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Karl Ulrich
University of Pennsylvania

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Design is Everything?

Abstract

This essay attempts to demarcate the industrial practice of product design and situate it in the context of academic research. The term product design presents definitional challenges, as it is used in practice in different ways, and even varies in usage regionally. For this article, product design is “conceiving and giving form to goods and services that address needs.” The activity of product design can be thought of as comprising several key decisions. Because the decisions of product design do not map cleanly to any one academic discipline, the subject has not garnered enough attention in any one field to develop fully its own academic identity. Scholarly research in product design has often been cultivated by the emergence of a methodological paradigm. While several such paradigms are in use, several others offer substantial promise.

Keywords

design, product design, design research, industrial design, product development, marketing

Disciplines

Management Sciences and Quantitative Methods | Marketing

DESIGN IS EVERYTHING?

Karl T. Ulrich
The Wharton School

May 2010

Abstract

This essay attempts to demarcate the industrial practice of product design and situate it in the context of academic research. The term *product design* presents definitional challenges, as it is used in practice in different ways, and even varies in usage regionally. For this article, product design is “conceiving and giving form to goods and services that address needs.” The activity of product design can be thought of as comprising several key decisions. Because the decisions of product design do not map cleanly to any one academic discipline, the subject has not garnered enough attention in any one field to develop fully its own academic identity. Scholarly research in product design has often been cultivated by the emergence of a methodological paradigm. While several such paradigms are in use, several others offer substantial promise.

Keywords: design, product design, design research, industrial design, product development, marketing

Biographical Sketch

Karl T. Ulrich is the CIBC Professor of Entrepreneurship and e-Commerce (Wharton School) and Professor of Mechanical Engineering at the University of Pennsylvania. He is a co-author of *Product Design and Development*, a textbook used by over 250,000 students worldwide. One of his product designs, the Xootr scooter, was named by *BusinessWeek* as one of the “50 coolest products of the 21st Century.” He received bachelors, masters, and doctoral degrees from MIT.

The marketing consultant Regis McKenna wrote a famous article in *Harvard Business Review* entitled “Marketing is Everything” (1991). I know several product designers whose blood boiled in response to this title. A common refrain among these professionals is that indeed *design* is everything. Design has popped onto the radar of the business media and emerged as an area of interest to researchers in several fields, including management and engineering. Yet the conceptual boundaries around product design are muddy. This essay attempts to demarcate the industrial practice of product design and situate it in the context of academic research.

Academics have a compulsion to define, and the subject of design seems especially compelling to those who love taxonomies. I can’t resist joining in. The word *design* comes to English via French from the Latin root *signum* and means literally to mark out (OED 1989). The term *product design* presents definitional challenges as it is used in practice in different ways, and even varies in usage regionally. For example, in Silicon Valley *product design* is often used as a term of art referring to the nuts-and-bolts activity of turning elegant forms created by *industrial designers* into production-ready plans. On the East Coast of the U.S. *product design* is used more synonymously with industrial design. In academic research, more important than any particular definition is clarity in expressing what assumptions and definition guide a particular line of inquiry. Here I use this definition:

*Product design is conceiving and giving form to goods and services that address needs*¹.

This definition is of product design as an *activity*. I adopt an information processing view of design in general, largely consistent with that articulated by Herbert Simon in the 1960s (Simon 1996). From this perspective, design is part of a human problem solving activity beginning with a perception of a *gap* in a user experience, leading to a *plan* for a new artifact, and resulting in the *production* of that artifact (Figure 1)². In this definition I intend *artifact* to refer to any result of intentional creation, including physical goods, software, and services. This problem solving process includes both design and production of the artifact. Design transforms a gap into a plan. Production transforms a plan into an artifact.

¹ This definition draws on those proposed by at least two others. Edgar Kaufmann, Jr. (curator of the industrial design department at MOMA, 1946-1948) wrote “design is conceiving and giving form to objects used in everyday life.” Klaus Krippendorf and Reinhart Butter (1984) wrote “Design is the conscious creation of forms to serve human needs.”

² Terwiesch (2007) provides a comprehensive discussion of product development as problem solving, and those ideas apply quite well to the more narrow activity of product design.

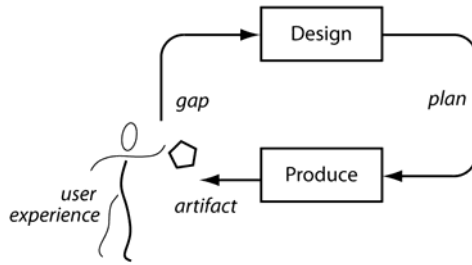


Figure 1. Design and production are the two activities that deliver artifacts to address gaps in the user experience.

This conceptual model is of design at the broadest level, and includes, for instance, architectural design, graphic design, and lighting design. My focus here is *product* design. I believe that we usually intend *product* to mean an artifact that will be supplied repeatedly. Creating an artifact that will be produced in some quantity distinguishes product design from say architectural design, although clearly design domains overlap somewhat.

Elements of Product Design

To further sharpen the concept of product design and its relation to other activities of the enterprise, consider the actual decisions involved in creating the plan for an artifact that will be produced more than once³. For concreteness, I articulate these decisions in the context of the *Ducati Monster*, a highly successful motorcycle launched in 1993, which led to many subsequent models and to the popular “naked bike” category of motorcycle. I use the Ducati Monster as an example because it embodies a fusion of many different design challenges including those related to aesthetics, technology, and cultural meaning. Thus, the design of the Monster comprises a superset of the elements of design for most other products.

³ A review article I co-authored with Vish Krishnan (Krishnan and Ulrich 2001) argues that rather than view product development from the perspective of either academic disciplines or of professions, we would benefit from focusing on what *decisions* must be made, and then consider what information, perspectives and tools are most relevant to those decisions.



Figure 1: The Ducati Monster motorcycle, a highly successful artifact introduced in 1993. (Source: Ducati Motor Holding S.p.A.)

Product design typically begins with a focal group of customers, which in the language of marketing is called the *market segment* (Ulrich and Eppinger 2011). Given a market segment, Table 1 lists decisions that must be made by intention or default in designing a product. Certainly many issues in product design have not been made explicit here, including for example, issues of aesthetics, meaning, cost, sustainability, and usability. However, these issues can be thought of as specific design *criteria*— performance objectives in the context of the decisions articulated here. Design criteria like these may arise from user needs or from the objectives of the producer.

Table 1: The elements of product design.

| Decision | Example for <i>Ducati Monster</i> |
|--|--|
| What are the user needs? | “The motorcycle sounds powerful” etc. |
| What is the core product concept? | A <i>naked bike</i> as a raw counterpoint to the faired sport bikes in the market. Designer Miguel Galluzzi: “All you need is a saddle, tank, engine, two wheels, and handlebars.” |
| What are the target values of the product attributes? | 0-100 km/hr acceleration time <4.0 seconds, etc. |
| What will be the overall physical form and appearance of the product? | ...usually the form is initially represented with a sketch and eventually is represented by a three-dimensional computer model. |
| What is the product architecture? | Welded tubular frame; Ducati L-Twin engine/transmission hung from frame at four points; chain drive; rear swing-arm suspended from transmission casing; etc. |
| What variants of the product will be offered? | M900 initial model, to be followed by M400, M600, and M750 (differing primarily in engine displacement). |
| Which components will be shared across which variants of the product? | Most components except engine shared across all models. Different engines also share many components. |
| Which components will be designed and which will be selected? | Frame, seat, gas tank, fenders, wheels are unique designs; L-twin engine is an existing Ducati design; brake calipers, tires, etc. are catalog items from suppliers. |
| What are the values of the key design parameters? | 904cc engine displacement; 1440mm wheelbase; 14 liter fuel capacity; etc. |
| What is the detailed design of the components, including material and process selection? | ...usually the detailed design of components is represented with three-dimensional computer models plus annotations for materials, finishes and other attributes. |

What isn't product design?

Given the decisions in Table 1, what then is *not* product design? Is design everything?

Many of the decisions in product development are clearly not design decisions. Just as *marketing* is not everything, *product design* is not everything either. Many of the decisions of product development are contextual and boundary-spanning, forming the backdrop against which product design is performed. Other decisions are ancillary to product design, but central to the

commercialization of a new product. For example, here is a list of some decisions that are connected to product design, but that most observers would not include as part of that activity.

- How can the universe of potential users of a product be divided into segments?
- What channel will be used to deliver products to customers?
- What will be the name of the product and under which brand will it be sold?
- What products will be bundled together in a single offer to customers?
- What will be the price of the product?
- How can the benefits of the product be best communicated to customers?
- What warranty will be offered to customers? How will product service be provided?
- What will be the portfolio of products offered across all segments?
- How much will it cost to bring the product to market and what is the expected return for the associated investment?
- What will be the technology platforms on which future products are based?
- What intellectual property associated with the product is most important and how can it be safeguarded?
- How will individuals be organized and managed to develop the product?

Collectively, these decisions have probably garnered substantially more attention from researchers than have the decisions of product design. Every one of these decisions benefits from the perspectives of multiple functions of the firm, but they more naturally fall into areas of traditional functional responsibility (and therefore perhaps have received more attention from scholars). For example, leadership in making the first six decisions is usually provided by the marketing function, and a great deal of research in marketing tackles these decisions.

Academic Research in Product Design

Product design is and has been studied in several academic communities. Indeed, while perhaps inadequate, there has been some academic research on each of the decisions in Table 1⁴. The profession and academic community most focused on product design is called *Industrial Design*

in much of the world. Industrial design is centrally concerned with the form, aesthetics, symbolic meaning, and user experience associated with products. For product domains that involve little technology (e.g., housewares), the industrial designer often is responsible for much of the entire product design activity⁵. In more technology-driven enterprises, the industrial designer is usually a member of a team that includes engineering designers, manufacturing engineers, software developers, and other professionals with specific technical skills (Coates 2002).

Industrial design is largely taught in a studio model adapted from fine arts and architecture. Relative to engineering design, little theory and few methods are widely accepted and taught in industrial design. Few faculty are *researchers* in the sense used in the academic communities of engineering or business. Indeed the industrial design community uses the term *research* to refer to the process of understanding user needs, a notion very different from that used in most universities. So, while the industrial design community has been very effective in educating professionals, and its instructors are usually highly connected to practice, the academic field of industrial design is not driven by scholarly research in the way that are management, engineering, or really most other fields in the sciences or humanities. So while in some ways the academic community of industrial design would be a natural home for scholarly research in product design, in other ways the community is simply not concerned with that pursuit.

Because the decisions of product design do not map cleanly to any one academic discipline, the subject has not garnered enough attention in any one place to develop its own academic identity. Some research in product design appears in organizational units of communications and psychology. Some shows up in engineering schools and in business schools. This is not necessarily a bad thing. Academic communities tend to coalesce around methodological disciplines. Those communities are useful in developing and refining methods and in ensuring rigor. It may be that academic research on product design is best pursued by scholars residing principally within traditional academic units who then engage with each other via social institutions like research centers, conferences, interest groups, and journals.

An empirical regularity in scholarly research on product design is that a new paradigm often spawns a cluster of valuable projects by different scholars. When one or a few scholars identify a

⁴ Much of the academic research on these decisions is cited in the review article I wrote with Vish Krishnan (Krishnan and Ulrich 2001), and in the review article by Luchs and Swan (2010).

new way to think about a product design problem or to represent it, then other scholars identify a large number of questions that may be explored with that approach.

Here are some of the major paradigms that guide current research in product design.

Consumer utility comes from microeconomics and in the field of marketing is often represented by multi-attribute utility models. This paradigm led to important methods, such as conjoint analysis, for addressing product design decisions related to specifying the key performance characteristics of products (Eliashberg and Lilien 1993).

The *Design Structure Matrix* articulated by Stewart (1981) resulted in an impressive body of research related to the interdependencies of tasks and decisions in product design (e.g., Eppinger et al. 1993).

The paradigm of *product architecture* (Ulrich and Tung 1991, Ulrich 1995) is the basis for a substantial body of research and methods related to product platforms, variety, and product development management (e.g., Baldwin and Clark 2000).

Statistical models have been applied productively to the challenge of generating and testing product concepts (e.g., Dahan and Mendelson 2001, Girotra et al. 2010).

Mathematical optimization is a prominent paradigm in schools of engineering and business for tackling parametric design problems (e.g., Papalambros and Wilde 2000).

Most of these paradigms are rooted in mathematics, which gives them academic credibility, and which may have resulted in research investments disproportionate to the importance of the product design decisions addressed.

Promising Paradigms Not Yet Fully Applied to Product Design

Several other research paradigms offer promise in product design research. They inform key issues closely related to product design, yet have not yet been fully applied to this domain. Here are some examples.

- *Social networks*, in which individuals are nodes and relationships are links, have been used to study organizational dynamics, technological evolution, and scientific discovery

⁵ The three-volume set Phaidon Design Classics (2006) displays about 1000 wonderful examples of such artifacts.

(e.g., Rosenkopf and Tushman 1993). However, there has been little application of this approach to the study of product design. A social networking perspective might inform the gathering, analysis, and interpreting of user needs.

- The concepts of *contracting and incentives* from economics have been applied extensively in management research related to the organization of the firm and to supply chain coordination (e.g., Cachon 2003). However these ideas have not yet been widely applied to problems in product design. This paradigm is relevant when multiple parties have conflicting incentives. Since product design typically requires coordination of suppliers, and of multiple agents contributing to a single product design, this paradigm is likely to prove useful.
- *Evolutionary aesthetics* is an emerging topic within the framework of evolutionary psychology, offering a biological basis for some aspects of aesthetic preferences (Volland and Grammer 2003). This line of inquiry is promising in better understanding aesthetic responses to products (Ulrich 2010), which might lead to better decisions around product form and aesthetics.
- The *psychology* of human perception has been explored for brand names (e.g., Yorkston and Menon 2004), and there is just beginning to be some research in the psychology of packaging design (e.g., Deng and Kahn 2010). The discipline of psychology, probably more accurately described as a collection of paradigms, offers promise in understanding how users process information about products.
- Mathematical *models of search* have been developed in biology (e.g., Kauffman 1993) and applied to organizational search in the field of competitive strategy (e.g., Levinthal 1997). The most popular of these approaches is the NK model. This perspective of search might be productively applied to exploration of concepts in product design (Kornish and Ulrich 2010).

Concluding Remarks

Product design is conceiving and giving form to goods and services that address needs. The economic activity of product design is central to the success of most companies, and thus is worthy of study in academic communities concerned with improving performance of these organizations. More important than any particular definition of product design is clarity in

articulating the focus and purpose of a research project. Thinking of product design as a collection of decisions may facilitate that articulation. Paradigms like multi-attribute utility models can catalyze productive research projects. Several paradigms, like evolutionary aesthetics, have been successfully applied elsewhere and offer promise for further application to the decisions of product design.

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