

A View of Design Research

The National Science Foundation (NSF) is an independent federal agency created by the US Congress in 1950 “to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense” NSF is the primary source of non- defense engineering research support for America’s colleges and universities, including design research and education. Financial support influences directly and indirectly the areas of inquiry we pursue and their positioning in our market-based cultures. Dr. Judy Vance, a Professor of Mechanical Engineering at Iowa State University and a recognized authority on virtual reality in design, is currently serving as the NSF program director for Engineering Design. Judy is also the Chair of the Design Engineering Division of ASME. I am pleased that she has agreed to share some of her experiences and vision, and thus offer us some food for thought.

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Guest Editor



Judy Vance

When I tell my academic colleagues and friends that I am the NSF Program Director for Engineering Design I am often met with a quizzical stare. “What exactly is research in engineering design” is the question that follows. It seems that many academics have a clear understanding of what constitutes research in materials, manufacturing, mechanics, combustion, controls, or dynamical systems, but they do not understand what could possibly constitute research in engineering design.

After attending a recent NSF workshop, I believe I have come to an understanding of the problem. Let me address two related issues that form the basis of the confusion: the word “design” means different things to different people, and design is thought to be the defining aspect of all engineering that separates this field from the more traditional scientific disciplines.

I can frame the first observation in the context of the story of the blind men and the elephant where each person perceives the topic through his/her own particular lens. Some have a view of design that only encompasses conceptual design, others view design as the “design process”. To further complicate the matter, the

focus of any design activity can be a wide variety of things, such as a product, building, infrastructure, network, system, each of which carries its own lexicon of design. When discussing conceptual design, some of my colleagues believe that successful conceptual design relies primarily on the ability of an individual to be creative. There is a perception that engineers do not possess this skill, and that it is innate and can not be taught; so research here is meaningless. Others believe that design relates only to the “design process” which is already so well defined that surely there is no more research that can be performed to provide new insights. The second observation results in further devaluing the field of engineering design. The “all engineers are involved in design” attitude implies that engineering design researchers do not possess any unique knowledge. A discipline or research area is formed around unique fields of knowledge, therefore engineering design is not a valued research area.

The effect of these two key observations is that we do not speak the same language (whether within our discipline or across disciplines) in a field that is highly dependent on interdisciplinary research, and many of our colleagues believe we all “do” design so no unique research area exists.

Strong evidence to support the existence of a defined area of engineering design research is the long history of the Engineering Design Program at NSF. The NSF Design Theory and Methodology Program started in 1984, through the leadership of Dr. Nam Suh. I am honored to serve as the sixth program director, following in the footsteps of Drs. Susan Finger, Jack Dixon, Stan Settles, George Hazelrigg, and Delcie Durham. Major direction-setting workshops were held in 1987, 1988, 1996, and 2004. Looking back on the 1988 conference proceedings, I am struck with the similarities to current directions of the program. Dr. Suh’s goal was to establish engineering design as a field of engineering research and to support research on a science of engineering design. Today, the Engineering Design program at NSF supports research based on a holistic view of design which considers the total system, life-cycle context of design and recognizes the need for advanced understanding of the identification and definition of preferences, analysis of alternatives, effective accommodation of uncertainty in decision-making, and the relationship between data and knowledge in a digitally-supported process. The program supports research on the complex interface between computational capacity and human wants and experiences. The role of information technologies, automation and visualization, learning technologies and systems are areas of increasing activity in the program. Our research field is inherently interdisciplinary. As related fields of research realize advances, these results serve to influence research in engineering design. I have witnessed advances in our understanding of cognitive processes influence our ability to understand and model human behavior related to product preferences, system design, decision making and team-based design. Advances in computational capabilities have influenced research in optimization, geometric modeling and visualization to support design.

The ASME Journal of Mechanical Design has a key role to play

in this effort. The Journal provides the community with a respected mechanism to publish peer-reviewed scholarly papers. With the emergence of graduate programs in Engineering Design, the strength of the ASME Journal of Mechanical Design and the continued support of engineering design research through the NSF Engineering Design program, I believe we have come a long way toward achieving Dr. Nam Suh's vision of establishing engineering design as a distinct research field. As engineering design re-

searchers, we know who we are, what we do, and what our value is to the research community. Our ongoing goal is to continue to grow our field and expand its contributions to the wider community through scholarly research.

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