Conclusions to seminar II: computer aided structural engineering

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Conclusions to Seminar II, Computer-Aided Structural Engineering

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From the inception of computer use in an engineering environment, the expectations about what the computer can do for the engineer have been growing at an ever-increasing pace. As a counterpoint, however, so have been growing - perhaps at an even faster pace - the things that the engineer has been required to do for the computer.

Nevertheless, we have constantly been told that better solutions were just around the corner, that the next-generation hardware, or software, would sweep away what little difficulties were still being encountered, etc.

Nowadays the cry and hue in the engineering milieu is all about CAD, or CAM, or more generally CAE. Many powerful corporations are vying and manoeuvering for elbow space in the field, offering "working stations" of ever more glamorous performances.

The hardware people are telling us that they have squeezed the computing power of a "mainframe" into dedicated miniprocessors which form the heart of "intelligent" working stations, giving the user faster response and avoiding the "information jams" that can result in centralized systems with many "stupid" working stations sharing a common large computer. The software people in turn tell us that, above and beyond the "engineering" programs, they have developped "data-base" techniques allowing all informations and decisions about the different elements of a design to be stored, cross-checked and made consistent at every step.

Taken at their face value, such assertions could convey the impression that tomorrow's engineer - if not exactly today's - will just have to relax in his ergonomically designed armchair and let the machine do all the dirty work: he will have still to attend to some little tasks, like getting the input right and keeping an eye on the output drawings, but otherwise he will discreetly fade away into the background and let the computer steal the show.

If you can get the inside view of people having actually tried to kick a C.A.D. system into day-to-day activity, they will,however, quite often tell you a somewhat different story. A story of toil and sweat - not usually of blood, it is true, but quite often of frustrations, maddening delays and amazing stumbling blocks or dead-end alleys.

Why, one is bound to ask oneself, such a dramatic discrepancy between rosy expectations and hard reality? Where does the truth lay? Why, above all, in spite of recurring waves of disillusionments, still the profession is falling for the pleas of the "informatics" man?

I must confess that I have given a great deal of thought to this riddle, and I feel that there is, in fact, an answer. Maybe it is only a part of the truth, but I am convinced that every engineer worth his salt and bread would concur in it.

This rationalization of the "C.A.E. puzzle" hinges, in a nutshell, on the following considerations:

1) It is perfectly true that EDP can speed up considerably some phases of the engineering process: all those phases involving

lengthy, complex, but well-defined computations. In all these phases not only the human designer cannot compete: it would be very stupid and inefficient not to step back and let the computer go number-crunching happily.

2) It is also perfectly true that not all the phases of the designing process can be formalized (either analytically or logically) so as to be automatized. Engineering, alas, is not an exact science: it is an art. Quite aptly, it could be defined as the art of reaching acceptably "correct" decisions based on insufficient (incomplete) information and taking avail of previous experience. There are, in other words, logical "jumps" in the process of design, which we couldn't , and shouldn't, demand the computerized system to bridge.
It is in these "jumps" that a really good practising engineer shows his mettle.

3) The logical solution seems, therefore, to lie in a symbiosis between the C.A.E. system and the experienced engineer. For this symbiosis to be effective, several conditions have to be met.

3.1) The C.A.E. software and hardware systems should be flexible enough to allow the expert's intervention at every step of the design process, and to incorporate those interventions smoothly into the "automatic" phases of the process and into the "data-base".This "interactive" character is underlined in the articles by McGuire, Anderheggen.

3.2) The system should "prompt" the user to take the meaningful decisions at the appropriate steps (when the machine finds "holes" in the input data, or reaches a stage where non-formalizable decisions have to be taken). This prompting should be made as "user-friendly" as possible, through well-established interactive techniques such as the presentation of menus of options etc.
These features are variously present in the papers by Pfaffinger, Monsarrat, Anderheggen.

3.3) The use of the system should be in the hands of an experienced engineer. A beginner could well use the system to "learn", under the guide of an expert, but should never be let to "design" all by himself an actual project: he will soon run into trouble or produce very doubtful results.

3.4) The system should be "open" for future additions and improvement "without tears" (Monsarrat).

These considerations may look, and sound, rather obvious and anticlimaxing; nevertheless, I think they could be helpful in dispelling many myths about what C.A.E.. systems can do for us, as well as many disillusionments and heartburns about what we engineers are currently required to do for C.A.E. systems. The latter, for sure, are here to stay; maybe in the future the technique of the so-called "expert systems" will further ease the burden that the human partner of the system will have to carry; but that there will always be a burden to carry is a fact of life and the profession had better face it. It is, and will be, a burden of responsibility, intuition, experience and faith. We should be prepared to carry it with pride.