

The Fundamental Challenge of Product Design

Steven Eppinger

Product design practice is an evolving art form. We have made tremendous improvement in methods for and execution of the process in recent years. Yet the challenge of environmental sustainability of products is one area where design practice remains largely in the dark ages. This essay argues that we need to embrace the imperative of design for environment and must evolve design practices to address this challenge.

The practice of product design and development has evolved in recent years to utilize new technology and to apply new practices to create new products better and faster than ever. I see this evolution as an ongoing process. More importantly, I believe that we—as researchers, practitioners, and managers—can influence this ongoing evolution. Before I suggest one critical direction for greater emphasis, it may be useful to consider some of the most striking elements of the recent evolution in product design practice:

- Development speed—We are learning that many design processes are in fact procedural and amenable to lean principles and continuous improvement, yielding much faster product development cycle times.
- Digital processes—We are adopting new digital design, analysis, and collaboration tools to create better products with less time and effort.
- Platform flexibility—We are using modular product architectures to provide more product variety to customers, with less development effort and lower manufacturing cost.
- Complexity management—We are better able to engineer complex systems through careful system architecting, subsystem decomposition, and analysis of interaction networks.
- Outsourcing and offshoring—We can take advantage of supplier skills and capacity, international operations, and new global markets.
- Customer involvement—We are using the Internet to bring customers' ideas into the product development process much more quickly and easily than ever before.

- Innovation networks—We are using the Internet to create systems that connect both internal and external resources in ways that can create more ideas to address more opportunities than ever possible before.
- Sustainability—We are learning how to reduce the environmental impact of the industrial world in order to protect and sustain the natural world.

Taking stock of these trends, it should be clear that the field of product design has evolved in a remarkable way. However, faster development, better technology, and new products may not be addressing some of the world's greatest challenges. We all know the list and we probably each have our own particular concerns among them: global health, poverty, hunger, clean water, sanitation, global warming, renewable energy, environmental destruction, biodiversity, population control, genocide, political instability, religious conflict, nuclear threats, terrorism, etc.

I would like to call attention to one fundamental challenge where new product design methods and practices can play a pivotal role: environmental sustainability. This is not a new problem; it is the legacy of our industrialized society. This is not a small problem; it is a large and growing concern. This is not the government's problem, or any one industry's problem, or the consumer's problem; it is all of these. Most importantly, we must bring to bear all of the tools and methods we have used to develop great products, all the technology and creativity we know and love, and apply these to redesigning our own processes.

I have been observing how the practice of design for environment has evolved over the past 15 years. There are plentiful examples of marginally improved products with lower environmental impact on perhaps one or two dimensions. It is very difficult to know if these products are truly better for the world. There are many advocates of a product design approach based

Address correspondence to: Steven Eppinger, Massachusetts Institute of Technology, Sloan School of Management, MIT Room E62-468, Cambridge, MA 02139. E-mail: eppinger@mit.edu. Tel: (617) 253-0468.

on life-cycle assessment tools. These seem to be helpful in many types of product redesign to guide better design decisions. There are also advocates of environmental guidelines for product design to remind designers about a long list of considerations such as recycling, packaging, hazardous substances, disassembly, and so forth.

However, the challenge of sustainability is to protect our environment forever, and this requires us to find ways not merely to reduce the negative impact of our products but instead to eliminate the environmental impacts. The challenge of product design for environmental sustainability has been termed “cradle-to-cradle design” by McDonough and Braungart (2002). I believe this fundamental challenge can be succinctly described as a materials problem, with four dimensions:

- Designing products and processes with industrial materials that can be recycled continually with no loss in performance, thereby creating new industrial materials.
- Designing products and processes with natural materials that can be fully returned to the earth’s natural cycles, thereby creating new natural materials.

- Designing products and processes that do not produce unnatural, toxic materials that cannot be safely processed by either natural or industrial cycles.
- Designing products and processes with renewable sources of energy, rather than using our limited supply of fossil fuels.

With increased focus of product design for environmental sustainability, we can begin to transform our products, our industrial processes, and our lives in the right direction. This change is critical if we are to reverse the current trend of environmental destruction. It will begin slowly at first. But as designers, businesses, and consumers begin to understand the importance of this change, it will accelerate. Certainly it will take a long time to reach an acceptable level of sustainability.

I believe that we must take these steps. This will require much more research and development of new materials, new product design methods, and new industrial practices. I hope that many of us will work in this area and that we will share best practices as they emerge.

Reference

McDonough, W., and M. Braungart. 2002. *Cradle to cradle: Remaking the way we make things*. New York: North Point Press.

BIOGRAPHICAL SKETCH

Steven D. Eppinger is Professor of Management Science and Innovation at the Massachusetts Institute of Technology Sloan School of Management. He also holds the General Motors Leaders for Global Operations Chair and has a joint appointment in MIT’s Engineering Systems Division. Prof. Eppinger is the Co-Director of MIT’s System Design and Management Program. His teaching and research is in the area of product development methods and management of complex engineering projects.