

## Sustainable Design?

The Brundtland Commission defined sustainable development as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Since it is not possible to prove that the welfare of a future generation is being compromised and future generations are not sitting at the design table, the issue is easy enough to ignore. But as a community of designers serving humanity, we know better. Perhaps we have been ignoring it not as individuals but as a community for too long.

This special issue of *Journal of Mechanical Design* captures some current efforts in our community to address the challenges of sustainable design. Rather than trying to define whether a specific design is sustainable or not, we seek to catalyze the discussion by suggesting that sustainable design is achieved when economically viable designs are created that significantly reduce important environmental and societal concerns relative to other available options. In short, we solve the environmental, health, and wealth problems of society today without creating bigger problems for tomorrow: all within the constraints of markets and regulations. No small task!

Accordingly, the papers in this special issue fall into three broad categories: (1) design of a *thing* to move society toward sustainability, where the thing can be a gizmo, production process, service, policy, or infrastructure system, (2) development of a design process to increase the likelihood of producing a thing that moves society toward sustainability, and (3) evaluation of the sustainability of other things. All three categories are dependent on still evolving sustainability metrics, which collectively serve as a compass to identify when society is moving toward sustainability. Despite the imperfections of existing metrics, certain directions on the compass are obvious: reduce energy consumption and greenhouse gas emissions, minimize water and air pollution, conserve material and energy resources, avoid toxics at all costs, and do not simply export environmental problems to another part of the planet. As designers, it is our passion and core function to understand and resolve the trade-offs that arise within these categories and between these categories and economic and societal welfare.

In the following paragraphs, we elaborate on the broad categories of papers in the special issue followed by a summary of the papers.

1. *Gizmolgy or designing things for sustainability*: Woe be the Manager, Dean, or Department Head that thinks the thoughts of the first U.S. Patent Commissioner that everything of importance to be invented has already been invented. Too often, design groups have been downsized by legume summatting life forms who think design has no intellectual content and can simply be purchased as a commodity! May the grand rule of design and reciprocity strike and outsource their simplistic managerial functions too! Accordingly, in this issue, we seek to show that the creative process catalyzed by sound engineering science and fired by practical knowledge can lead to the creation of new gizmos that yield forehead slapping moments (FSMs) with exclamations of

“that’s so simple, I should have thought of that,” or just as good “that’s neat but I see how I can make it even better.” Indeed, good managers and designers must work together as a team because the world needs renewable energy machines. But given the apparent low cost of coal, the team will have to work smarter, harder, and more creatively if we are going to help save our planet from ourselves.

2. *Developing capacity for better decision making in design*: If every designer and engineer has to be a sustainable designer, it would entail that design is not only taught with a sustainability framework embedded in it but also that innovative designs that can satisfy functions for the consumer are also sustainable. For example, new incentive driven environments may encourage product take-back while generating consumer interest through multigeneration product portfolio designs. The early design decisions have to be made not only based on structure, material, and manufacturing choices but also on transportation, distribution, and the product’s entire life cycle. Developing strategies for the life cycle requires change from several perspectives. Consumer awareness has to increase and demand for such products rise, the regulatory environments and policies that support sustainability have to change, and finally good models and data that are life cycle aware have to drive decision making. We need a greater understanding of these problems before we can develop tools to support appropriate decision making.
3. *Evaluating sustainable designs*: Who deems a design “sustainable”? Is a design sustainable if it looks or feels “green”? If it makes us feel like we are giving something up for the planet or future generations? If it looks good on a life cycle assessment comparison table? *If it passes a paper review process?* As we move into sustainable design, we must not presume to know more than we do about the needs of the future. We must also challenge dogma. Suppose that we find a technology that increases carbon footprint but reduces incidences of cancer and protects water supplies. Who decides? We must recognize that while global warming is *the* challenge of the 21st century, it is not the *only* challenge. If that technology increases carbon footprint negligibly compared with other actions we could take inexpensively, while the technology prevents a significant contributor to illness and water ecosystem damage, then, we must be courageous enough to make the right decision, even if the carbon accountants disagree. There is an aspect of community involved in these decisions such that they cannot be undertaken by the single designer working alone. Finally, we must recognize that sustainability has a core market component. We have would-be sustainable designs all over the place: from rethought transportation systems to next generation energy systems. But why don’t we deploy these systems? Sustainable design must address attributes of things that resonate with humans. Our design community has the DNA to seek and deliver sustainable solutions that are craved by society; we must express this core value more often.

The special issue papers in designing things for sustainability include design of an energy harvesting device, design of a piston free expander for energy sustainability applications, a solar collector design, practical methods for addressing telecommunications product LCA, and complex design applied to a city of the future. Papers that span *sustainable design decision making* and *evaluation of sustainability* include a comprehensive review of sustainability design methods, methodology for quantifying perception based attributes using vehicle silhouettes as a case study, development of a sustainable design repository, strategies for resolving sustainability trade-offs, checklist based methods for sustainable design, long range planning in product design for optimal take-back times, lifecycle design of plug-in electric vehicles, and sustainable material selection in design and manufacturing.

It is clear that the broad interdisciplinary challenge of sustainable design transcends scientific questions and ultimately relates to societal values in a globalizing world, intergovernmental, economic and policy questions, and, last but not least, “designed”

products and services that we consume. Despite this breadth, it is imperative that we develop organizational capabilities to design and define these challenges, translating them to funded programs for research that can have impact. We believe the organizational capabilities in federal funding agencies that have encourage specialization to overcome the challenges of developing and funding interdisciplinary research, especially in areas pertaining to the sustainable design and evaluation of new things.

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