Information Technology in Design

ROGER PELLETRET
Centre Scientifique et Technique du Bâtiment

INTRODUCTION

First, let me explain briefly what the CSTB is. In many ways, it is similar to the National Research Council's Institute for Research in Construction in Canada or to the National Institute of Standards and Technology in the USA. We are involved in standardization, but we are also acting as consultants on particularly difficult projects. We intervene only when the problem is too complex for normal engineering offices.

For example, we were involved with the Grande Arche in Paris and the pyramid of the Louvre where there were problems due to the flatness of the triangles which composed its four sides. We also worked for the new French National Library where there were comfort problems due to the over glazing. Sometimes we also work for other kinds of projects than buildings. For example, we have worked for the high speed train (the TGV) where we have been asked to help design protections against noise. We have also worked for the Ministry of Defense for the new nuclear aircraft carrier where there was also a problem of noise caused by the stabilizers.

The title chosen for my paper is "Information Technology in Design." If you allow me, I would like to enlarge this title to "Information Technology in Procurement, Design and Construction." This is because before designing can start, somebody has to have decided that a building (or a bridge or a road) is required and will be built, and for that procurement is initiated and a request for proposals (RFP) is launched. Information technology is very important and very useful at that stage, and I will explain why in a couple of minutes. During the design phase, as we shall see later, there is a frequent movement of data between the parties to the design process. For example, design simulations—eventually using virtual reality—are exchanged. When electronic means are adopted, it becomes possible to introduce concurrent engineering. And after designing occurs, the building has to be erected, and nowadays information technology (IT) is very important to improve the construction phase in order to attain a level of quality which complies with the design. In other words, there is a complete chain of activities; design is not a stand-alone phase.

IT AND PROCUREMENT

The procurement phase involves a full specification of the project. For an RFP or a call for tenders to be launched, the owner has to produce administrative and technical documents that constitute a huge pile of paper. This pile has to be copied and sent to potentially interested firms who in turn try very quickly assess whether it is possible for them to develop a proposal and, in the affirmative, send it back in time to the owner. The owner in turn makes a comparison between the various bids and decides who will have the contract. I would like to explain in more detail what is going on in this procurement process, primarily because there is a project in Europe to replace the paper-based procurement process by a fully electronic one.

As I mentioned, in the building industry, the specifications are quite complex and many documents are required to describe in detail what the owner's project comprises. The average cost of one such set of documents is about $100 to $200 US. When we realize that there are thousands of RFPs each year multiplied by the number of contractors involved each time a call is issued, we can see that there are millions of specifications which are distributed every year. So the question is: What are the benefits for the contractor or the architect if the procurement process is replaced by an electronic process? The owner develops an RFP which is sent to a number of contractors. Each one does not have a lot of time to prepare the bid so he is in a hurry. The first thing he does is to check if the RFP is interesting for his company or not and it turns out that only 20 percent of the RFPs are actually acceptable for his company. If it not suitable, the process is stopped and the specifications and all the technical documents are simply trashed. If the RFP is assessed as being potentially profitable, then the process continues and all the people in the technical office in the construction company intervene in order to build up a proposal.

The problem there is that there is a lot to check and most of the data embedded in the RFP has to be input into the contractor's computer. The technicians of the construction company double check the plans received from the owner to be sure that the quantities given are correct. To do that, they very often digitalize the plans—which is also a time consuming process. In the end, there are a lot of administrative documents to fill in and the proposal is sent back to the owner at the last minute by courier (this also costs money). A study done in Europe has shown that the global amount wasted in the paper-based procurement process by the private offices and companies is US$1 billion a year! Another very detailed study showed that on the owners' side, about the same amount of money could be saved if paper-based procurement was replaced by a fully electronic procurement system. So in some countries and especially in France, the Ministry in charge of construction decided to launch a national program in which the goal is to build up a network of servers for RFPs. This is currently at the prototype stage.

The number of public sector RFPs for constructing buildings, roads, bridges and so on, launched each year in France is about 100,000; there are about 100 different administrative regions so there are about 1000 public sector RFPs in each one, which is about four per day. These are entered into a local server. The idea is to have a national gate to enter the whole system. This will display the various regions in which there are local dedicated servers. So a person who is looking for a call for vendors which could potentially be interesting for him or her would select a region, access a detailed map of the region which will display the cities in which an RFP has currently been launched. By clicking on the name of the city, they will access a list of the RFPs and find a very brief description of the project. They can access some photos and they can then go to the down loadable part and take all the specifications, plans, and general and special conditions. These are put on the servers in various formats in order for people to be able to download in passive or interactive formats. This project is in the process of reaching the experimental stage, after which four servers will be developed and tested for one year starting this fall.

After the experimentation, we hope to be able to deploy the system at the national or even at the European level.

IT AND DESIGN

The main contribution of IT is to facilitate a better understanding between project participants, for the engineer to better understand the architectural constraints and for the architect to better understand the technical constraints. The goal, of course, is to improve the dialogue and to develop a shared capability of understanding. The purpose is to exchange plans and technical data, and to be able to retrieve data from catalogues. It is both a new method of working and a new tool.Let me enter into some technical details and explain how technology is going to change the process.

Presumably most of you are using CAD tools and sometimes you are exporting files to give them to partners in the design team. One of the most commonly used formats is DXF but it is a "dumb" format with absolutely no semantics and no embedded intelligence. Data is only lines, circles and points, so that a wall with a window in it, for example, means nothing to DXF. If you look into a DXF file, the number of commands is very high, yet all these data only describe a drawing which could represent something quite different from a wall and a window. Consequently, the program used in the engineering offices cannot know that all these data correspond to a wall and a window—because, as I said, there are no embedded semantics. Indeed, the receiver of the file must interpret the drawing with his or her own brain.

Currently, there is research being conducted in many countries to improve the way data can be exchanged, to the point that there are now many different national standards intended to harmonize the way layers and the blocks are stored in DXF files. In France, for example, the Communication Unifier System provides a way of labeling the various layers in order to improve understanding. ISO/TC10 also tried to introduce some standards to DXF (see ISO standard 13 567).

It was decided that to comply with the ISO standard 13 567, a layer of a block in a DXF file has to follow a rule stating that each character in the label of the name of the layer must comply with the meaning which ISO had decided to give to the precise character at that precise position. Fortunately, the French standard (Communication Unifier System) I have just mentioned is compliant with the ISO standard. Consequently, if people use both the national standard plus the ISO standard, they can put some intelligence into their communications. Nevertheless it is not very powerful.

There is another standardization process which is going on at the ISO level TC 184). It is STEP, Standard for the Exchange of Products (ISO 10303). The idea is not to exchange just plans but really to exchange models, or, if you prefer, to exchange virtual buildings, virtual roads, virtual bridges, virtual offices, etc. The power of STEP lies in the fact that it is fully object oriented. There are two different parts to STEP: the first one describes the object in question in a very general way, then when you want to pass on to one of your partners the concrete instance of the general object, you describe it by simply giving figures to complete the general idea.

To find out more about STEP, one can consult the NIST server <http://www.nist.gov/sc4/>.But it is taking such a long time to achieve a complete standard that industry is tired of waiting. Consequently, the initiative launched by Autodesk three years ago is important: Industrial Alliance for Interoperability (IAI). The new format is based on the so-called Industry Foundation Classes (IFC). Currently, version 1.5 of the IFC is being used to demonstrate the power of the approach, but until now, no real industrial applications have been made. It is important to know more about this system, because it completely changes the way architects and engineers work together. To find out more about this project, one can consult <www.interoperability.com>.

I want to stress that the point of IT in the design phase is to help people to better understand one another, to help architects and engineers to speak the same language and to help them to design better buildings, better and faster. To do that, they have to communicate and they have to exchange data. They can save a lot of time by not having to re-enter data if, instead, it can be input automatically.

For example, since complex thermal engineering programs like TRNSYS now have convivial human-machine interfaces and they are now user-friendly. The complexity is hidden behind the human machine interface. They are more frequently used by HVAC or indoor air quality engineers in order to design the thermal performances of buildings. Therefore, the need to transmit information from one system to another directly is even more important than before. Programs such as SYNCAD—which is compliant with TRNSYS—bridge the gap between the CAD tool and the transient simulation program.

VIRTUAL REALITY

It is one thing to exchange data, and it is another thing to be able to display the object you are working on. That means you have to have a virtual representation of the object being designed inside the computer which you have to be able to materialize. Whereas for the public, virtual reality (VR) is associated with games. For architects and engineers, VR is a technology to enable one to simulate reality; it can be used to show the owner what you have decided on his or her behalf.

The main characteristic of VR is interaction in real time and with "'improved reality," real and virtual images can be combined. For example, you can take a picture of a real urban environment and you can add to it an virtual image of the building being designed.
Improved reality also allows people to visualize physical phenomena which are difficult to actually see. For example, in a large amphitheater, there are complex air movements which can be visualized and made understandable through improved reality.

So let me explain some examples of the current the technology of VR. The first is an AVI video file. The interest of this technology lies in the fact that on a floppy disk (or on Internet) it is possible to communicate the results of your design. However, only certain predetermined views can be displayed.Then there are other technologies to overcome the limits of AVI files. Quick-time virtual reality (QTVR) panoramas. They allow the user to decide what he or she wants to look at, but only at predetermined locations. The third technology is the fully open visit of the building. It assumes that a complete computer model has been built. Note that it can be organized in such a way that when arrows appear, they can be associated with retrievable descriptive information.

Then the problem is that you need some visualization devices and they are expensive. You can invite your client to an "immersive showroom;" anyone in the room can play with the mouse and see exactly what he or she wants to display. (Generally the immersion showrooms are designed for 50 people.) You can use a 3D table and stereoscopic glasses (about 10 people can stand around the table and see a 3D version of the building coming out of the table). It is very practical compared to the immersion showroom because it takes less space and can put it in a normal office.

The other possibility is to buy a "cave." A cave is a fully immersive environment in which the images are displayed on the six surfaces. Again, you need to have the stereoscopic glasses. The problem with the cave is that only three people can go in at once.

TRENDS WITH VR

There are many new joint ventures between CAD developers and VR developers. Also, asVR devices are becoming less and less expensive, PC developments are possible and new technologies are emerging including very powerful formats based on projective geometry. We are also going to real imaging opening the door for electronic commerce. A retailer of watches, for example, allows a client to go into his virtual gallery and select one; it can then be purchased by credit card and be delivered to his or her office.

But there are few applications in the building sector. However, in some cases, major building owners, in their procurement documents, stipulated that the bidder had to develop a 3D model of the proposal and that this 3D model had to allow the owner to change the lighting or to change the climatic conditions and to move freely in the model.

By way of conclusion, let me say that VR is useful to design, build and maintain better because it allows one to explain to people what one has in mind the most effective way by showing it. VR facilitates access to information and thus should also help with the processes of teaching and learning.