

Design Cognition

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Design is an inherently human undertaking, modifying the natural environment for human ends. It is core component to all value added activity taking raw materials into a finished product. A central component of most designs are human users or participants. Thus the issues of design are open-ended and partially culturally defined.

While most of the work in a science of design addresses the properties and structure of the artifacts being designed, or the designer's tools, it is also very important to study the *human designer*. External representations, optimizations and simulations of a design are needed because of human limitations in mental ability to carry large amounts of complex information. Cognitive psychology and cognitive science (slightly different foci on similar issues) both have reported many studies dealing with the ways that creative human designers work. We now understand that design cognition has at least the following components:

Structuring the design task: what are the objectives, external constraints, side effects, lifetime impacts and other issues that go into the design? Some of these issues are technical and can be well-defined. Others relate to users and cultural values. Why is a MacIntosh different from a Dell PC? Why is a Camry better than a Taurus? Designers are successful because they are able to reliably answer such questions.

Human control of and interaction with design tools: all design tools are truly tools – they enhance human activity. How can we study the relation between human users and their tools? One aspect is the sharing of *representations*. Computers provide new ways of depicting design information: the physical form of the design, the design's behavior as matched against its needed performance, the design's construction: manufacturing, assembly, maintenance. How do people reason and mentally represent design form and behavior? How do designers reason about the interaction between its form and its behavior? How do creative

designers use computer-based tools to enhance their ability to develop unique designs?

Design collaboration: since design is undertaken in large teams, and because the results of these team efforts are so varied, it is apparent that the structure, coordination and communication, and the management of design teams and is an important determinant of their overall capability. Can design capabilities of a team be enhanced or diminished by how the team is structured? I'm sure we all think so, but there is no science to help us know or verify why.

Design cognition spans two research areas. One is to improve the objective measurement and definition of what is an innovative and creative design. What are the properties that distinguish a good from a great car, computer, or camera? The second is to develop methods of study of such creative design behavior. Because of the span of design activity, often taking several years, by scores of people, design cognition spans the second-by-second level mental processes of individuals, to how individual use cues in their surroundings to identify issues in the design they are dealing with, to how designers represent a design for sharing and collaboration, to how design teams are organized and communicate. It is as broad and deep as economics. Design cognition uses the empirical tools of cognitive science to relate outstanding design to its mental, organizational and cultural enablements. The human designer is a central aspect of any design system. Designers must be an important aspect of any science of design

Chuck Eastman is an architect and computer scientist, with appointments in both colleges at GA Tech (and earlier at Carnegie-Mellon University). He did the earliest cognitive science studies of design behavior under the Carnegie-Mellon ARPA contract in 1969. He has examined both design work in creative areas, i.e. architecture, and also in more technical areas, such as management of design.

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