Beyond User-Centric Models of Product Creation

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Abstract

Industrial and technical products have traditionally been designed from two complementary perspectives. The other has focused on functionality and the other on external appearance. Research on usability and human-centric design has partially bridged the gap by integrating cognitive and contextual considerations with emotional, semantic, and esthetic considerations.

This paper argues that to fill the gap between function and form in technological products, it is important to understand the social basis of use. Technologies are appropriated in social practices through social learning processes. Products that are elements in complex systems, and whose functionalities can be programmed, need to be designed using methodologies that go beyond user-centric models of product design.

Introduction

The problem of design in technical products has historically emphasized functionality. In the traditional division of labor, product development was often separated from industrial design. The latter was sometimes delegated to a role where its task was to design packaging for already designed products. In practice, “lack of design” was indicated by gray paint and robust boxes. This “engineering” approach to design often prioritized functional design and separated it from the “packaging” of products.

More recently, the engineering approach to design has been extended to manufacturability, quality, and usability. Design for manufacturability and quality typically focus on production and product life-cycle economics, and pay little attention to the user. Usability design, in contrast, has invited the user at the center of the stage. Usability research has informed product developers by studying human-machine interaction, first as a problem of user interface design and later by studying the use of products and product prototypes in simulated and real user environments.

The traditional approach on human-machine interaction research was a cognitive one. Case and laboratory studies commonly focused on information presentation in fighter cockpits, nuclear power plants and data entry terminals. Such studies constructed “use” as a relationship between humans and designed objects. Human-computer interaction research and, before that, man-machine interaction research typically have been informed by this view.

Many contemporary products are elements in complex systems. For example, a mobile phone or a computer has to be connected to a network before it becomes a fully functional product. This has led to a more system-oriented view on human-machine interaction. Whereas the traditional design problem was viewed as a problem of creating essentially independent machines that perhaps interfaced with other machines in a relatively static configuration, modern technological products are combined and configured with components and infrastructures that are constantly changing. Interaction, therefore, is now at least in theory understood to extend beyond a simple relation between an individual user and an individual technical artifact.

Modern products are also becoming increasingly “intelligent.” Their functionality can often be programmed and it can change according to use context and across time. Traditional everyday objects and the lived environment are becoming networked and embedded with information and communication technologies (Ducatel, Bogdanowicz, et al., 2001).

The networked nature of many modern products highlights the point that machines are media that connect systems of social activity. Usability, therefore, is not only about human-machine interaction. “Independent” products are social artifacts that become usable only in a context of social practice. On the factory floor, machines reify specific work practices that are organized for productive purposes. More generally, technical artifacts acquire their meaning in relation to social systems of activity. To understand the “usability” of a device such as a computer or mobile phone, we therefore have to penetrate through the interface and study the underlying social processes that drive the use of technical artifacts.

This paper outlines challenges for design in this emerging world and proposes some theoretical starting points for a social and communicative theory of design. The paper is organized as follows. The next section discusses the social character of material and functional objects. To make the introduced theoretical concepts more concrete, the subsequent section shows how an ordinary everyday object, a coffee cup, implements—and could implement—social and cognitive functionality. The next section moves then beyond the conventional user-centric view and discusses users as social practices. It points out that redesign of product functionality, in general, implies redesign of social relations and that the appropriate conceptualization of the user needs to be extended beyond an individual user. The following section discusses the traditional way of doing this: task based abstractions of use, which, for example, provided the foundation for division of labor in mass manufacturing. The next section will then introduce the concept of “communities of practice” and argue that it can provide a starting point for understanding the social contexts of product functionality and product use. The following section introduces learning models that could be integrated into product design methodologies and product concept definitions so that the resulting products would support social change and learning. The paper ends with a short summary and some concluding remarks.

Social objects

The "social" character of designed objects becomes particularly visible in communications products. Communication is inherently social, and understood to be so. In everyday usage, we associate communication with speech and text. On a more fundamental level, however, communication is a specific form of social interaction. The different functionalities that a communication device provides are functionalities that connect the user to a complex system of social relations.

This view on communication extends beyond the conventional view. Communication is social interaction and linguistic communication is one of its specific forms. The fundamental difference between linguistic communication and other forms of communication is not in the use of words. Instead, the difference has to be located in the specific self-referential character of systems of language (Maturana & Varela, 1988; Luhmann, 1995). Although in this paper it is not necessary to discuss the deep theoretical issues that relate to communication and language, it is important to note that as soon as humans start to operate on the level of language—in other words when they operate as social beings—objects and actions become meaningful and culturally constituted. Objects become defined as elements in social interaction. Technological tools are no exception here. We can therefore say that all technologies are communication technologies.

Although prototypical technologies, such as the wheel, compass, microscope, steam engine, or dynamo have traditionally been perceived as man's rule over nature, technologies are materialized in systems of social interaction. "Man's rule over nature" is not a relation between an individual and her environment; instead, it needs to be conceptualized as the rule of specific social practices over their environment. This environment can be the natural environment, or a social environment. In both cases, the "environment," however, is fundamentally social, as encultured humans can understand and perceive "nature" only through cultural systems of meaning.

Cultural objects are appropriated in meaningful social practice, and they do not exist in any meaningful way outside those practices. Material objects and technological tools enter the social system as elements of social practice that is maintained by communication. Different technologies afford different types of communication and in actual social life different technologies are used to complement each other and to create "interaction media portfolios" that make social action possible. Relatively static artifacts, such as a microscope or a steam engine, define conceptual nodes in the system of communication, enabling more transient communication and interaction to be built around these partly material and partly semantic nodes. More dynamic artifacts, such as characters on a display screen, are used to support the more dynamic layers of linguistic and communicative systems.

Such a communicative view on material and functional artifacts means that when we design a product, we actually design structures for social interaction. Social interactions, in turn, are reified in practices, routines and institutions that are embedded and "sedimented" in material artifacts.

The socio-cognitive coffee cup

The concepts discussed above an abstract and integrate several theoretical traditions. It is therefore useful to illustrate them using a practical example. I will use a well-known designed object, a coffee cup, to show how the social world is embedded in objects.

The functionality of a coffee cup is commonly taken for granted. We assume that the essence of a cup is that that it holds hot liquid. The design of a cup as a container of material is therefore constrained by the characteristics of gravitation, temperature gradients, the shape of human hand and mouth, and the human digestive system. A cup is there to hold coffee, until the coffee-drinker drinks it.

Mass production systems are trying to fulfill the demand for coffee cups. To respond to competition, they need to differentiate their products and lower manufacturing costs. Industrial designers, therefore, have for a long time been shaping different forms of coffee cups using different materials. The mass production system has created “individualized” coffee cups by producing large portfolios of different designs, from which the consumer has been able to pick subsets.

An important design factor for coffee cups is how they feel. This relates to the material characteristics of the cup and its shape, but also to the emotional aspects of the cup. Designers have tried to attach emotional content to coffee cups, for example, by choosing colors, non-functional shapes, and by adding symbols, text and pictures to the cup.

In such approaches, the functional character of coffee cup is taken as the starting point and this starting point is fixed. Typical coffee cups do not need engineering. The designer therefore focuses mainly on non-functional design, for example, in an attempt to add layers of meaning to the basic functional container of hot liquid.

If the functions of a coffee cup are not taken for granted, however, a completely new emerges. We can try to observe coffee cups in real use environments and try to understand what they are about. Such an “ethnographic” perspective reveals that coffee cups are complex social and cognitive objects.

This first simple observation is that the liquid that is put into the cup contains alkaloids that interact with the human brain. Specifically, caffeine adjusts the level of alertness. Coffee cup, therefore, is a cognitive tool. Humans use it to control their mental processes.

Coffee cups also need to be filled. This often requires walking. People grab the cup, take a break, and go for coffee. Coffee cups, therefore, are used to organize time and space.

Coffee cups are social objects. People walk to a coffee machine to meet other people and have a chat. They go to coffee shops to meet friends. Coffee cups are often used to organize random meetings and to exchange information. In fact, in many knowledge-based organizations, coffee cups have an important role in the management of information flows. They are extensively used to share unstructured information and tacit knowledge. Indeed, coffee cups are among the most important information technology tools in many cultures and organizations.

The social role of coffee cups also extends to the symbolic and institutional sphere. Events are celebrated by lifting coffee cups. People are invited to join meetings with coffee cups. Trust is built by talking over coffee cups.

Cultural variations exist, and in some parts of the world cups are bigger than in others. Sometimes the cup is filled with tea instead of coffee. The main functionalities of the cup, however, remain the same. It controls mental processes. It organizes time and space. It is a communication and information processing tool. It creates and maintains social interactions. It signals and institutionalizes meaning.

From this perspective, the design space for coffee cups opens for interesting challenges. If, for example, we could embed sensors, information processing systems, and wireless communications in the structure of the cup and make it programmable, how could we redesign the social and cognitive functions of the cup? Could we reconfigure the mood control functionality, for example, so that when we approach the limits of healthy consumption of caffeine, the cup starts to play Mozart instead? Could the cup know when we need to get up and walk a little? Could the cup detect that there is hot liquid in it, and invite our coworkers for a chat, or open our email for informal communication, for example?

These questions indicate that the functional character of a coffee cup is not fixed at all. Instead, we have taken the functions of a cup for granted. This obviousness has made it difficult to see that the actual use of coffee cups extends far beyond its role as a container. In fact, its role as container would not make much sense without cultural and social practices that have adopted coffee into their portfolio of social interaction tools.

User as a social practice

In the modern society, artifacts are often created in productive processes that output commercial products. They are produced as independent objects but they gain their functionality only when they are plugged in an infrastructure of ongoing social relations. This, however, means that also the user needs to be conceptualized as a relational entity; not as an individual user, but as an agent of interpersonal interactions.

Categories of use—in other words, different ways of integrating products in social interaction—do not form endless sets of idiosyncratic uses. Social interaction is based on routines and the reduction of unpredictability. As a result, socially meaningful uses are recurrent uses. The themes of use, as it were, stay relatively constant. Practical variations can then be created around these themes (de Certeau, 1988). To design products that can be used to play meaningful themes, we therefore have to refine the "user" in a way that allows us to speak about the "use" as a social practice.

Functional design has traditionally been understood as creation and combination of capabilities. More fundamentally, however, modified functionality means modifications in social relations. Simple "non-revolutionary" products plug in to existing practices and require little reorganization in social relationships. More revolutionary products may lead to lengthy experimentation and adjustment processes. The "usability" of a specific system, therefore, becomes a question of either matching a given form of social activity, or a question of social learning.

Mass manufactured products typically have been products for given and predefined uses, and therefore the social character of products was not always apparent. Designers could take the social structure for granted. Cultural variations were limited and rapid social change was more of an exception than a rule. For innovative products, and for societies where the timescales of social change approach product lifetimes, social learning becomes more important. Both society and products require capabilities for social learning. If a new product has functionality that remains unused because the social activity system where it should be used does not have the capability to change, the functionality remains latent or the product dies away. Similarly, if the society has the capability to change, but its cultural and material artifacts are structurally and functionally rigid, social change remains a theoretical possibility. Killer applications respond to such tectonic tensions, releasing accumulated social power and by facilitating reconfiguration of social relations.

This conceptualization of the "user," therefore, extends beyond the boundaries of a single individual. It becomes then important to understand where are the proper boundaries of the design problem. If we cannot design a product simply based on a given list of engineering specifications or by looking the characteristics of a specific individual, where should we look? In more philosophical terms, what is the ontological unit for design?

Task functionality

The traditional answer was the one that underlies Adam Smith's discussion on the division of labor in his famous pin factory, and the Tayloristic system of manufacturing. In the 19^{th} century and early 20^{th} century, consumer durables were not yet invented and the user was a user of tools. Functional products were mainly tools for work. In this view, the user was conceptualized as a sequence of tasks that were chained into a work process. The outputs of specific tasks created the components of manufactured products. A modern version of this view can be found in enterprise integration systems and information technology supported organizational process redesign.

The problem with this process-based view is that it is an abstraction that does not match well with social reality. Chaplin was right: process abstraction forces humans to imitate machines. This has become particularly visible in knowledge-based organizations, where informal communication and interaction are important. Although there may be "processes" in organizations and also outside them, these processes rely on an extensive infrastructure of social relations. Indeed, many process re-engineering projects failed in the 1990s as they took the process abstraction for reality.

A more realistic view on social activity, including productive activity, is based on studies on social learning. Here the question is how people gain the competences that are needed to participate in social activity and how they become proficient actors within given systems of activity.

Communities of practice as loci of social learning

During the last decades researchers have proposed that the unit of social learning could be understood as development within a "community of practice."[1] An important contribution has been Lave and Wenger's (1991) proposal that was partly based on the Vygotskian cultural-historical model of learning. In the Vygotskian tradition[2], cultural artifacts, such as technological tools, were important carriers of social practice. Lave and Wenger argued that novice practitioners become experts in a gradual socialization process where the first step is that they are given the right to be "peripheral participators" in a community of practice. Each community of practice has its own stocks of practice related knowledge, as well as tools that it uses in its practice.

I have proposed elsewhere (Tuomi, 2002) that the adoption of new technological products often depends on the dynamic capabilities and constraints of communities of practice. When a community of practice explores the possibilities of a technological artifact, it can adopt the artifact only if the artifact facilitates existing practice, or if the community is able to change and align its practices according the constraints of the artifact. The first case is generally driven by the objective of improving the efficiency of existing practices. The latter case underlies the creation of new innovative practices. Creation of such innovative practices, in turn, indicates that the product and material artifact in question is an innovative product. Although many innovative products exist in theory, they become real only when they are adopted in social practice. The bottleneck in this process is "downstream innovation," i.e., the innovative capability of the user community.

[1] These include Ludwick Fleck, Ed Constant, Donald Schön, Julian Orr, Jean Lave and Etienne Wenger, and John Seely Brown and Paul Duguid, see Tuomi, 2002:ch 6.

[2] From a design perspective, a central work is Vygotsky (1987). Introductions to the Vygotskian tradition include Wertsch (1985; 1991), Kozulin (1990) and van der Veer & Valsiner (1994).

The innovative capability of user communities depends on the institutional rigidity of the community in question. To be able to adopt new functional products, a community has to change its practices. These are embedded and grounded on existing relations of interaction, meaning, and material structures and artifacts, and can not always be changed easily. In fact, the concept of "community of practice" has been mainly used to describe communities that reproduce their existing practices and which are inherently resistant to change. Social learning, in Lave and Wenger's sense, is about becoming a socialized member of an existing community of practice, and not about innovative learning that transforms social practices. Therefore, the Lave and Wenger conceptualization of community of practice is not particularly well suited for studies on innovation and adoption of new technology supported social practices. Although, for example, Brown and Duguid (1991; 2000) have applied the community of practice concept in describing innovation processes, also their focus has been on communities as producers of products for others. The adoption of products, however, requires that the focal community creates internal change.

The concept of community of practice is important as it shows that humans use technological products, tools, and material artifacts in contexts that can be described as networks of social communities that embed practices. Individuals define their identities and they interpret the meaning of their social action in relation to such communities. Product functionality, therefore, can be understood in relation to this social context. Whereas the traditional view abstracted functionality as tasks and decontextualized actions, a community of practice -based view defines functionality in relation to a social infrastructure that consist of communities that are created and maintained through continuous socialization and social learning.

Communities of practice, however, do not exist in isolation. Social practices form complex interrelated networks. This creates constraints for social learning. When one community wants to change its practices, in general it is constrained by the practices of other communities. Adjustment for a new technological opportunity therefore typically requires mutual adjustment and co-creation of new forms of social practices in several communities. Such non-local learning may be difficult. Indeed, the observed long lags in the introduction of many key technologies of the modern society reflect this slow adjustment process. Although one particular community may have capabilities to adopt a new technology, it can only do so when other communities are willing and able to make the necessary adjustments. For example, it might appear obvious for a designer that great cost savings could be achieved by building a sales system that links information technology, phone support and product management. In practice, the designer may have difficulties in implementing and deploying such a system if the phone network does not support interfaces with information systems, or if the legal validity of contracts require physical signatures. The design problem, therefore, requires also that the designer considers the interfaces between the different interacting communities that are stakeholders in the product adoption process.

Social learning and appropriation of technology

The above discussion indicates that the design of functional artifacts is fundamentally a question of designing social relations. The problem of design, therefore, cannot be in any trivial way be reduced to abstract functionality in the traditional engineering sense any more than it can be reduced to esthetic considerations about product color and shape. Implicitly and intuitively the social dimension has been included in the traditional industrial design. Usability design, in turn, has extended the traditional engineering design towards everyday practice and real social contexts. There remains, however, a gap to be filled. This gap can be filled by refining design methodologies so that they take the social foundations of product use into account. This requires that we define design methodologies where social learning is incorporated. For this, we need models of social learning.

One such model can be built using Dewey's model of experimental learning as a starting point. The Dewey learning cycle is schematically shown in Figure 1. According to Dewey (1991), new forms of action emerge in a process that starts when routine activity breaks down. This breakdown is perceived as a problem that requires conscious attention to the causes of the breakdown. As a result, the problem becomes articulated and conceptualized. Based on the articulated conceptualization, the learner then defines a "working hypothesis" as a potential repair of the breakdown. The working hypothesis is tested mentally. If it seems promising, it leads to experimental action where the hypothesis is tested as a concrete solution to the problem. If the experiment is successful, the problem is solved and action can proceed. Simultaneously, a new conceptual idea is generated that can be communicated with others.

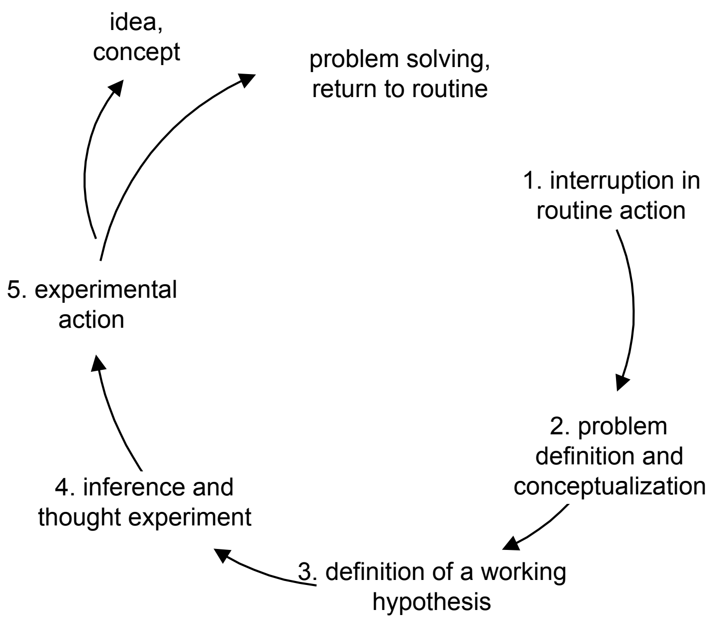

Figure 1. Learning cycle according to Dewey (Tuomi, 1999:309, adapted from Miettinen, 1998).

Design methodologies that incorporate the learning aspect need then to answer two questions. The first is about the design process itself. If social learning is important, and if many of its core parts occur in the user communities, how these learning processes can be integrated into the product development and manufacturing process? The second question is about the products. If social learning and reconfiguration of social interactions is important for appropriation of new technological products, how the products could be specified so that they support the problem articulation, experimentation, and social learning.

The basic Deweyan learning cycle can be used to describe how new functional products enter the process of human learning. Typically they are generators of breakdowns, elements in working hypotheses, or means to implement new forms of routine action. Dewey’s model, however, focuses on individual learning. It can be interpreted as a schema for social learning by switching the unit of analysis from an individual to a group.

A well-known adaptation of Dewey’s model is Kolb’s (1984) “experiential learning” model, which has been used to implement team-based learning processes in organizations. Theoretically more robust models can be built using, for example, Engeström’s expansive learning cycle (Engeström, 1987; 1999; Tuomi, 1999). Engeström’s model has the benefit that it has strong conceptual roots in the Vygotskian tradition, which links social activity, cultural artifacts, and the conceptual systems of language. This theoretical tradition makes it possible to cross the boundaries between communication and artifacts.

Engeström’s model has been extensively used in organizational development during the last two decades (e.g.Virkkunen, Engeström, et al., 1997; Virkkunen, Helle, & Poikela, 1997). It can, however, also be deployed in a relatively straightforward way to extend product design processes so that they include the social dimension as an integral part. The model starts from the assumption that learning is inherently social and that it generates new forms of social practice. The basic learning cycle in the Engeström model is shown in Figure 2.

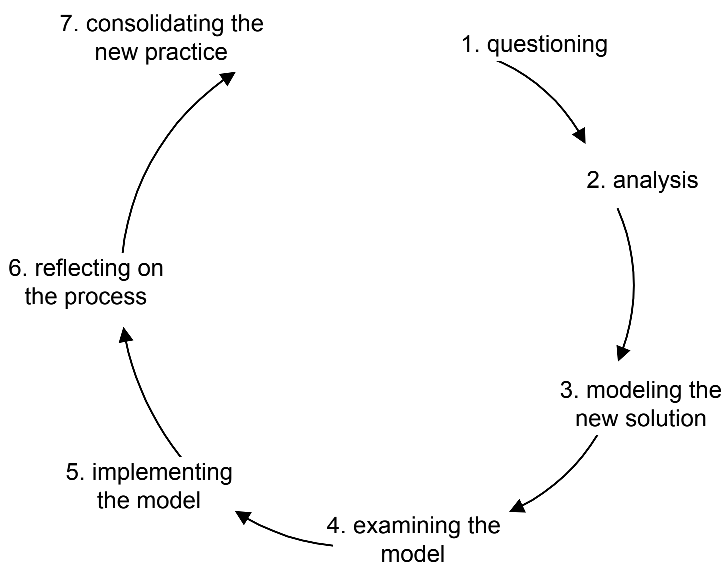

Figure 2. Learning cycle in Engeström's model (Tuomi, 1999:311).

From a designer's point of view, Engeström's model is a risky one. It starts from questioning the current practice and creates a model of new possible form of practice. Due to its "expansive" character, its results are unpredictable. The model is a model of innovative learning, and it is "revolutionary" in the sense that it creates new forms of social practice. There are no internal guarantees in the model that, for example, the generated practice requires a specific product or technical tool. It may as well generate a solution where the product or tool may become redundant. For example, the originating problem may disappear by reorganizing social interactions between different practices. This, indeed, is often the case. Design that takes into account the social dimension of use often designs away artifacts or simplifies their functionality. This is partly because a redefinition of the problem may make old problems disappear, but also because artifacts often reify historical remains of practices that have become non-functional or dysfunctional in the course of social development.

Technical artifacts act commonly as boundary objects that link complementary practices. This means that such objects cannot be designed simply for a given specific community of practice. Indeed, boundary objects function from the social perspective essentially as interfaces between practices. The flexibility of product functionality, therefore, to a large extent determines the possible developmental dynamics of the linked communities. Metaphorically, boundary objects can either oil the interactions between communities or nail them down in ways that make change impossible without destructively breaking the connection. The degree of social flexibility that is built into material and functional objects is to a large extent determined by the designer.

Socially successful products have historically often resembled more oil than a nail. They have acted as social learning platforms. On such platforms, the users have been able to experiment with new forms of social practice and reconfigure existing practices in innovative and often unanticipated ways. This process has been particularly visible in information and communication technologies (Tuomi, 2002), but a sociologically oriented study of most modern artifacts shows similar characteristics also in more mundane products. For example, as it has often been noted, the car created complex social transformations that refined the structures of cities and families, but produced also a new conceptualization of individual freedom, as well as picnic baskets, portable plastic chairs, and experimental sexual relations. The last point probably partly explains the design of traditional post-war American cars, for example.[3]

Conclusion

In this paper I have tried to expand the user-centric view of design beyond the individual user, arguing that users and uses can only be understood against a social context. Material objects are used as concrete artifacts in complex systems of social interaction, and the functionalities of artifacts both constrain and enable social interaction. New technological products are appropriated in social practice through a process of social learning, where, in general, social practices need to change before a new technological product can be taken into use. Social learning models, therefore, need to be integrated in product development and manufacturing processes. Improved understanding of the social character of artifacts helps us to design product functionality that facilitates social learning and the adoption of new technological opportunities. This is becoming particularly important as everyday objects are enhanced with programmable functionality and linked with their environment with sensors and communication networks.

Above I have only briefly discussed some learning models that could provide the foundation for new socially-aware design methodologies. This area obviously deserves more theoretical and empirical work. I have emphasized the importance of "downstream" innovation processes in the creation of technology facilitated social practices. I have also noted that product functionality and characteristics can be explicitly designed so that they take social learning processes into account and that the products support innovation in user communities.

[3] Engineers often claim that the function of a car is to "transfer people from point A to point B." As a consequence, they easily think that transport vehicles should be optimized from this point of view. The link between the American system of values in the 1950s, sexual relations, interests of oil industry and big cars becomes invisible from this "engineering" perspective. I am grateful for Manuel Castells for reminding me that the design of cars has also important demographic dimensions. In modern Spain also small cars apparently play an important role in mating rituals, probably partly due to a historical combination of Catholic traditions and old cities with small streets, but also because of congested houses with extended families with multiple generations under the same roof.

The traditional approaches to design separated functional design and the more "artistic" design of external appearances. Engineers commonly believed that they are responsible for the actual design of the product and that industrial designers join the design process only when the product needs to be packaged and marketed. Usability design, better understanding of product life-cycles, mass-customization and product individualization, emotional design, and human-centric design have considerably narrowed the gap between function and form in technological products. A more social understanding of product functionality, which sees product meaning as grounded on social interaction, has the promise of filling the gap. As products are becoming increasingly interactive and linked in complex information and communication infrastructures, it is becoming increasingly important to understand the social basis of material objects.

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