ago, at the point where the primitive architecture carried out in sun-baked brick, wood, and reed gave way to the stone architecture of the future, the drawing was invented. At first it was the ground plan, staked out on the site, that was copied onto limestone or clay tablets. It was now possible to represent and plan that which was to be built on a different scale and in a medium that was transportable.

The drawing is, then, an invention that has its beginnings in architecture and has been of inestimable significance for humanity and technical development in every imaginable field.

Through the gradual development of perspective drawing during the Renaissance in the fifteenth and sixteenth centuries, our power to describe that which is not yet built increased. It was architects and artists who step by step discovered and deduced the laws of geometrical perspective and so-called central perspective. It was now possible to make an exact

representation of space. This in its turn created the possibility of drawing visionary pictures of future street spaces, townscapes and complete "ideal" cities.

Perspective means "through-seeing". After five hundred years it is still the wholly dominant method of showing architecture at a distance, as if through a pane of glass. With his eye behind the plane of the picture, the person presenting his design places himself "outside" the picture and there is a definite distance between the observer and the observed. This is in distinct contrast to oriental culture, where the world is depicted from the inside and outwards. There is a connection between our way of making pictures and what we in fact build. It is therefore worth considering what kind of houses and cities we would have built if we had been able to visualize the world without that "pane of glass" between the observer and the space.

Architectural perspectives and presentations developed into an art form in its own right. University educated architects active around 1900 acquired a masterly presentation technique. They used wash-drawings to present plans, fronts and sections. These fulfilled simultaneously two quite different functions. They provided the builder with a very good picture of how the future edifice would look. This was a help in making a decision. But they also showed the builder how the edifice was to be built, right down to the last detail.

In contemporary language this is the technique of planning a building with the help of a model. Models can take various forms; for example in plan, front or section. The Renaissance gave us mathematical rules for the construction of central perspective. Using these rules we could make a realistic, three-dimensional representation – that is if we studied the perspective drawing from the correct distance and with one eye only. In this way the model, represented in drawings or in perspective sketches, functions as both *concept*, showing what we wish to achieve, and *recipe*, showing what we must do to achieve our result.

In the main article on architecture in the Encyclopaedia Britannica, Björn Linn is looking after the technology in architectural knowledge but finds only material about building technique and construction.

> "It does not cover the technology that the work of architecture itself is based on - such as the work of the designer and artist. This technology, based on some form of "pre-

pictures", is the absolute pre-condition for the creation of large and complicated buildings." (Linn 98, s. 146)

> "Architecture has grown out of ancient, manual building skills through the development of a method: studying proposed objects, at first buildings, in the form of models, and then working with the problems of design using these models, *before* the object is actually built in full scale." (a.a., s. 15, translation)

Björn Linn calls this basic technology "the technology of architecture" and compares it with the game of chess:

> "The situation is similar to what happens in chess: when you play through the game move by move, the consequences of individual actions and possible choices between alternatives become visible and susceptible to treatment."

> "The significance of the technology of pre-pictures as a creative method lies in the fact that it has made it possible to insert a projection surface so as to make the game tangible, and open it up move by move. The method has worked extremely well. It has created a rich tradition and for over four thousand years it has dominated the field. It is as usable today as it ever was, but we have now begun to see the possibility of alternative methods more clearly than before." (a.a., s. 75)

Computer modelling has provided this technology with quite new possibilities.

**Views from models**

The information technology of the twenty-first century gives us a completely new possibility of further developing our power to visualize the future and thus to organize and shape industry and society in a new way.

Geometric models can now be created and displayed by computers. This increases our power to describe, analyze, simulate and visualize. In this way we can obtain a better basis for decision-making and be in a better position to predict the consequences of various ways of doing things. We can separate information about planned buildings and constructions into classes, systems and structures with such great precision that we can also transform this

information into data that can be processed in data models. In these models we can combine data so as to be able to calculate, analyze and optimize constructions. From these models we can project any desired combination of data to the "views" or documents of various kinds that we require for various purposes.

> "What is new is that the model's existence, before the picture is thus divided up into two stages. After the first stage, which is purely mental, a virtual existence has been inserted. Here the model has been made collectively available. Several people can work with models that, from the start, are identical. Changes can be traced back to the model. The significance of the model is in this way communicative. Up to now only parts of this new potential have been understood." (a.a., s. 147)

From the beginning of the nineteen-sixties a completely new way of "looking at" models has been developed.

Virtual Reality - which in priceless data jargon has been reduced to "Reality" - places the observer once again in a central position. Surrounded by realistic motion pictures on walls, floor and ceiling, you can examine a mountain cavern, an industrial construction or your future home before it is built. A tracking system follows your movements and ensures agreement between physical and digital reality. The calculating capacity of the computer is so great that the projected pictures can be synchronized with your movements in real time. The illusion of reality is remarkably convincing. Cybersickness is the name of the travel sickness of the new era!

But is VR merely pop, trend or a transitory phenomenon that will soon be a thing of the past? No. I believe we are at the beginning of a technology that will have as great a significance as the drawing and central perspective have had.

The digital, interactive presentation of data from models can be distributed to the building site and be made available exactly when needed. It can be projected via transparent spectacles right into your eyes so that you can see simultaneously the physical reality and the digital picture of what you are about to build. In this way, this technology will be easily managed and "invisible" and perhaps as natural and unremarkable as the drawing is today. But data modelling constitutes a great challenge for practical people today.

**Reflective practitioners - the heroes of the construction sector**

The practitioner is the hero of the construction sector. It is practical people that count. But what is a practitioner if not a person who practices a theory, who has a clear idea about how a good job should be carried out and judged? Successful practitioners think about their work, see cause and effect, collect experience, patterns and characteristics. Skilful practitioners can therefore quickly recognize underlying problems and in so doing also prescribe the truly good solutions to real problems.

Our best architects and designers, planners, project leaders and builders reflect continually over everything they do and decide. Outsiders talk about intuition and luck, when it is in fact a question of a very systematic accumulation of insight and expert knowledge. The practitioner chooses with great precision working methods and tools that best support a personal interpretation of the basic idea of his profession - "Best Practice". In a corresponding way the professional rejects with absolute certainty and at lightening speed tools that claim to be innovative but which do not completely meet the complexity of the task. Seen from the outside, this can be wrongly interpreted as conservative behaviour and prejudice against new technology.

And what is a researcher if not a person who, with clearly defined terms, builds coherent theories by observing practice and reflecting about it? This is the way the researcher makes it possible to systematically develop knowledge, methods and tools just for the demanding professional on the practical side.

The antithesis between theory and practice is merely an appearance. Lack of understanding between the practitioner and the researcher in the construction sector is however a grim reality. It is a serious obstacle when trying to bring the oldest of industries into an era where knowledge is paramount. This obstacle must now be removed. A technological shift is taking place. This shift must give us a new view of research and development, and lead us to recognize the clear interaction that in fact exists between theory and practice.

**The model - the construction sector's sharpest tool**

The model is a simplified representation of reality. Both the practitioner and the researcher make models in order to be able to examine and talk about a complex existing or imagined

reality. This simplification is not as theoretical as people suppose. It is, on the contrary, extremely practical - indeed absolutely necessary if we are to be able to talk about our ideas and understand each other. Exactly like the drawing, the model is a genial abstraction, which however presupposes a silent agreement about how it should be interpreted. This agreement is among other things the knowledge we gain in our basic training and through the practice of our profession, and which constitutes our expert knowledge.

The idea of a model has got renewed importance through the introduction of information technology into the construction and real-estate sector. This introduction has not seldom created, to put it mildly, certain confusion. This is after all no longer a question of handy, physical representations in cardboard, clay and wood of planned buildings and constructions, or for example lucid organizational diagrams. The IT industry offers to "map" our working processes in order to automate them. So it expects us to be able to organize information about components, systems and spaces in buildings and constructions in strictly logical so-called product models that can be handled by computers. Pioneering applications of this technology are very promising in regard to swift, secure and entirely digital information supply in projects and administration.

**IT meets the construction sector in a Big Bang**

As been said above data modelling constitutes a great challenge for practical people. The silent agreement as to how models should be interpreted does not exist here. And for most of us there was no trace of data modelling in our basic training. What is needed is a considerable upgrading of our knowledge if we are really to take advantage of the possibilities of product and process modelling in the construction and real-estate sector. To be able to capture, process, analyze, distribute and store information digitally will in the future be of strategic importance for individuals and companies. But this makes great demands on IT companies and their ability to listen to their customers in our industry.

The automobile, aviation and shipbuilding industries can of course - so why not the construction industry? Yes. But isn't our industry rather special? Unfortunately, we build our products only once and our companies co-operate horizontally, not vertically as for example in the engineering industry. Isn't that so? No, the IT industry replies, every industry claims it is special and a bit slow to change, but it is not true! You are not special, only the last on to the field!

Blind to the special expertise of each of the professions within the sector, the IT industry tries to implement general solutions which, in the best of cases, are tolerably well adapted to individual companies. The results are not seldom expensive sub-optimizations and imperfect communication between companies that in fact are completely dependent on being able to co-operate with others and exchange information very effectively. To organize a building project is to select and combine various kinds of competence and to establish effective methods of co-operation. Information technology offers *in principle* exactly the infrastructure the sector so greatly needs in order to bridge over antiquated guild boundaries and geographic distance. This is at any rate the way it looks.

In all innocence expensive licenses are bought for software that cannot be delivered or which, when it at last has been delivered, is not debugged. The many companies within the quality-certified construction and real-estate sector are used to being under penalty to deliver quality-assured products absolutely in time. But they wait obediently for updatings that they have paid for in advance and that will arrive at some indefinite time in the future! Talk about a collision between old and new industries! That the construction sector has found it difficult to accept IT is true. Certainly it has marked time for ages. But the question is whether the IT industry really can meet the construction sector's requirements and needs.

**IT strategies decided by the companies**

The leading construction and real-estate companies have now made their IT strategic decisions at management level. There is no longer any reason for thinking of the whole construction and real-estate sector as being in sackcloth and ashes. The will exists to use IT in order to create better products and smarter business processes. In an international perspective Sweden is in a very forward position. Together with Finland we constitute a kind of fuel-tender for USA's steam locomotive. Since the early eighties Finland has systematically built up an impressive IT proficiency within the building industry, and in the future we will see interesting IT products and research results from Finland. What is now required in Sweden is a large, widespread effort out in the construction companies.

Since the seventies, IT has been brought step by step into the activity of all kinds of firms active in the construction industry - consultants, manufacturers of building material, real-estate and construction companies. This development has shown that there are gaps in the

information systems and exchange formats that ought to guarantee that the exchange of information between companies and individuals really works. The Internet has given us the TCP/IP format. But where, for example, is the information structure in a construction product model to come from if not from the construction sector itself and in international collaboration across many national frontiers? A seat at the table in international co-operation on the frontiers of knowledge requires considerable investments at home. It is such investments that open doors to the world's development centres.

**A common IT platform**

"IT Construction and Real Estate 2002" is a programme involving the whole of the construction sector. Its purpose is to implement information technology in the construction and real-estate sector on the sector's own terms. A total of 120 million SEK is being invested during a period of five years in three sub-programmes covering research and development, standardization and implementation. During the first two years 59 million SEK have been invested in 51 projects at universities, companies and standardization organs. The aim is to build a common IT platform in order to facilitate co-operation and thereby increase the sector's ability to create improved products for its clients. The first half of the programme has now been carefully evaluated by independent assessors. The judgement is brief and to the point: "A world beater!"

"IT Construction and Real Estate 2002" demonstrates how industry and society can collaborate in financing and carrying out a strategic development programme. Of the 120 million SEK, 60% comes from industry and 40% from the state. It is also an example of how the construction and real-estate sector in words and actions pull down barriers between the practitioner and the researcher. In principle all the projects are built on the idea that there is a distinct personal relationship between industry and university. In this way it is demonstrated quite clearly that theory and practice are mutually dependent. What is also demonstrated is that researcher and practitioner work under different conditions, but must show respect for each other and each other's integrity.

The results of the programme are of several different kinds. During the five years of activity the work will take substantial steps forward. The fields involved are the formulation of necessary standards for product and process modelling, data exchange, document management and metadata, administrative information and project network and project

communication. We can already see excellent results. I believe that most suppliers of programmes by the year 2002 will have implemented important parts of these standards. But it is important that the sector continues to be quite clear in what it demands of these suppliers.

January 1, 2001 the second half of the programme started. 30 million SEK are to be invested in a number of purely implementary projects in which partial results are put together to make, from the practitioner's point of view, a working whole. This will then be tested. Three projects have been decided on.

The first has to do with implementing IFC, Industrial Foundation Classes for product modelling and data exchange. It is a collaboration between construction and real-estate companies and IT suppliers. They are to apply these de facto standards to their products.

The second has to do with document management and metadata. An essential task is, in a context of international co-operation, to decide how information about information, i.e. metadata, should be handled so as to cover the special requirements of construction and real-estate companies.

The third project is about project networks and project communication. One of the questions to be dealt with is how working routines and organization are affected by collaboration over the net and what possibilities are created.

One of the programme's most central themes is facility management information. This project is now going further after the first-stage report in November 2000. This report made seven recommendations to real-estate companies. Central to the project is that an agreement was reached on a general process model for the administration of information in facility management. With the support of a number of leading real-estate companies, the foundation is being laid for a system of facility management information, which will facilitate every phase of facility management. Among other things, the information created during design and production is prepared from the start so that it can be re-used and supplemented for use in the basic activities of real-estate companies.

**All is not information that glitters**

In this era we tend to see various problems just as information problems, and we often look for solutions to problems of the most varied kinds in terms of information technology. To offer more and more information can be counter productive. Problems can look even more complex, and a state of indecision be even greater. The connection between cause and effect disappears in a fog of information of unknown quality. Information abounds, but what is needed is insight and knowledge, so difficult to gain.

A current and perhaps extreme example are the many companies that have quickly abandoned their basic activity in order to offer, instead, IT services, e-business with business to business solutions and web-sites without really knowing what they are doing. A factor common to all these IT solutions is that they lack a stable information structure which would make the information something more than a superficial picture of information. Well-structured information can be used in many ways and grows old beautifully. It is a pre-condition for data modelling and communication and thus for the development of the architecture technology.

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This presentation is based on two earlier articles written in Swedish and published 1999 and 2000.

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**www.itbof.com**

"IT Construction and Real Estate 2002" gives continual information about its operation. The quickest route is to visit the home page, address www.itbof.com. Every year an IT Forum is organized with lectures and demonstrations. On the occasion of these IT Forums the presentation takes place of the Face-IT prize - Facility, Architecture, Construction, Engineering - to the best IT implementation of the year. In a hearing, which is also annual, researchers and developers talk about work in progress. A series of seminars on various subjects is arranged, sometimes at short notice. After all, this is an area of rapid development. Everything is announced on the home page. Soon after the turn of the year a printed account of the year's activities is published. This summarizes what has been achieved and also the economic results.