The Product Ecology:
Understanding Social Product Use and Supporting Design Culture

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The field of interaction design has broadened its focus from issues surrounding one person interacting with one system to how systems are socially and culturally situated among groups of people. To understand the situations surrounding product use interaction design researchers have turned to qualitative, ethnographic research methods. However, stripped from underlying theory, these methods can be prescriptive at best. This paper introduces Product Ecology as a theoretical design framework to describe how products evoke social behavior, to provide a roadmap for choosing appropriate qualitative research methods and to extend design culture within HCI by allowing for flexible, design-centered research planning and opportunity-seeking. This product-centered framework is illustrated as a method for selecting a set of design research methods and for working with other research approaches that study people in naturalistic settings.

Keywords - Design Theory, Interaction Design, Product Ecology, Social Products.

Relevance to Design Practice - The Product Ecology is useful because it articulates all of the factors that evoke social behavior around products. The factors in the framework can be used in a generative manner to scaffold the selection of design research methods for understanding current experience and generating new products to change that experience.

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Introduction

The field of interaction design has broadened its focus to understanding how systems of technology-based products are socially and culturally situated among groups of people. Most user-product interaction in interaction design has been conceived as the interaction between one user and one product or service (Postma & Stappers, 2007). There is little knowledge about what happens when groups of people interact with or through a product, evoking social behavior, or in how to help designers think about design for social interaction. Recently, interaction design researchers have turned more and more to qualitative design research methods to understand the situations surrounding product use.

These methods are often inspired by methods in disciplines such as anthropology and social science, but within the interaction design community these approaches can be reduced and simplified. Stripped from their history and underlying theory, methods lose their power, often simply becoming prescriptive lists. For example, one can trace the uptake and trajectory of cultural probes in the design community, where some authors have noted that some uses of probes as a research method "have been criticized as poor substitutes for ethnographic and other methods for generating qualitative analyses of the practices of everyday life. " (Boehner, Vertesi, Sengers, & Dourish, 2007, p. 1077)

Frameworks and theories in design and interaction design are relatively new, there being few examples and some disagreement about what constitutes a theory, especially in design. They are not scientific theories in the narrow sense of predicting action irrespective of context and situation. Rather, they are concerned with transforming the conditions and potentials for human action. However, scaffolding design methods with the use of design frameworks and theories is important for interaction design and the related field of human-computer interaction for many reasons. Firstly, design theories are not like scientific theories. While scientific theories often predict action irrespective of context and situation, design theories describe conditions for change, often looking holistically at groups of phenomenon together. This represents important problem framing in design, which is different from problem framing done by scientific disciplines. Secondly, design frameworks and theories can liberate the designer from preconceived notions of how the design process can and should be performed (Löwgren & Stolterman, 2004). This is important for those new to design research, new to using qualitative research methods, or having little experience in working with designers.

Frameworks and theories in design allow designers to assess a complex and unique problem by articulating the phenomena involved in a design problem and the relationship between those phenomena. In addition, they allow for movement between prescribed design and research processes and the use of the designer's implicit judgment, knowledge gleaned from other design examples, ethical responsibility, and pattern seeking

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in solving problems. By using a framework to select design methods, designers can avoid prescriptive design processes and choose research methods that best discover information about the relationship between phenomena constituting the design problem. Finally, design frameworks facilitate collaboration between designers and non-designers, in particular those who work with scientific theories.

This paper attempts to show how design frameworks and theories can be used to select qualitative research methods in flexible, non-prescriptive ways. To do so, it introduces the Product Ecology framework as one approach for understanding how products evoke social behavior. The Product Ecology is based on social ecology theory, and is useful for obtaining rich, detailed data about how people interact with products.

In the following section, the Product Ecology is described as a framework for articulating the context of product use and for selecting a set of design research methods. Next, this approach is combined with other approaches for collecting data about users: participatory design, experience prototyping and prototyping social action, cultural probes, and contextual design. Finally, the Product Ecology is situated within a culture of design, showing how it might scaffold the use of other qualitative research methods in support of a philosophical stance that extends the design research community and benefits the HCI community.

The Product Ecology Framework

The Product Ecology is a theoretical framework that 1) describes social product use — how products evoke social behavior; 2) provides a roadmap for choosing appropriate qualitative research methods to discover social product use; and 3) extends design culture in interaction design and HCI by allowing for flexible, design-centered research planning and opportunity seeking. Design culture, a concept discussed extensively by Nelson and Stolterman (2005), is a way of thinking and being that allows for intentional change.

The Product Ecology is informed by social ecology theory, which is broadly concerned with the dynamic relationship between an individual and the social environment (Social Ecology Web, n.d.). The Product Ecology can also be used for selecting a set of design research methods to understand the interactions between people and products.

In the Product Ecology, the product is the central unit of analysis. This is because product-centered models often provide the most straightforward application to design practice, assisting designers and non-designers in the process of creating products (for examples and an overview of product-centered, user-centered, and interaction-centered models, see Forlizzi & Battarbee, 2004). The functional, aesthetic, symbolic, emotional and social dimensions of a product, combined with other units of analysis, or *factors*, in the ecology, help to describe how people make social relationships with products. These include the product; the surrounding products and other systems of products; the people who use it, and their attitudes, disposition, roles, and relationships; the physical structure, norms and routines of the place the product is used; and the social and cultural contexts of the people who use the product and possibly even the people who make the product. A schematic diagram of these factors is shown in Figure 1.

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Social Ecology Theory

As in any design research process, true knowledge in the form of models and theories from behavioral science must be integrated into the early part of design inquiry (Zimmerman, Forlizzi, & Evenson, 2007). Social ecology theory was used to inform the development of the product ecology. In social science, social ecology theory focuses simultaneously on the environment and the social relationships among the people within it. The underlying assumption is that human behavior can be understood as an adaptive fit to an external environment, and that the relationships between the human and environmental factors are complex and dynamic (Netting, 1986). Context shapes these relationships and is understood as a complex, dynamic set of factors, including social context (social networks and support systems), historical context, cultural context, and institutional context.

Social ecology theory makes certain assumptions about the dynamics of social relationships (for examples, see Ettner & Grzywacz, 2001; Evans, Lepore, & Schroder, 1996; Genereux, Ward, & Russell, 1983; Heise, 1998; Hoglund & Leadbeater, 2004; Moss, 1997; Netting, 1986; Social Ecology Web, n.d.). First, human experience is influenced by multiple factors in the physical environment (e.g., geography, architecture, and technology) as well as the social environment (e.g., culture, economics, and politics). Second, analyses of the ecology should address the multidimensional and complex nature of the factors in the environments. Third, just as environments can be described in terms of their relative scale and complexity, their inhabitants can be studied at various levels including individuals and small groups (micro level analyses), organizations or neighborhoods (meso level analyes), and regions or populations (macro level analyses). Multiple research methods, including questionnaires, behavioral observations, and environmental recordings should be used to assess contexts, conditions, and the experience of individuals within an ecology. Fourth, the social ecological perspective incorporates a variety of concepts derived from systems theory, including interdependence, homeostasis, and negative feedback (Stokols, 1992).

Social ecology theory is by nature multidisciplinary, offering theoretical constructs that integrate concepts from multiple disciplines. They are useful when the approach of one discipline may not offer a well-rounded perspective on a particular problem. For example, strategies for healthcare may be grounded in clinical medicine, and ignore facets of the physical environment in which patients reside. A social ecological view of such a problem might reveal interventions at the individual, organizational, and environmental level.

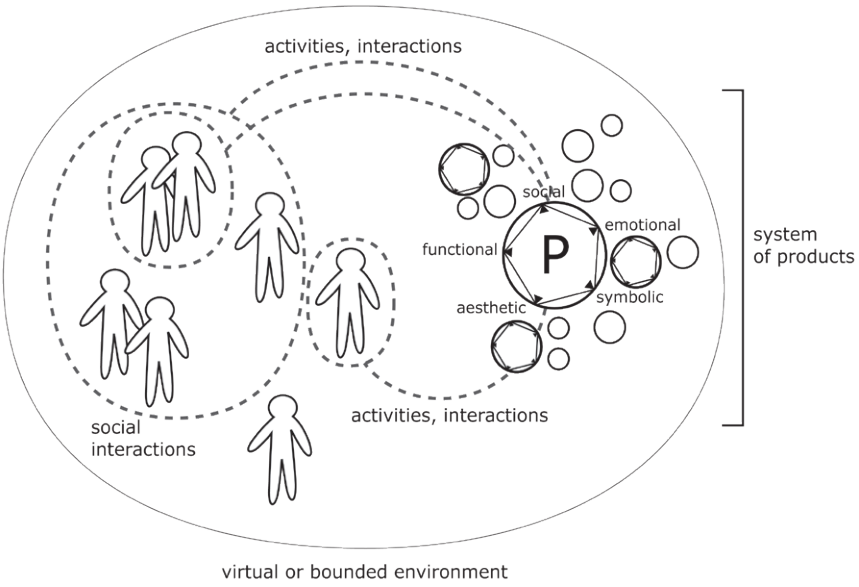

Figure 1. Schematic diagram of the Product Ecology.

Key Ideas About the Product Ecology

Just as Social Ecology theory makes certain assumptions about the dynamics of social relationships, the Product Ecology framework makes certain assumptions about social relationships with products, which help to define the framework and describe the dynamic issues of product use: each instance of a product has its own ecology; the factors in the ecology are adaptive; the factors in the ecology can play different roles; and the product ecology can be geographically or virtually bounded.

First, each product has its own ecology, resulting in subjective and individual experience in using the same product. However, this experience of product use is mediated by other factors in the ecology. Looking at the subjective experience of product use from a range of perspectives can be useful in discovering patterns that lead to generalizable knowledge for design.Take, for example, the product ecology of a Dyson vacuum cleaner that has been purchased by a family. Each member of the family has different relationships with this particular vacuum depending on their circumstances and relationships with one another. The wife likes it for weekly housecleaning, but finds it too large and overpowered for spot cleaning. The husband loves the engineered quality of the vacuum and participates in an online Dyson owners group. The family uses other products in coordination with the Dyson: a Swiffer for quickly dusting the floor and a Dustbuster for opportunistic cleanups. However, the Dyson represents two values important to the family in purchase and use of a vacuum: engineered quality and contributing to an allergen-free home.

Second, the factors in the Product Ecology are dynamic, and interconnected in several ways. For example, if someone sprains an ankle and is unable to vacuum, product use within the ecology will change in response. The vacuum might remain unused, and cleaning may be done less, or other people, products and services might come into play, such as spouses or a cleaning service. Additionally, new products can change the existing ecology, as activities are modified and new ones are developed, or in extreme cases cause the ecology to break down.

Third, changes in product use cause changes in other factors of the Product Ecology. Products help people in a variety of activities and experiences, supporting independence and well-being, mediating activities, and helping people to accomplish goals. Fundamental changes in product use contribute to changes in the product ecology. When a product no longer plays a key role, it is marked by events such as people changing roles, or going in and out of the ecology; owning more than one product to do exactly the same task or making modifications to a particular product; allowing products to clutter the environment, unused and without special significance; and modifying the social relationships that exist around a product.

Fourth, the Product Ecology can be delimited by a group of people in close proximity, or a group that is spread out over a great distance. For example, the Product Ecology for the housebound is often the home, surrounded by a small, physically-bounded social network. The community of use for a product such as flickr, a photosharing service (flickr.com), is quite different. This environment is a group of people who may not be physically co-located, but who share the perceived values and benefits of sharing digital images. The factors in the Product Ecology are the same whether the people using the product are close to or far away from each other.

The Product Ecology can be used to study a variety of products, services, and systems. Like the Dyson example, the impact of a robotic vacuum on household cleaning and the existing product ecology of floor cleaning products are reported in a study by (Forlizzi, 2007). Interviews, shadowings, and photographic journals done by all members of the family revealed who did the floor cleaning, how often and at what times of day, and what products or systems of products were used. After understanding the current experience of cleaning, families were given either a Roomba robotic vacuum or a Hoover Flair upright stick vacuum, which are functionally the same except that they need to be manually pushed to clean the floors.

At one, three, six, and twelve months, follow-up research was done with each family to determine if and how cleaning had changed as a result of receiving a new vacuum. The Roomba substantially changed the experience of cleaning for families and factors in the product ecology, while the Flair did not. The Roomba changed individual relationships with cleaning products, affecting cleaning over different ages, genders, and roles in the family. Other factors in the product ecology changed dynamically in response. For example, two households entirely abandoned vacuums that were currently in use, and in one home, the environment was modified to better accommodate for the vacuum. Finally, the study of Roomba use could be delimited either by a single family, by a set of families (in some instances, families shared their Roomba with neighbors), or by a larger user group (for example, the Yahoo! Roomba user group).

Design Theory and Its Role in Design Research

Theory in many fields can be placed along a continuum from nascent to mature (Edmondson & MacManus, 2007). Design frameworks such as the Product Ecology can be characterized as nascent theories, proposing tentative questions about groups of phenomena observed in the world. Often, design frameworks in the form of early theories suggest a stance or lens with which to understand the groups of factors that produce the observed phenomena. Intermediate theory, on the continuum between nascent and mature, presents provisional explanations of phenomena, often introducing a new construct and proposing relationships between it and established constructs. Mature theory presents well-developed frameworks and constructs that have been studied over time with increasing precision by a variety of researchers, resulting in a body of work in a field that is largely in agreement and represents the cumulative knowledge of the field.

A growing group of design researchers are formalizing frameworks about how complexity and context affect a design problem, ultimately shaping methods, approaches, and theories of experience and product use. Subsequently, a number of design theories have been developed and adopted to help understand how people interact with products, services, and systems. (For a comprehensive overview, see Battarbee, 2004). These have been informed by the disciplines of design, business, philosophy, anthropology, cognitive science, social science, and others.

These frameworks can be used to describe a general paradigm for selecting design research methods structured by design frameworks and theories. This paradigm has been well described by Kurvinen, Koskinen, and Battarbee (in press), who articulate three main issues specific to doing research to construct design theories. First, research must be done in the place where the product is naturally used, with attention to the physical structures and social norms of the environment rather than the laboratory. Second, understanding the same experience from multiple perspectives is important. Third, looking at experiences over time is important. The Product Ecology takes these issues into consideration, as articulated below.

Place

The Product Ecology framework considers place — comprised of the physical and social environment — broadly. People, acting individually and collectively, actively structure situations where product use occurs. Issues of place relate to both the physical space and social and environmental norms described by all of the factors within the Product Ecology. Physical context plays a role in how people interact socially. For example, a shared physical environment has been shown to promote informal social communication (Kraut, Fish, Root, & Chalfonte, 1990; Whittaker, Frohlich, & Daly-Jones, 1994). The specific design of a place may simultaneously encourage some activities and discourage others (Alexander, 1979; Genereux et al., 1983). A particular physical environment may describe behavioral norms that support certain kinds of interactions and discourage others (Gaver, 1996). For example, the experience of drinking coffee at a conference break is vastly different from drinking coffee at a smoky coffeehouse while a jazz band provides ambient entertainment.

Issues of place indicate ways that designers can discover how physical and social context might affect the design of future technology products. The role of context has also been examined through the concept of embodied interaction, where appropriate use of technology is described over social and temporal structures (Dourish, 2004). According to Dourish, social structures play a role in how people connect and collaborate with each other, and temporal structures describe how patterns of interaction change over time (Dourish, 2001). Quentin Jones and his colleagues expanded the notion of context to describe a socially-defined place that determines a person's information-sharing and communication needs (Jones, Grandhi, Whittaker, Chivakula, & Terveen, 2004). This view of context takes into account location, one's familiarity or lack of familiarity with a particular place, and the routine behaviors that happen there. The place-based view of context allows for the fact that people actively and collectively structure their environments, and have different information needs based on familiarity and activity at a given place and time. The Product Ecology framework takes these concepts into consideration, focusing on the product as a lens through which to view combined elements of place and time.

Multiple Perspectives

Unlike human factors, which seek to generalize human behavior, the Product Ecology seeks to find differences among individuals that help form patterns relative to product use and adoption. These include personal history, age, lifestage, gender, one's role in a situation at any given time, and one's role in a group. For example, one's role within a social structure, an organization, or a cultural setting can play a part in the social use of a product. Such issues, examined over a number of people and combined with aspects of a social product, sketch out questions for design relative to accessibility, values, product adoption, and long-term product use.

Time

Aspects of time are important in the Product Ecology framework. Designers must pay attention to the ebbs and flows of time, and the

phrasing of interactions with products, combined with particular hours, days, and seasons and the ages and lifestages of key people using a product to best understand how to shape the experience that results.

Additionally, people's needs within a situation are always changing, so designers must examine how relationships to products over time. Adaptation examines the product as an instigator for change — how it has an effect on people, place, and other products in use, effecting dynamic change on all of the factors in the Product Ecology. For example, a new technology product might replace or augment other products that functionally accomplish the same thing, encouraging certain activities and discouraging others. A product might force changes to a space, or evolve new features within a particular environment. For example, people might modify their homes by opening up floor space to make more efficient use of a new appliance or assistive product.

How To Use the Product Ecology

The design process, shaped by the Industrial Revolution, has been well characterized (for example, by Löwgren, 2007). The constituent activities include understanding the current problem or current situation; exploring how to improve the future through the design of new artifacts, services, systems, or environments; considering not only product function, but also the aesthetic, symbolic, emotional and social qualities of products; and codifying understanding and movement towards a solution in the form of sketches, models, prototypes, and other tangible expressions of ideas. A key aspect of design activity is that in seeking a solution to a design problem, design seeks beneficial change (Nelson & Stolterman, 2005).

However, the design process is not prescriptive. Designers understand, explore, and create based not only on data in the world, but also intuitive judgment. Frameworks and theories in design need to support, not minimize, the use of implicit knowledge. The Product Ecology is useful for structuring design activity between explicit information and intuitive judgment. Unlike more focused research methods, for example, a survey, it allows for simultaneous investigation of the many phenomena that contribute to the design problem. For example, while methods such as Cultural Probes are often used for free-from inspiration of the design team, independent of any data analysis, the Product Ecology could provide a coding structure for Cultural Probe data to examine the presence or absence of factors, and use this information to support decisions about what to design.

Factors in the Product Ecology can be examined in isolation or in combination at the level of a single product, to understand what particular product features will inspire social use, or at the system level, to understand how a particular product will have an impact on a system of products retained for similar functional, aesthetic, symbolic, social and emotional factors. Similarly, behavior of individuals or groups using products can be studied.

Table 1 is a matrix showing factors and associated research issues in the Product Ecology. Factors can be examined singly or in combination, and the research issues can be used to guide the selection of research methods during a design project.

As an example of how to use the Product Ecology to select design research methods, consider the class of religious products that might be used together in a home: bibles, display artifacts, altars, services such as television and music programs, and behavioral rituals. The Product Ecology framework can be used to discover ideas about how to design religious artifacts, environments, services and systems for the home that socially connect members of a religious group through their display and use.

At the level of the individual, the Product Ecology framework helps to describe individual differences in the potential adoption and use of religious social products. Researchers and designers can choose research methods that ask how age, gender, role, and lifestage differences might create differences in religious product adoption and use. These methods, with a focus on the individual and her private, possibly emotional rituals, could include interviews and diary studies. For example, a cell phone, which is a personal device, might be a good vehicle for delivering time-sensitive reminders for prayer and religious rituals, but observations of children at school may reveal that this concept is not sustainable at the group level, since many young people are not allowed to carry phones with them into the classroom. In terms of age, lifestage, and role, comparative interviews may show that teenagers and young adults may shun religion as a common practice of their lifestage. However, participatory design sessions could be employed to understand which designs could reduce some of the stigma, resulting in more readiness to adopt a religious social practice if it is delivered in the form of a technology game, for example.

To consider groups of people, the Product Ecology framework helps to understand how groups might collectively adopt a religious social product, while maintaining subjective perspectives on its use. Here, methods must be selected that allow for observation and comparison of groups, their social behavior when using products, and the emotional issues that result. For example, observations in public places might suggest a need for products might address differences in religious perspectives and educate individuals about the religion of others. A review of the popular literature could reveal that a religious social service might help the housebound feel as if they are still participating members of a religious community. New practices may be adopted over time, if they are collectively valued by the group. These can be discovered with time-based diaries, or interviews with individuals in a group using a product. Additionally, individuals within the group might have different experiences of the same product based on their role: one might participate due to personal behaviors of devotion, another might join to meet new friends, and a third might do it in preparation for death. These could be discovered with diaries or photographic journals. A product developed for the housebound will need to match human desires for functionality, while considering subjective issues of adoption such as privacy, ritual, and the perceived benefits of such a social product or service. These issues could be revealed with multiple interviews about a working prototype.

At the level of place (environmental and social context), the Product Ecology framework can help describe how distinct

Table 1. The Product Ecology, broken into factors, along with examples of relevant research methods. At the level of a single product or a system, the Product Ecology framework helps to select research methods to understand the current experience of product use, and to design new products that improve that experience and evoke social behavior.

Product Ecology Factor	Variables	Questions	Examples of Relevant Research
Product	Function, aesthetics, symbolism, fit, accessibility, mutability	Is the function, appearance, or symbolic quality of the appealing enough to replace products that accomplish the same function? Does it bring social aspects to those functions?	Observations of product use, with think alouds (Bødkur & Buur, 2000); Field tests with working prototypes (Mäkelä, Giller, Tsheligi, & Sefelin, 2000; Tollmar & Persson, 2002).
System of products	Function, aesthetics, symbolism, fit, mutability, to fit with, replace, or augment other components of the system	Is the function, appearance, or symbolic quality enough to augment products that accomplish the same function? Does it bring social aspects to those functions?	Log data of a group of friends accessing a system of products (Koskinen, Kurvinen, & Lehonen, 2002); Diary studies (Frohich, Kuchinsky, Pering, Don, & Ariss, 2002).
Person/people	Age, gender, lifestage, attitudes, dispositions towards new technology	Is the product functionally beneficial? Can the product be valued for initiating or supporting social interaction, or shifting the role of the primary user?	Diary studies; observations; design interventions in public places (Battarbee et al., 2002); longitudinal studies (Forlizzi, 2007).
Roles	Cohort, attitudes, values, projection of values, social and cultural norms	Is the product functionally beneficial for more than one person within the group? Can the product be valued for initiating or supporting social interaction, or positively affecting roles of primary users within the group? Can it affect social structures in a meaningful, ethical way?	Diary studies; longitudinal studies
Environmental and social context: Place	Physical benefits and limitations of a particular place, social and behavioral norms of a particular place, temporal patterns of a particular place	Can the product help overcome limitations of place? Can a place adapt to the product?	Collect stories from people about product experience (Boess, Durling, Lebbon, & Maggs, 2002).

types of place and people's relationship to a place determine their social needs at a given time. Issues of place can be best ascertained with longitudinal observations and site modeling. For example, a visitor to a family home might have different religious needs and rituals that should be addressed independently of the family. People's needs for social intervention in religious rituals is related to how confident they are in performing a particular activity in a particular place, and how well the activity may translate to other environments and social contexts: mobile travel, a public place, or another home.

Factors can be combined to better understand the context for design. For example, combining the factors and methods associated with person and place might raise issues of private and public display of religious behavior. Combining the factors and methods associated with individuals and systems of products might provide insights into how to offer a consistent religious experience over a number of contexts. Combinations of factors may best explain the conditions for new products and systems. Furthermore, the factors can be applied at the level of the individual or the level of a religious community to better understand how the use of new technology products might vary by setting. Returning to the Roomba study cited earlier, opportunities for design improvements to both the vacuums, to better evoke social behavior, and to the home to better accommodate this product were discovered. The Product Ecology can also be used to explore a whole realm of opportunity, for example, in the use of online medical information products, or games in virtual communities.

Finding Out About People

The design and interaction design communities have long recognized the benefit of finding out information directly from the people who will use the product. Participatory Design, Experience Prototyping, Cultural Probes, and Contextual Design have traditionally focused on gathering qualitative data in naturalistic settings. The Product Ecology can be used in combination with these methods to study user-product interaction and the social behavior that results.

Participatory Design

Participatory Design can be broadly defined as a movement to improve the relationship between technology and people. Participatory Design was created by the Scandinavian Collective Resources group, which created a process for inserting workers into processes for the design and management of their own workplaces. The process was iteratively tested through the DEMOS, FLORENCE, and UTOPIA projects (Ehn & Kyng, 1991). The core values of Participatory Design include improving the work conditions of individuals and groups, valuing and retaining human skills in the workplace rather than deskilling, and fostering and extending democracy in the workplace. In the US, Participatory Design has developed with less of a focus on democracy and more on commercial success, spawning the development of Contextual Design (Spinuzzi, 2002).

The role of the mockup, or prototype, is instrumental in Participatory Design. A loosely informal process exists within Participatory Design for using mockups, which is described as the creation of "design games for envisionment of the future work process" (Ehn & Kyng, 1991). Sheets of paper, cardboard, chunks of blue foam, and cardboard boxes are used to offer a hands-on experience of how technology might be engaged relative to the problem at hand. Early prototypes are then refined, often with the assistance of industrial designers, to more closely resemble a possible solution.

Participatory Design research methods, such as user prototyping and prototype evaluation, can be used to codify understanding about users by suggesting possible future scenarios. The Product Ecology can be used with Participatory Design techniques, because it first seeks to understand how products are being used currently, before introducing a new prototype or product.

Experience Prototyping and Prototyping Social Action

Experience Prototyping is a form of prototyping that allows shareholders on a design team to understand existing and future conditions through engagement with prototypes (Buchenau & Fulton Suri, 2000). Experience prototypes are commonly used by a design team to understand existing experiences, for example, the experience of receiving a shock as a patient in a cardiac care unit; to explore design ideas, for example, creating an arrangement of chairs and dividers to represent the interior of an airplane; and to communicate ideas to users, for example, mocking up a video camera with foam controls to prototype the interaction with a new kind of video capture system. In these three examples, we see how experience prototyping can be used in a free form manner throughout all phases of the design process.

Experience Prototyping allows shareholders from various backgrounds to actively engage in the design process. With this method, active, first-hand aspects of prototyping are valued over passive means of understanding experience. As Buchenau and Fulton Suri (2000) point out, "we cannot actually be other people" (p. 432), suggesting how this method may be affected by the bias of those who play a role in the experience prototyping. In many cases, however, this can actually be desirable. An extension of Experience Prototyping is an exercise known as Prototyping Social Action (Kurvinen, 2007). This approach is meant to directly investigate processes of social interaction using designed prototypes. The focus is on human behavior, rather than human conversation, and on behavior in groups, rather than one person using a product in isolation.

Since the Product Ecology focuses on social behavior evoked by products, it could be used in coordination with both these methods to sensitize shareholders on a design team to social interaction with products. For Prototyping Social Action, it is suggested that a conceptual framework is selected, which should be detailed, tried in previous research, and open enough to sensitize designers to social interaction (Kurvinen et al., in press). The Product Ecology approach could be used in coordination with Prototyping Social Action, as well as other frameworks that examine co-experience, conversation analysis, activity theory, or sociology of science and technology (Battarbee, 2004; Kurvinen, 2007; Van House, Davis, Ames, Finn, & Viswanathan, 2005).

Cultural Probes

Cultural Probes were developed as a design-oriented way to acquire inspirational glimpses of communities targeted for design, in an EU-sponsored project on aging communities (Boehner et al., 2007; Gaver, Dunne, & Pacenti, 1999). They support gathering inspirational glimpses of users, returning bits of data over time, since participants are usually at a distance. Historically, they have aligned with approaches from art and critical design; originally they were not subject to any type of methodical analysis. Extensions of and modifications to the probes have had great traction in the interaction design and HCI communities (Boehner et al., 2007; Mattelmaki, 2006).

The goal of Cultural Probes is to inspire the design team with glimpses of the everyday life of those who will benefit from newly designed products. One idea is to use the Product Ecology in coordination with Cultural Probes, coding the data for presence or absence of factors in the Product Ecology to help identify factors of potential interest in conducting probes research.

Contextual Design

The practice of Contextual Design was formalized in the mid-1980s when a majority of industry was looking for ways to make better products. Usability testing as a practice was fairly well established, but could not significantly impact the structure or design of a product because it happened after a product has been designed. Contextual Design emerged in response to the need for a set of practices for going into the field to see how the work practice unfolds (Holtzblatt, 2003).

Contextual Design can be used to address particular issues in a design, evaluate a design that has been planned, or to assess how a stepwise release in the design might be changed. Formulaic procedures are given for each step so that even team members who are unfamiliar with user-centered design processes can conduct Contextual Design. For example, when conducting a contextual interview team members are taught four principles that are used to guide the interview: context, partnership, interpretation, and focus. After the data are collected, they are used to populate five work models, which include the Flow Model, the Cultural Model, the Sequence Model, the Physical Model, and the Artifact Model. These models are then consolidated and combined with an affinity diagram that brings issues and insights across all customers into a wall-sized hierarchical diagram. Selected opportunities are storyboarded to test designs early on. Storyboards essentially function as a future scenario guided by the vision and reined in by the data.

The goal of Contextual Design is to quickly find similarities among users, usually through one interaction in a particular context. Both Contextual Design and the Product Ecology rely on associated models to help organize the data. However, the Product Ecology looks to find subjective differences among people interacting with the same product over time, rather than

through one intervention with users and products. The Product Ecology might be used to help those practicing Contextual Design to flexibly select or add different qualitative research methods when constructing a design research plan.

These examples help to articulate how the Product Ecology differs from other research methods, but also how the Product Ecology might be used in coordination with these methods. For example, in the study of cleaning in the home one may identify the history of technology in the home, the role and gender issues that are present, and the long history of how people use, display, and make relationships with products in the home as important research themes. Once the themes have been identified, research is done over an extended period of time, and from multiple perspectives of a group of users surrounding a product. In the research phase, one might choose to use Cultural Probes, Experience Prototyping, Prototyping Social Action, or to employ other visual or documentary methods. The goal of the Product Ecology theory is to understand how particular products increase or foster social interaction. This is done by researching systems of products to explore an opportunity space, or refined prototypes to understand the social response to particular product features. The Product Ecology has the potential to allow designers to think more clearly about social interactions, and to explore various forms of social behavior that evolves over time using technology products.

The Culture of Design: Flexibility in Seeking Change

As discussed earlier, one motivation for this research is to provide an understanding of how to use qualitative research methods to scaffold explicit knowledge in the world and the implicit knowledge of a design team. This is a key component of the culture of design, which is characterized by particular activities and approaches to choosing research methods.

One view of design culture is of the design team as a self-organizing system in response to a wicked, or unconstrained problem (Löwgren & Stolterman, 1999; Nelson & Stolterman, 2005). Horst Rittel, a mathematician, architect, and designer, extensively studied and compared approaches to problem solving over a variety of disciplines (Rith & Dubberly, 2007). Rittel sought to differentiate the approach of designers and scientists in solving problems, differentiating problem types as either tame or wicked. Tame problems have trivial concerns, are quickly identified, and are solved rationally, practically, and efficiently using linear problem solving methods (Nelson & Stolterman, 2005). On the other hand, wicked problems do not lend themselves to simple characterizations, or to simple procedures for solution. According to Rittel, wicked problems are a "class of social system problems which are ill-formulated, where the information is confusing, where many [shareholders] have conflicting values, and where the ramifications in the whole system are thoroughly confusing" (Churchman, 1967, p. 164). These problems are well suited for intuitive, design-centered approaches to opportunity and solution-seeking.

Nigel Cross (2001) has also attempted to differentiate approaches to problem solving in design, contrasting the rational, positivist approach of Herb Simon with the intuitive, constructionist approach of Donald Schön. Cross (1999, 2001) felt that it is important for the discipline of design to develop its own domain-independent approaches to theory and research, urging members of the discipline to focus on "the 'designerly' ways of knowing, thinking, and acting", the study of the practices and processes of design, and the study of the form and configuration of artifacts as an embodiment of knowledge.

Flexible research and design methods, in addition to best addressing wicked problems, can also be seen as tools for developing the abilities of the design team (Löwgren & Stolterman, 1999). Design researchers and practitioners should be able to develop skills in executing a research plan and trying out different methods. In contexts where new products need to be developed, it is possible to select methods flexibly, choosing methods and structuring a research plan for the situation at hand and the people involved. Such a procedure allows for the designer as self-organizing system, allowing for intuition and reflection on the research process.

One potential problem with methods that are more attitudinal than procedural, such as Participatory Design and Experience Prototyping, is that some aspect of the method may be lost or weakened in the translation. This is because any use or adaptation of a method must inevitably make decisions about which aspects of a method are essential, and which aspects might be modified to suit the current problem at hand. This has been well chronicled in the history of Cultural Probes and their uptake within interaction design and HCI, where it has been argued that what is adopted from a particular research method, in the form of copying and changing a single design method, serves as an implicit valuation of what is essential (Boehner et al., 2007). This is particularly the case with design methods and frameworks that are not clear-cut. Often, what is lacking is a conceptual framework or theory (Kurvinen et al., in press). The associated framework should be detailed, mature enough so that it has been tried out in previous research, and, most importantly, able to sensitize designers to the aspects of experience.

The Product Ecology and the Culture of Design

The Product Ecology framework provides an alternative way of understanding the complex physical and social context of use around a product, and a means for suggesting change within the current state of the world. Like Participatory Design, Experience Design, Cultural Probes, and Contextual Design, it is focused on real world contexts, and plays a role in developing future products. Like Prototyping Social Action, it focuses on groups of people using a particular product or products. Unlike Participatory Design, Contextual Design, or Prototyping Social Action, it allows for exploration of new phenomena arising from groups of factors in combination, and the discovery of how different people think about the same products, creating social, emotional, and symbolic relationships with them. Unlike Cultural Probes, it offers a framework for systematically exploring a design problem and opportunity for change.

To further articulate the differences in the Product Ecology framework, two key points should be highlighted. First, the Product Ecology approach involves doing fieldwork over an extended period of time. Numerous observations are done, including observations of several people interacting with the same product. In addition, Product Ecology fieldwork involves understanding related activities of all people, as well as the physical and social environment in which product use unfolds, the interdependence of how people interact with a product, how people interact with each other around a product, and how the physical and social environment interacts with products.

Second, the Product Ecology framework involves introducing a prototype (or a new product) into the context of the research. This activity serves several functions. First, the prototype acts to codify understanding of the current situation. Next, it serves as a way to investigate a means of improving that situation. Finally, it allows researchers to understand the changes in the Product Ecology over time. In some cases, it may be useful to compare two prototypes or products in order to see comparative changes.

The Product Ecology framework is useful for broadening the view of what a product is. For example, many products are much more than functional objects of use — they serve important emotional and social functions in people's lives. These uses and meanings of products evolve over time and are often not revealed in single-visit fieldwork.

Conclusions

This paper has presented the Product Ecology, a theoretical framework and an approach for conducting qualitative design research with the goal of understanding the complex context of use around a product. Rather than a prescriptive approach to conducting design research, the paper has attempted to endorse a more freeform organization and adoption of methods that allows for the designer's interpretations and sensibilities to play a role in the execution of the research.

As noted in previous work in the community, adopting any kind of research method, including the Product Ecology, is not just a question of methods, but also a question of epistemology (Boehner et al., 2007). While design research offers the fields of interaction design and Human-Computer Interaction new ways for conducting research with people, there still appears to be limitations in understanding how designers evaluate good research (Zimmerman et al., 2007). These concerns must be articulated and addressed for design research to continue to increase its presence in the world.

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