Computing in the building process
beyond Computer-Aided Design

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…Computer-aided drafting, as practice today, is an "island of automation," the automation of a self-contained task within the design and building process. Although it can be viewed as central to the process because of its visual dimensions and because it can be linked to databases that contain data about the building, it is just another island of automation, like the engineering analyses, cost estimation, project scheduling, etc…

Many perceive the application of information technology (informatics) in the design and building process as computer-aided drafting. Computer-aided drafting has indeed changed the nature of producing construction drawings by lowering the cost of producing those drawings and, more importantly, by providing a partial automation that facilitates repetitive design. Furthermore, three-dimensional modeling, usually part of the process of making the architectural drawings, has facilitated the communication between the designer and the client by providing vivid renderings and animations. Computer-aided drafting is cheap to acquire and has been accepted by most design firms, so it does not constitute a novelty anymore but it is considered a mainstream practice.

Nevertheless, computer-aided drafting, as practice today, is an "island of automation," the automation of a self-contained task within the design and building process. Although it can be viewed as central to the process because of its visual dimensions and because it can be linked to databases that contain data about the building, it is just another island of automation, like the engineering analyses, cost estimation, project scheduling, etc.

Database information

Many researchers focus on schematic design as a target area to expand the use of computing in the design process. I would make the argument that this would be another island of automation and, in addition, it may be of little value to represent schematic design in the computer. Schematic design is an individual task and needs the least technical support. On the other hand, I would be more interested in accessing database information relating to the subsequent design stages during schematic design. Many designers, however, find it redundant and feel that their experience and printed catalogs of building products are sufficient and there is no need for computer-based automation. Further research is required to establish if there is a need in this area.

I believe the use of computers should start before schematic design, at the programming stage. This is where important decisions are made, and access to expertise would assist the client in making the right decisions and create a building that meets his/her expectations. Then, after the program is set, and after the architect develops the first

sketches of the schematic design, the computer should be used for developing the architectural drawings, and could serve as the means for communication among the design participants, for accessing information, for linking to previous projects, and for incorporating engineering and financial analyses as early in the process as possible.

However, computing in design should be considered beyond islands of automation. There is no doubt that computer-aided drafting can improve quality by leading to a better design and by improving representation that results to better communications. Computer-based concurrent design has been identified as a way to increase design interaction. Concurrent design suggests that several designers from different disciplines work simultaneously on the same database by processing data and adding information that is constantly represented in a visual form. Some suggest that specialized expert systems could supplement concurrent design and provide advice and solve technical conflicts during the process. There is no question that the concept of concurrent design is powerful, albeit sometimes utopian, as it is short of defining a management hierarchy and is based on a non-conflict value system.

Marketing approach

From a manager's perspective, however, this should not be enough. Managers of the building process should ask "what is the objective of employing computers in the building process? Is there a larger picture than just automating a few tasks within the domain of each design participant?" If the answer to these questions is to provide better service to the client by efficiently producing a better building, then the focus should be to use informatics in order to achieve that better service.

This represents an alternative way of thinking: a marketing approach rather than an engineering approach. Seeking a better service, in a service oriented industry, is the right approach than just reducing the cost or using technology for technology's sake. Along this marketing approach, we should employ informatics to reduce the *inefficiencies of the process* that prevent the client from receiving a building that meets his/her objectives, including design as a well as financial objectives.

Inefficiencies

To reduce inefficiencies, it is necessary to identify the sources of the inefficiencies in the design and construction process. Although each building experiences a different set of inefficiencies, there are some patterns, based on my observation of the design and construction process of various buildings of signature architecture:

1. The most common source of inefficiencies starts from *improper choices* by the design participants. Such improper choices originate from bounded knowledge, that does not permit the designer to choose from all the available options. Improper choices often start during the programming stage and continue during the subsequent design and building stages.

2. It is the norm rather than the exception to *duplicate information* at the different stages of the process, from programming all the way to producing the building. The

duplicate information originates from the different professionals who view the information from different angles and use different representation tools to facilitate their own processing. As a result, inefficiencies originate from using additional resources, requiring a longer time, that eventually result to higher costs.

3. It is more than often that the design process leads to *incomplete documentation* that does not fully depict the intention of the designer or the client. Most often the incomplete documentation is the result of assumptions that have not been made explicit, other times they are just omissions and errors. Let us accept that it is almost impossible to produce a perfect set of documentation of today's very complex buildings which, I would argue, is not natural. Most important building of the past were being designed as they were built, in a much longer process that took into account the experience of the actual building process.

4. Even in those cases that the design participants want to establish better communications, there is lack of easy access to each other that creates a *barrier of communications*. The present segmentation of the industry promotes formal and limited interaction among professionals

5. Another serious source of inefficiencies that underlies all the above points originates from the *different incentives* in an uncertain environment that allows design and construction participants to benefit from ambiguities. In a conflict process, where each design participant looks for meeting their own values (most of the times with the most respectable and honest criteria), and their own objectives, the current process does not serve the client but leaves the client as a secondary player to the value system of the participants. In the past, different project delivery schemes have been devised to address this problem, including the development of the professions of project manager and construction manager. However, the problem today is as acute as has ever been.

I believe that the above inefficiencies of the design and building process could be significantly reduced by using informatics. It would be quite inviting for the managers of the process to rethink each one of the above 5 points of inefficiencies and examine how informatics could significantly reduce if not eliminate each one of them. Even conflicts could be reduced by making the decision criteria explicit, and by giving the owner the necessary tools to control the process and understand each decision.

However, as a manager, you should also ask what are the incentives for the design professionals to reduce the inefficiencies, and who will take the lead to do so? In the long run, the benefits will pass to the client. In the short run, however, any reduction of inefficiencies will benefit those who take the lead to improve the process.

Restructuring the process

The effective use of informatics in reducing the inefficiencies by improving the coordination of the process and by automating distinct tasks will inevitably lead to restructuring the organization of the process itself. Informatics has brought not only a technological revolution but a revolution in the structure of organizations by making

traditional organizational structures obsolete. The design and building process is a perfect candidate for a new organizational scheme utilizing the power of informatics. The design and building process involves a number of professionals and experts who produce detailed specifications for an one of a kind artifact, to be followed by its realization with physical materials, subject to the laws of physics.

It is inevitable that automation will hurt professions that handle tasks that can be automated. On the other hand, those professions that handle uncertainty will become even more important in the process. Undoubtfully, the client faces the higher uncertainties and its role will be even more central in the future. It is unclear who among the design participants who handle the most uncertainty will benefit most: the architect that deals with subjective decisions during programming and schematic design or the project manager that deals with the uncertainties of the overall process. I believe that the roles and responsibilities of the professions will change so much as a response to a wider use of informatics that this question will become irrelevant in the near future and there is room for empowerment for those who want to take the risks.

Research area

Nevertheless, little progress has been made so far in restructuring the design and building process, which can be easily explained: first there are legal barriers that prohibit the design participants from expanding their activities beyond their territories; and second, this is a mature and conservative industry with too many too small companies where innovation is very limited. However, I believe that this represents a major research area, with its time long overdue.

Reprinted from B.O.S.S. Magazine, number 4, pp. 28-29, April 1997