

# Research in Engineering Design

SPECIAL ISSUE ON DESIGN REPRESENTATION

Chuck Eastman, Michael McCracken, Wendy Newstetter

The theme of this special issue is the role representations, external and internal, play in engineering design. Of particular interest is the role of representations in design education, and their centrality or peripheralness in learning. A variety of formal external representations are conventionally used in engineering design, such as mathematical representations for analysis, functional block diagrams for systems description, spatial representations for product design. External representations are an intrinsic part of the engineering knowledge domain. Also important, however, are external representations that may be characterized as informal and intuitive. Engineers often rely on so-called back of the envelope calculations to frame problems and cue possible solutions. These are also used in conversations to convey concepts outside of the formal representations of the field. Such representations are used to depict concepts and to communicate with other people those concepts. They are also used to carry out internal design dialogues with oneself, generate a representation of some concept, then test it or refine it in some way.

As educators we teach formal external representations as a part of a design curriculum. In thermodynamics we teach the equations used to solve energy balance problems. In electrical engineering, we teach the formal representations of signals and systems. From a cognitive science standpoint we don't know how those educational practices support or don't support a student's ability to internalize the information carried in these representations. Another concern is when and how students learn to chain or link different representations in tackling design problems. Planning at a meta-cognitive level is suggested by the linkage between these four attributes, formal and informal, external and internal and the facility of moving between them.

While most engineering curricula make various assumptions about the issues above, very little seems to be actually known about the questions raised. We are interested in studies, more detailed hypotheses, and surveys of other fields that can cast insight into the issues that we have outlined.

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Send papers to

Dr. Chuck Eastman

College of Architecture

Georgia Institute of technology

Atlanta, GA. 30332-0155

chuck.eastman@arch.gatech.edu