

## Design Analysis and Synthesis

What is design? Why is design “special?” And, is it really?

Many of us have often heard these questions, pondered, and participated in the ensuing arguments. When bringing up these questions and promising to answer them, I have occasionally and somewhat cheekily put forth the position that “design is a state of mind.” In a very real sense, design is the expression, the instantiation, of everything humans create. If you care about creating things, you care about design. It is not an accident that “design,” as a word, is both a noun and a verb, and has no real translations in many languages; for example, “construction” in German or “plan” in Greek is just not the same.

Engineers have been designing things from the start. Some will argue that design (plus manufacturing) is just plain, old engineering. However, the advent of science has changed things. As the complexity of the things we create increased, we have increasingly relied on science to help us predict the behavior of our creations should they be built. Our predictive ability for the behavior of not-yet-built designs is now indispensable in engineering, going by names such as simulation or virtual prototyping. I prefer to call it simply *design analysis*. If a design exists, I can analyze its behavior. Based on the results of the analysis, I may have to modify the design to make it fit better to my purpose. The implication of analysis being an integral part of design in engineering has led many engineers to insist on the distinction of naming our calling *engineering* design, lest it be confused with, say, fashion design.

Yet, analysis presumes the design to be analyzed exists. Someone created it. This creative part of design we usually refer to as *design synthesis*. Synthesis need not be only the glorious moment of invention, the rare events washing out of our brainstorms. Synthesis can be also systematic ways for coming up with design ideas, modifying designs, generating alternatives, and choosing among them, often using analysis.

This somewhat philosophical, and perhaps obvious, discourse

has some very practical and specific implications for the *Journal of Mechanical Design*. What should its contents be? If design is almost the same as engineering, then everything fits in the journal and we have no focus. My approach to maintaining focus in JMD is to look for research work that presents or supports design synthesis in a clear, evident manner. Design analysis research has its place in JMD, but it should be analysis with a clearly articulated design purpose. It should help us design things better.

A case in point is with the newly established sister publication, the *ASME Transactions Journal of Mechanisms and Robotics* (JMR), which will start appearing later this year under the editorship of Michael McCarthy. Michael and I have discussed at length how to serve our community best with our journals. We have agreed that research work in mechanisms and robotics aimed at design synthesis would belong to JMD, while theoretical analysis work would fit better in JMR. Thus, we will be re-routing submissions using this main criterion.

Obviously, such distinctions are not always clear. Occasionally, a discussion with the editors, the associate editors, and the authors will be required. My goal is to maintain the high quality we have come to enjoy in JMD articles, while also making JMD the premier venue for mechanical design research—with the broad definition of “mechanical” that I discussed in my February 2008 editorial and “design” as I discussed it here.

Design is special. You cannot do design without thinking about humans. Humans create; and humans in the end will use or will have to live with your design, if it is any good—but also if it is not, which is why design analysis is necessary.

**Panos Y. Papalambros**

March 2008