

New Buildings

The Effective Use of Computers in Engineering Design

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“Old ideas can sometimes use new buildings. New ideas must use old buildings.”

– Jane Jacobs

“Computers have changed the landscape of tools and capabilities available to engineers, yet they have also allowed many old ideas to be preserved without rethinking basic principles fully.”

– John Voeller

“What is needed at present is a clearer, more definite, more flexible restatement and correlation of fundamental procedures”

– Hardy Cross

Enter the Computer

Computers are both new buildings and new ideas. As buildings, they require significant capital investment; as ideas, they make new analyses and design procedures possible.

At first, computers were adopted as buildings. A new investment was made, but no fundamental change in design occurred. This is normal.

Now, they have aged: the initial investment has been paid off and they are no longer strange and unfamiliar machines. Design procedures can begin to take advantage of the computer's native ideas and concepts.

The way forward is to identify the fundamentals of good design and the new concepts that are now available. We can then take advantage of the computer's potential by restating the fundamentals in terms of the new ideas.

Fundamentals of Good Design

A good design process is marked by the engineer's *Strong Background Knowledge*, “a basic understanding of engineering principles and system behavior.” and their decisions of *Relevance & Focus*. “Focus is essential to problem solving”. (Robert Englekirk)

Transparency is also important. “Judicious engineers decline to use theoretical formulas whose derivation they have no time to unravel.” Finally, a *Simple, Flexible Analysis*: “Simplicity is more important than speed,” and “the method of analysis shall be flexible.” (Hardy Cross)

New Ideas

Abstraction: Computer Science can be considered the formal study of abstraction. Information is abstracted into data structures and procedures are abstracted into algorithms. Thinking in term of abstractions will lead to simple, flexible and transparent software.

Model–View–Controller: Explicit separation of information from representation. *Model*, relevant data, stored as raw data; *View*, a format that displays the data; and *Controller*, logic that updates the model

Evaluating Design Tools

Since few designers write their own software, evaluating existing tools is an important task. This checklist will help to think through the various aspects of a good design process. It is by no means complete, but will hopefully be thought-provoking and helpful.

Background Knowledge

- is the tool more useful to senior or junior engineers?
- does it help build your structural sense?
- does it allow a review of the design process once it is over? is this a simple task?
- can you 'eyeball' the results to check the tool's output?

Focus & Relevance

- how much time is spent learning how to use the tool?
- what proportion of time is spent interacting with the tool, versus advancing the design?
- is a final design produced more quickly?
- is the final design improved?
- does the tool give you greater or lesser confidence in the final design?
- what information is absolutely required? is this information relevant?
- does it hide and show different information for different people?
- what information is emphasised?
- what key abstractions are used?
- how is the information organised?
- does it required you to change the way you organise your thoughts?

Transparency

- do you have any idea what the tool actually does?
- are assumptions listed?
- are assumptions presented clearly with analysis results?
- can the design data be accessed without the tool?
- can you check the analysis visually?
- can someone unfamiliar this tool check a design quickly?
- is useful information buried in a flood of data?

Flexibility & Simplicity

- can uncertainty be considered?
- how much information is required for the tool to work?
- how much definite data does it take to set up a model?
- can you change what the tool shows you?
- can you create a new presentation of the tool's output?
- does it increase the maximum complexity of systems that can be considered?
- does your design process need to be changed to accommodate the tool?