2013

The product service ecology: Using a systems approach in design

Forlizzi, Jodi

The Product Service Ecology: Using a Systems Approach in Design

Jody Forlizzi

The expansive growth of technology, rapid changes in the world, and resulting social outcomes are becoming the domain of designers. These problems and their solutions are exceedingly complex; deriving the optimal solution is extremely difficult. According to Ezio Manzini, any attempt to solve these problems requires a shift from a product to a service economy, a systemic approach that serves a social economy and obliges social innovation to uncover the optimal solution [Manzini, 2011]. These design solutions must aggregate different stakeholders, actors, resources, materials, and users to identify a problematic situation and develop an actionable solution, and requires reasoning and judgment in deciding how to proceed.

Manzini maintains we can't design complexity, or even neatly predict it. Creating an optimal solution for a wicked problem, even as an informed designer, is nearly impossible. How can designers meet these demands?

In this paper, I propose that we can design conditions for systems that improve the world and impact human behavior in a positive way. I argue that we can do this by using a systems framing in three acts: moving from *problem solving* to *problem seeking*, from *sketching* to *modeling and abstracting relationships*, and from *prototyping solutions* to *understanding how potential solutions will perturb the system*.

To do so, I propose using a framework called the Product Service Ecology, which allows designers to look at a situation holistically, understanding a system and its part-whole relationships. The framework allows designers to access knowledge from other disciplines in creating a solution, either from domain experts, literature search, or other research methods. It allows

designers to understand the role of people within the system, whether they are consumers, clients, or other stakeholders. The framework allows a solution to unfold first as a set of descriptive statements that are used to guide the solution generation process. Potential solutions are then tested through prototypes to understand how they perturb the system. To create these prototypes, designers leverage existing methods from product, service, and interaction design that they are already familiar with.

Using this approach, the designer or design team can weigh the benefits and costs of a design intervention on a situation that has been deemed problematic, assess the potential effects to other parts of the system, and feel confident that the proposed solution is the “ultimate particular” [Nelson and Stolterman, 2012] — the optimal one for a particular problematic situation. The final solution takes the form of a meta-design, a plan for rectifying a problematic situation. It creates the resources for a solution to unfold within the system and a means for understanding the benefits and potential drawbacks for what will be designed.

When using the Product Service Ecology as an approach, there are two critical constructs that influence how it is used. The first is the construct of serving [Remen, 2003]. Sometimes, we approach problems with the notion that we are going to help someone or fix something. Helping incurs debt, and implies that we are above the person we are helping, that we have more importance or dominance. Fixing implies that something is broken and needs to be repaired. Serving eliminates the perceived hierarchy of the aforementioned constructs.

The second is that the designer is internal to the system under scrutiny, not an outsider who has little understanding about what an improved future state might be [Checkland, 2000]. In this view, the system includes the interaction of all who are affected by it and play a role in the co-construction of new artifacts, environments, services, and sub-systems into the existing system and in creating and communicating a preferred future state.

Additionally, when the designer is internal to the system, empathic and ethical imperatives exist for the designer to make the best possible judgments to resolve the problematic situation. Designers and design teams can ensure the ethical and purposeful quality of their designs by asking questions such as what is (the current situation); what ought to be (the ethical imperative for the situation); what might be (a set of all possible properties of the system to meet this imperative); and what will be (the set of properties that will be found in the final design of the solution that is deemed best for the situation). These statements can be used to achieve consensus from all of the stakeholders surrounding a system throughout the design process, insuring the co-creation of value in developing and implementing a solution.

In the next section, the Product Service Ecology is briefly introduced. It is first used in a descriptive way to understand the system under study; next, it is used in a generative way to understand how to design a new and improved future state. A case study is presented to exemplify how the system can be used.

The Product Service Ecology

The Product Service Ecology is an ecological system, inspired by social ecology theory, which takes a systems approach to describe and understand the dynamic relationships between people, products, social activities, and the context that surrounds a system [Forlizzi, 2008]. In the Product Service Ecology, the system of products and services is the central unit of analysis. The functional, aesthetic, emotional, symbolic, emotional and social dimensions of the products and services within the system, combined with other units of analysis in the ecology, help describe how social behavior evolves within the system. These include the relationships among products and services within and external to the system; the services that tie the products together; the people who use the system, and their attitudes, disposition, roles, and relationships; the physical structure, norms and routines of the places where behavior unfolds; and the social and cultural contexts of the people who use the product and even the people who make the product (Figure 1).

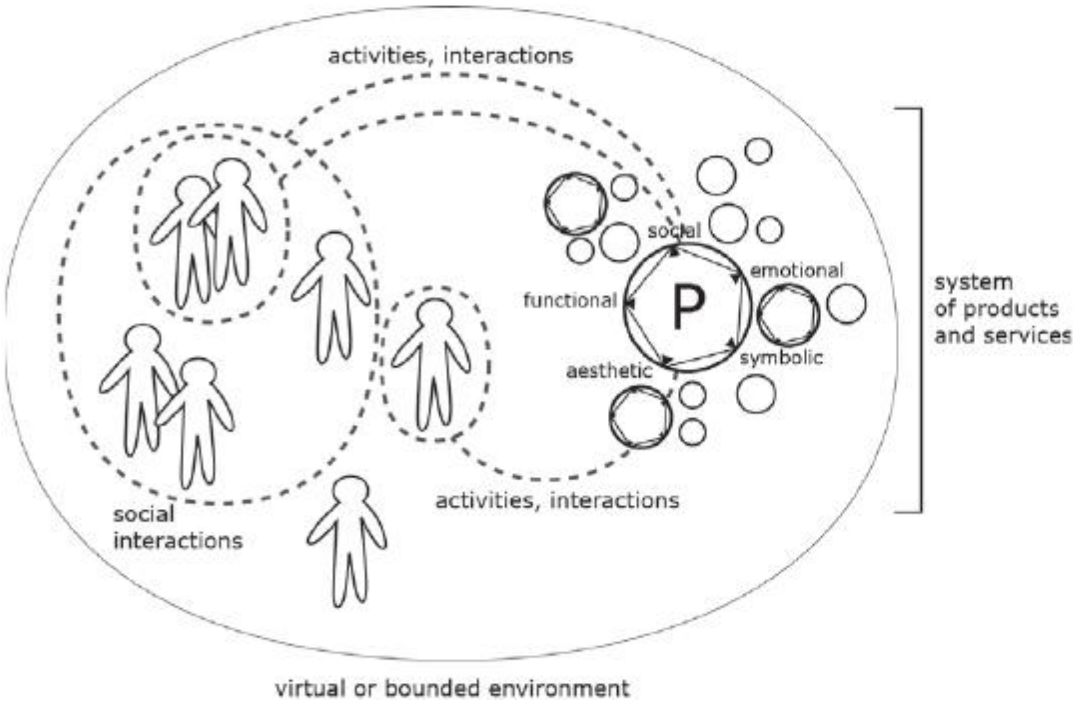

Figure 1. A schematic diagram of a Product Service Ecology, showing products, people, the built and social environment, and the social and cultural context of use surrounding a product.

The Product Service Ecology allows designers and researchers to evolve a rich picture of a system of products and services. It can be used to focus on small details such as individual product features, or broader issues such as the social and informational context surrounding a system. It allows for the notion of context, which originates from both social and technical perspectives, to be rectified into a unified view, with the goal of improving the world through what is designed.

Using the Product Service Ecology to Represent a Situation

To represent a complex system, designers need to rely on visual thinking and visualization processes to communicate the complexity of a system in a salient way. One approach that has been developed is GIGA-mapping, a technique for mapping out factors and relationships across multiple layers and at multiple scales [Sevaldson, 2011]. The GIGA-map is comprised of a number of individual models and representations of a system and component parts. These include mind maps, causal loop diagrams, information visualizations, diagrams and models, collages, user journeys, and service blueprints. Mind maps are used to visually organize related information, such as a category and sub-categories. Causal loop diagrams use nodes and values to visualize the interrelationships between two factors in a system. Information visualizations abstract information to reinforce key ideas and the cognitive processes that facilitate data processing. Diagrams and models also abstract information to make meaning, but are designed so as to convey a judgment about the most important aspect of a system. Collages are collections of images that are often used to convey emotion or to suggest a set of inspirational values for a design team. An experience journey maps out the experience of one stakeholder through a service transaction, focusing on the positive and negative emotional aspects of the experience, as well as potential service breakdowns. A service blueprint, borrowed from operations research and marketing, maps out the processes and resources that are used to enact a service [Bitner et al, 2007; Shostack, 1982]. Collectively, these diagrams serve as both a sketching tool in the design development phase and a guide for service enactment in the operation phase. A service blueprint is well suited for representing the stakeholders in the design, the service touchpoints, and the linear flow of service components such as interactions with people and products.

By mixing representations, designers can increase the clarity of their work and communicate what the relationships are between aspects of the system and if any gaps or any salient areas should be examined for redesign.

Using the Product Service Ecology to design

The Product Service Ecology can be used to design new systems of artifacts, products, services, and other systems. It can also be used to integrate the perspectives and knowledge of other disciplines. It unfolds in a four-part iterative process, inspired by Nelson's framework for social systems assessment: synthesis, analysis, redesign, and communication (Figure 2) [Nelson, 2003]. When resolving a problematic situation, a designer or design team moves from step to step, but the steps are iterative and not neatly demarcated over time or as a process.

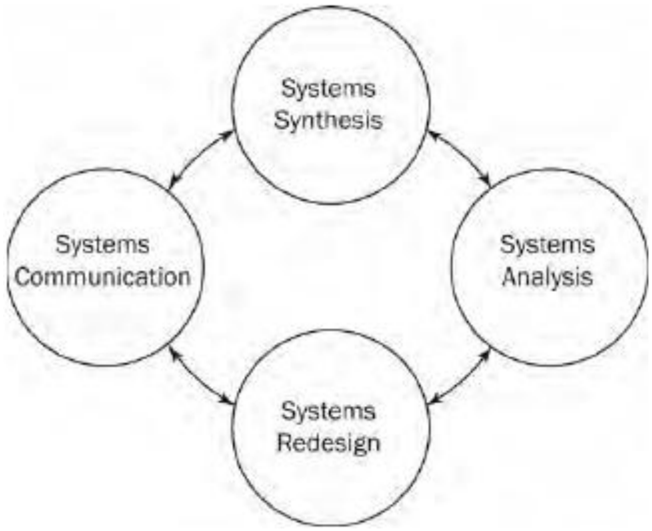

Figure 2. A schematic showing how the Product Service Ecology is used to design.

The first step in using the Product Service Ecology is to *synthesize* the ecological system under study. The designer, or design team, work to understand the system holistically and how it situates among other systems.

The systems *analysis* phase incorporates the understanding gained from the synthesis phase to reveal the structure of the ecological system. This is not to analyze component parts, but rather to understand the organization and framing of the system. The designer's perspective plays a critical role in

understanding the current structure, as well as describing a proposed structure and organization for a redesigned system.

In the systems *redesign* phase, plans and solutions take shape for putting a new and improved ecological system into place.

In the systems *communication* phase, the future is communicated to other stakeholders. The future ecological system can be represented using models, diagrams, experience maps, scenarios, and even prototypes or enactments.

Product Service Ecology synthesis

The first step in using product ecology is to *synthesize* the ecological system under study. In this stage, the designer or design team attempts to understand the system holistically [Nelson, 2003]. They may move from an initial problem statement to their own view of the system, seeking problematic situations instead of assuming the right ones to solve are evident. During synthesis, the system is interpreted factually and logically with the goal of understanding as much as possible. Various systems approaches and knowledge and research findings from other disciplines may be incorporated to further this purpose.

As a first step, each person involved with the systems redesign can start by mapping out what is known and what is assumed. Reconciling representations is useful to reveal any biases or perceptions that may play a role in the design team. The process of GIGA-mapping, creating multi-layered visualizations to help understand structure and complexity, is useful during the synthesis phase [Sevaldson, 2011]. These representations happen at varying levels of scale. Using a GIGA-map, designers can map the structure of a system and delineating the process through which something unfolds. It is common to work with imprecision or without understanding everything at first. True systems thinking works from documenting as much as is known at first and then developing thinking that further informs the understanding of the system.

A more formal process for creating a shared understanding of a system is Contextual Design. In the field of HCI, Contextual Design was a formative step towards a systemic approach to understanding people and the context around a design situation [Holtzblatt and Beyer, 2002]. Contextual Design took form in the mid-1980s when industry was looking for ways to make better products. As a practice, usability was fairly well established, but could not significantly impact the structure or design of a product because it happened after a product had been designed. Contextual Design, a set of practices for going into the field to see how the work practice unfolds, emerged in response to this need. The first part of this process, a Contextual Inquiry, takes place a designer or design team spends an hour or two with a stakeholder in the context of his home or work. Observations and interviews are conducted. A detailed analysis of the data is performed and a series of models are created to understand different aspects of the system under study.

Next, based on the knowledge that has been generated from mapping and modeling exercises, system designers can begin to map out research themes, understanding where knowledge can be drawn from other fields. A literature review must be performed that situates the work and demonstrates how a particular system framing can be taken into consideration.

It is also critical to think about the stakeholders within the system during the systems synthesis phase. Here, a more philosophic approach that considers the role of people within the system under scrutiny can be needed. For example, the Participatory Design movement had a goal of improving the relationship between technology and people. Participatory Design was founded 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, 1991; Spinuzzi, 2002]. 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. Valuing all stakeholders and their goals and actions is critical for during the synthesis phase.

Additionally, as much information as possible must be collected about the social and cultural contexts of the stakeholders within the system. Here, in addition to user-centered research methods, the designer may rely on theories of human behavior, information from cognitive, social, and organizational psychology, and other relevant fields.

Finally, in the synthesis phase, it is critical to understand the designer's position relative to the system under scrutiny. While the Product Service Ecology framework operates under the assumption that the designer is internal to the system, the system may not have been created with the same consideration. Understanding the designer's relative position to a system is critical in understanding the relationship between people and the system under study. In an ecological view, human interaction with the world is viewed as a system itself. This, in turn, shapes the design process and directs progress towards a solution that will benefit all stakeholders within the system.

Ultimately, the goal of this phase is to derive a thorough understanding of the social, economic, cultural, and technological context around the system.

Product Service Ecology analysis

In the Product Service Ecology *analysis* phase, the designer or design team builds on the holistic understanding gained from the synthesis phase to reveal the deeper structures of the system and the relationships between elements and subsystems. They move from sketching and modeling to

abstracting relationships in the system under scrutiny. The goal of analysis, as it is in some other efforts, is not to break down and analyze by component parts, but rather to understand the structure, organization, and interconnections of the system as it relates to the whole [Nelson and Stolterman, 2003].

In the Product Service Ecology, the factors within the system include the products with its functional, aesthetic, social, emotional, and symbolic aspects; the services, or human enacted aspects of the system; the people involved in the system; and the physical, social, and cultural contexts surrounding the system. Each of these are understood in turn.

The first step in the analysis phase is to create a Product Service Ecology diagram. This is a comprehensive map of the system under scrutiny, showing all of the products, services, the actors, the Product Service Ecology factors, and the context in which human behavior unfolds. This diagram serves as a means to understand all of the factors in the system and their relationships to one another.

Next, a matrix is created to explicitly draw out detailed relationships among factors. Using this matrix, the designer or design team can begin to understand the inputs and outputs for each factor in the system, including information, value, interaction, and economic transactions. Table 1 illustrates this matrix and poses some example questions to ask during the analysis phase. These questions help select and guide modes of inquiry in the analysis phase and reveal the rich interconnections between the subsystems.

Table 1. Subsystems and factors in the product ecology, along with inputs and outputs to consider to reveal information about subsystems and interconnections within the system.

	Inputs and Outputs			
	What	Value	Interaction	Social outcomes
Factors				
Product/Service: Function, aesthetics, symbolism, fit, accessibility, mutability				
System of products/services: Function, aesthetics, symbolism, fit, accessibility, to fit with, replace, or augment other components of a system				
Stakeholder: Age, gender, lifestage, attitudes, values, dispositions towards new technology				
Roles: Cohort, attitudes, values, culture, projection of values, social and cultural norms				
Physical environment: Physical qualities of a space that affect product use and service enactment. Social and behavioral norms of a particular place, or temporal patterns of a particular place.				
Social and cultural norms: Behaviors that identify as a group				

During the analysis phase, the designer or team must often reframe the problem to fully understand the structure and interconnected behaviors of the system under scrutiny. These framings provide lenses for describing that which is, and scaffolds for creating leaps to what might be in terms of a redesign. Framings are made evident through ethnographic methods that are familiar to many practitioners of user-centered design and to researchers conducting research through design. A good overview of methods can be found in [Hanington and Martin, 2012]. In addition, methods such as personas [Reimann and Cooper, 2000] and scenarios [Ericsson, 1995] are used to create abstractions of stakeholders to assist in analyzing the system at hand.

Product Service Ecology redesign

In the Product Service Ecology *redesign* phase, designers create plans and solutions for putting a new and improved system in place. The system is reconceived as a whole, and through this activity, the designer or design team strives to understand how the prototype solutions they create will perturb the system.

Designers begin with descriptions and models that represent the current system, then move to the potential and finally the ideal product service system [Shostack, 1982; Johnson and Henderson, 2002; Johnson and Henderson, 2012]. Here, the designer's judgment, perspective, and choice play a role in framing the future system, laying out a vision of that which ought to be, that which might be, and that which should be. Many possible futures are envisioned and described, and through prototyping, decisions are made about how to refine the composition of the system to be and how it will change and behave over time. A future system is developed by creating and evaluating many potential framings with stakeholders to refine the form and eventual structure of the system. The goal is to represent the future system and its subcomponents in a way that rearrangement or alteration of one element and its effects on the whole can be clearly understood. To do this, service models and iterative prototypes can be used.

The domain of service design offers several approaches to modeling complex systems, including molecular modeling [Shostack, 1982], conceptual models [Johnson and Henderson, 2002; Johnson and Henderson, 2012], engineering process charts, PERT charts, flow diagrams, and service blueprints [Morelli, 2002]. Using conceptual models, blueprints, and experience journeys, a coherent proposition for system redesign can be explored as designers can see how the components of a system can function in coordination. A conceptual model produces a high-level description of how a system is organized and operates [Johnson and Henderson, 2002; Johnson and Henderson, 2012]. An experience journey examines the process of each stakeholder when using and providing information. A service blueprint maps how resources are created to enact a product service system.

Conceptual model

A conceptual model represents aspects of the system to be redesigned, relying on abstractions of reality to clearly depict a situation. A conceptual model can serve as a classification, a set of elements, a process, an activity, or a depiction of interactions between people and things. Figure 3 shows a conceptual model Starbucks coffeeshops. A process model communicates the process of ordering coffee; an element model shows the most popular drinks. A structure is chosen to best represent the way elements in the model are interrelated.

As designers create a conceptual model, they delineate the many relationships between its substructures. Processes may be represented as linear, circular, branching, or as relationships, using spider or Venn diagrams. A good, simple checklist and examples can be found in [Roam, 2008].

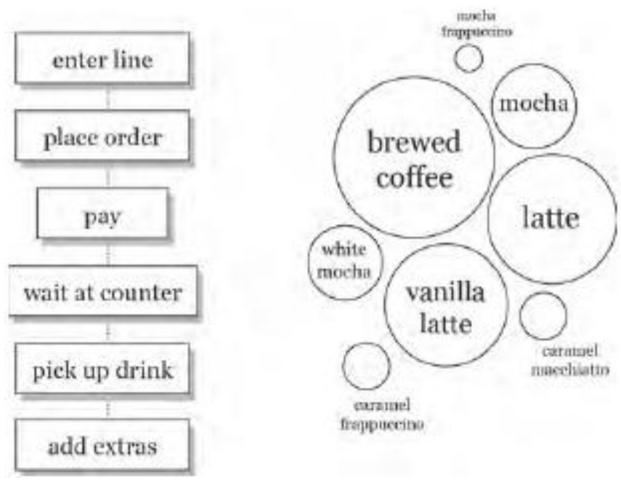

Figure 3. Conceptual model of Starbucks. Left: Process model of getting coffee. Right: Element model of the most popular drinks.

Experience journey

An experience journey diagrams the steps of an individual stakeholder when engaging with a product service system. Here, the designer or design team analyzes the arc, or flow, of experience in a given situation. They also examine touchpoints, or the places where stakeholders interact with products and services within the system. Experience journeys often focus on the emotional valence, the arc of experience, or even the breakdowns that occur during a particular experience. Figure 4 illustrates an experience journey of travelling by flight.

To create an experience journey, the design team focuses on problems or needs that stakeholders within the product service ecology may face. These are broken down into conceptual scenes and actions. Problematic moments are studied and addressed in the redesign phase.

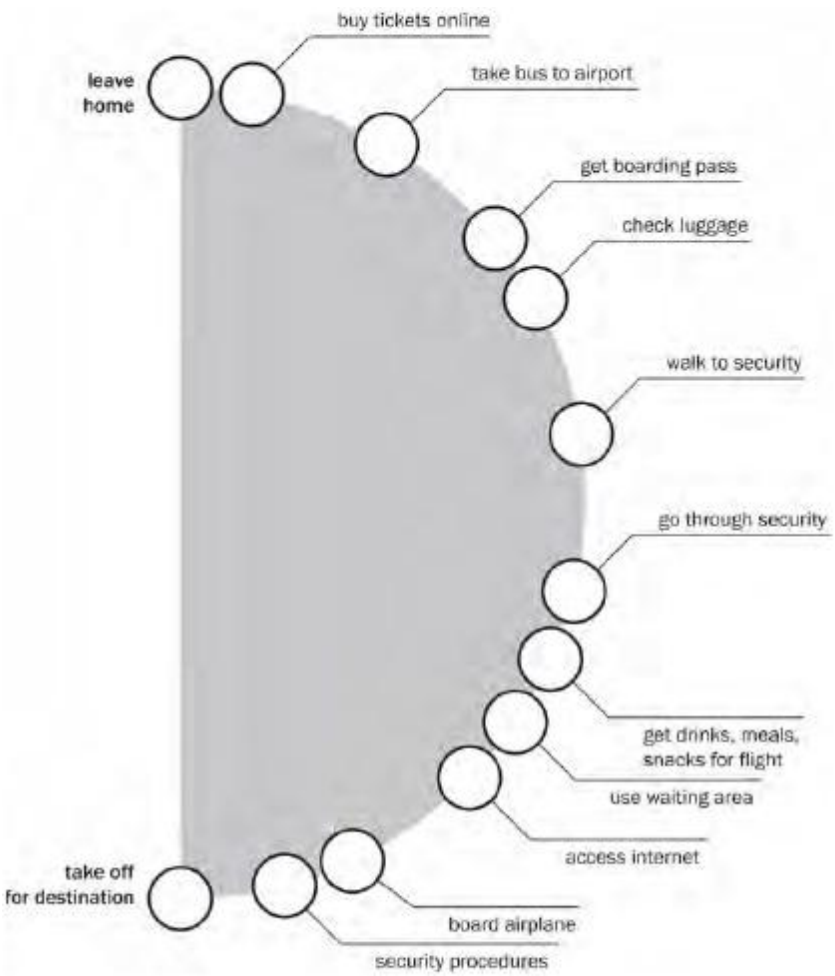

Figure 4. An experience journey of airport travel.

Service blueprint

A service blueprint charts the resources needed to enact the redesigned product service system. It shows the visible actions of each stakeholder both as information providers and information users, internal or unseen interactions of stakeholders and groups, the role of artifacts and services, and other support processes. To create a blueprint, designers categorize each item, define the processes, identify the stakeholders and their visible and tactical actions in using and providing information, and specify the environment and the roles of individual products and services within. Figure 5 shows the service blueprint of a robotic snack delivery service.

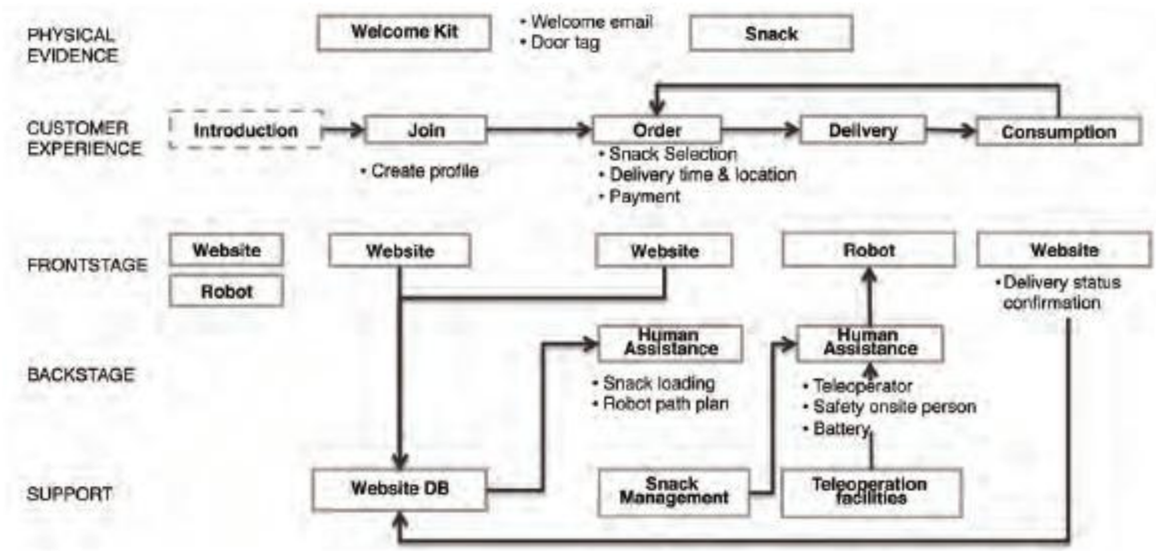

Figure 5. Robotic snack delivery service blueprint. Originally published in [Lee and Forlizzi, 2009].

These representations become the basis for design team coordination and can be used as a communication tool to keep all team members in agreement, to develop personas and scenarios of use, and to consider the implications of redesigned product service systems that are intended to improve the world.

Once the Product Service Ecology representations are created in the form of conceptual models, experience journeys, and service blueprints, the design team then begins to iteratively build and conduct future enactments of aspects of the service. This process may start with paper and cardboard, harkening back to the days of Participatory Design; over time, environments can be crafted that recreate aspects of the product service system with enough fidelity that stakeholders can suspend belief and interact with the future system under development. Other designers have developed iterative, more detailed prototypes for service designs; these include a discussion, a walkthrough, a simulation, and a full-scale pilot [Polaine, Løvlie, and Reason, 2013].

For example, Experience Prototyping is a method that allows shareholders on a design team to understand existing and future conditions through engagement with intangible aspects of a design [Buchenau and Fulton-Suri, 2000]. Experience prototypes can be used by a design team to understand existing experiences, like receiving a shock as a patient in a cardiac care unit; to explore design ideas, like 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 is used throughout all phases of the design process.

To extend this active, first-hand method of creating prototypes and understanding how they perturb the system, my research group extended a method called speed dating, where we use demonstrational prototypes to "field test the future" [Davidoff et al, 2007; Odom et al, 2012]. In this type of work, research with stakeholders in the system usually done through interviews and observations are synthesized and analyzed. Concepts are generated to explore the design space and potential futures. These are clustered thematically to more clearly articulate visions of both preferred and undesirable futures. Based on our fieldwork, the clustered themes, and the concepts themselves, we iteratively develop scenarios to show and enact possible futures to our audience.

In real-life speed dating, people have props such as a wine glass, a café table and candlelight. They go on many very short dates in a single evening, and at the end, they know very little about any of the people they met. However, they have developed a much better and more realistic vision of what they want in a partner. The user enactments follow the same approach, where stakeholders find themselves in a familiar scene, and they experience a "sip" of what the future might be like. Scenes are rendered with enough fidelity for stakeholders to suspend belief and try out the proposed changes to the system. Figure 6 shows a highly refined teenage bedroom, part of a system used to evaluate how social behavior would change through new social networking systems and associated metadata.

Following the enactments, stakeholders are asked to reflect on their current practices and then on their desires for the future. By combining wide exploration across multiple structured engagements, user enactments provide a broad perspective to understand changes to the system and to explore hidden social boundaries.

Figure 6. A set of a teenage bedroom that was created for user enactments in speed dating. Originally published in [Odom et al, 2012].

Product Service Ecology communication

The communication of the systems redesign functions as a vision, a representation of an unfolding purpose [Nelson and Stolterman, 2003]. When communicating this vision, the systems designer plays a role in sharing the intrinsic motivation for the redesign with other stakeholders within the system, showing the outcome of an improved future state.

Designers know how to communicate a solution in traditional design contexts such as industrial design, communication design, and interaction design. However, in systems design, a much wider range of actors and situations must be addressed. The goal of the Product Service Ecology *communication* phase depicts the future state to other stakeholders and to consider the far-reaching implications of the design. To do so, designers must communicate the system's redesign in a clear and holistic manner for all, including the perceived benefits and risks. They must also transfer ownership of the system from the designers to the stakeholders themselves.

When we communicate our vision, we share the abstract picture we have created in our imagination. Although this is most commonly done in the form of a sketch or model, prototypes, enactments, and outcomes of new modifications to existing systems inform and persuade others, allowing them to see the same things.

The Product Service Ecology of snacking

Over the course of four years, my research group explored snacking and its relation to healthy meals through a series of studies and systems developments [Lee and Forlizzi, 2009a; Lee et al, 2009b; Lee et al, 2010; Lee et al, 2011; Lee et al, 2012a; Lee et al, 2012b]. We hoped to explore the context of snacking and our organization, developing a product service system that would inspire positive behavioral change.

Nearly 65% of the world's population lives in countries where obesity and associated diseases kill more people than underweight diseases [WHO, 2012]. In addition, snacking is practiced by a majority of people in the developed world [Bellisle et al, 2003; Ovaskainen et al, 2006; Verplanken, 2006]. In workplaces, people snack in their offices and labs as well as in social spaces, cafeterias, and food vending areas.

Obesity and healthy food choices is also a societal problem where researchers and product developers have begun to focus. However, many questions remain unanswered about how design might help to support positive behavior change over the long term. We chose to use a systems framing to explore this problem, going beyond the individual to include other critical stakeholders such as colleagues, families and supporters, trained professionals such as dieticians and personal trainers, restaurants and food service providers, and even policy and lawmakers.

To synthesize the problem, my research group began by interpreting what it knew and what is assumed about snacking. Our context of exploration was one of the buildings on our campus. There, people work many long hours, and snack 24 hours a day. Snacks can replace meals and their consumption can represent commitment to hard work.

Snacking: Systems synthesis

We also considered our roles as designers relative to the system under study. After reviewing the literature on snacking, organizational behavior, and technology interventions that improve human behavior, we framed our problem as one of designing technology systems that increase people's healthy behavior choices. Our goals were to 1) develop designs to impact behavior around snacking in a beneficial way, and 2) to develop a product service ecology that would result in positive social outcomes.

Snacking: Systems analysis

In the analysis phase, we used a variety of ethnographic research methods to understand the activity of snacking, the context of interest and the shareholders that played a role. These ranged from observations and interviews in our office buildings, observation of a campus hot dog vendor, a competitive analysis of location of snacks and relative distances from the campus building, and a site analysis of the system that we hoped to improve.

We learned some interesting things (reported in [Lee et al, 2008]), including that for many younger people, snacks replace meals for days at a time; social behavior can drastically affect snacking (i.e., what kinds of snacks are consumed and when; that leaving the building for a snack is a break from work and routine). We also explored the behavioral economics literature [Lee et al, 2011] to understand the role of choice vs. default in decision-making. From this, we became interested in the role of social behavior in helping to make healthy snacking choices.

At this time, we also became interested in the role of robotic technology in the new and improved system. We reasoned that autonomous technology, in the form of a robotic product and service, could explore social behavior in the role of supporting healthy snacking. For example, a robot could form a social relationship with its client, remembering what snacks have been ordered and making suggestions for new ones. It could also evoke social behavior to increase trust and rapport in the system.

To progress our analysis, we used the Product Service Ecology matrix to capture some of the interconnections between the components of the system. Table 2 captures the results of our synthesis for the product service ecology of snacking.

From this effort, we developed three goals in developing a new product service system devoted to helping people make healthy snack choices. First, we wanted to develop the system holistically. Rather than advancing robotic technology or focusing on one part of the interaction, such as a dialogue system, we approached the problem at a systems level. This approach allowed us to think about the emergent qualities of the prototypes we would create and test, which might not be evident if we developed a piecemeal solution. Second, we chose to simultaneously develop a robotic product and service. The system would need to do something useful for people, and sustain their interest and engagement over time. Using autonomous technology meant that we could collect and record information about people's behavior over time, deeply understanding how our solution would perturb the existing system. Third, we wanted to develop a product service system that would evoke positive social behavior. This would ensure that people would engage with the robot over time, and that we could research trust, engagement, and rapport

Table 2. The Product Service Ecology matrix used to understand some of the implications of proposed changes to the system in the form of our designs.

	Inputs and Outputs			
	What	Value	Interaction	Social outcomes
Factors				
Product/Service: Function, aesthetics, symbolism, fit, accessibility, mutability	Robot, operators, website, service, order fulfillment	Fresh, high quality healthy snacks on order	Routine snacking, special events, social chat	What happens if a system “knows” your preferences, evoke more healthy snacking
System of products/services: Function, aesthetics, symbolism, fit, accessibility, to fit with, replace, or augment other components of a system	Office candy bowls, vending machines, cafeteria, local cafes	Snacks available 24/7, snack as meal so work can continue	Walk to a new location for a snack, social break from the workplace	Develop social routines outside of the organization
Stakeholder: Age, gender, lifestage, attitudes, values, dispositions towards new technology	Customers, designers, researchers, operators, order fulfillers		Coordination, socialization, service	Social routines, positive and negative ripple effects
Roles: Cohort, attitudes, values, culture, projection of values, social and cultural norms	Role in organization			Increase dialogue between roles, role switching
Physical environment: Physical qualities, social and behavioral norms, temporal patterns of a particular place	Properties of university office buildings, local cafes	Increase local business, interaction with community		
Social and cultural norms: Behaviors that identify as a group	Change snacking routines	Make healthy snacks available	Explore the role of personalized service	Increase rapport, liking, use of service

Snacking: Systems redesign

The Snackbot, a product service system that features a robot and a snack delivery service, was iteratively developed to explore these questions (Figure 7) [Lee et al, 2009b]. Stakeholders include customers, others in the workplace, the robot developers, designers, and researchers, the robot's assistants, and the people who obtain and load the snacks on the robots. The context of use and the norms of the workplace were also considered. A dialogue system was developed to foster natural interaction with the snack delivery service. A component of the system tracked information about customer behavior and preferences over time.

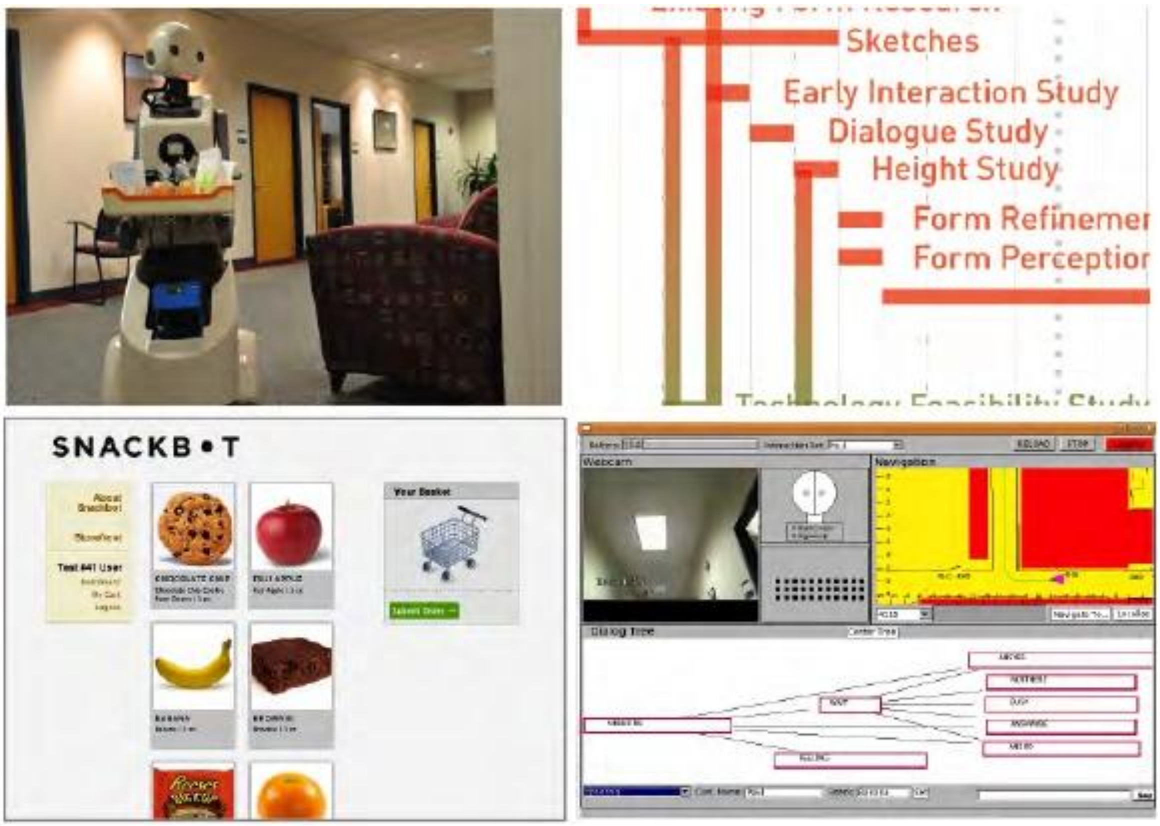

Figure 7. The Snackbot, a product service system to foster healthy snacking in an organization. Upper left: the robot. Upper right: The service design. Lower left: Web site for placing snack orders. Lower right: Dialogue system for interaction with customers.

As designers, we strove to understand the overall impact to the system under study by varying aspects of the system's behavior and then understanding how these outcomes might positively or negatively affect the system. For example, a study on recovery from service breakdown showed that while for some stakeholders, an apology would suffice, others wanted to feel in control of the service by having other options presented or to receive something for free [Lee et al, 2010]. Other studies explored the effects of a personalized snack delivery service and the positive and negative effects that offering personalized service has in the workplace [Lee et al 2012a, Lee et al, 2012b]. We examined the role of choice in offering and encouraging people to choose healthy snacks like fruit over cookies and cakes [Lee et al, 2011]. We also created new knowledge about how technology systems might adapt to their stakeholders over time [Lee et al, 2009a].

Snacking: Systems communication

We are currently in the systems communication phase of our system, helping all of our stakeholders to see and realize the vision of a new way of offering healthy snacks in our office buildings. Our goal is to develop a long-term relationship between stakeholders and the system we have developed, and to support positive behavior change over the long term.

Conclusion

This paper presented the Product Service Ecology, an approach for identifying and improving a problematic situation through a systems redesign. It is meant to guide the design team in *problem seeking* — creating judgments about improving the state of the world, in *abstracting relationships* — looking at the system at macro and micro levels to understand it holistically and analytically, and in *perturbing the system* — creating prototypes which will suggest an optimal systems redesign while understanding the implications of the system put forward. I have demonstrated through a case study how using the Product Service Ecology, a designer or design team can weigh the benefits and costs of a design intervention on the current state.

The skills required by designers are rapidly changing, and no single discipline can solve this. I hope this is the first step to creating opportunities for action, empathy, and energy in putting a redesigned system into place.

References

Bitner, M.J., Ostrom, A.L., and Morgan, F.N. (2007). Service blueprinting: A practical tool for service innovation. California Management Review, 50, 3, 66–94.

Buchenau, M., & Suri, J. F. (2000, August). Experience prototyping. In Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques (pp. 424-433). ACM.

Checkland, P. (2000). Soft Systems Methodology: A Thirty Year Retrospective. Systems Research and Behavioral Science, 17, S11-S58.

Davidoff, S., Lee, M., Dey, A., et al. (2007). Rapidly exploring application design through speed dating. Proceedings of UbiComp07. New York, NY: IEEE Press, 429-446.

Ehn, P. (1991). Cardboard Computers: Mocking it up or Hands on the Future. In Joan Greenbaum and Morten Kyng, Eds., Design at Work: Cooperative Design of Computer Systems. Hillsdale, NJ: Lawrence Erlbaum Associates, 169-195.

Erickson T. (1995). Notes on design practice: Stories and prototypes as catalysts for communication. In J. Carroll, Ed. Scenario Based Design. Blackwell, VA: Virginia Tech Press.

Forlizzi, J. (2008). The Product Ecology: Understanding Social Product Use and Supporting Design Culture. International Journal of Design V2N1, 11-20.

Hanington, B., and Martin, B. (2012). Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions. Rockport Publishers.

Holtzblatt, K. and Beyer, H. (1998). Contextual Design: Defining Customer-Centered Systems. San Francisco, CA: Morgan Kaufmann Publishers.

Johnson, J., and Henderson, A. (2012). Conceptual Models: Core to Good Design. Morgan and Claypool.

Johnson, J. and Henderson, A. (2002). Conceptual Models: Begin by Designing What to Design. interactions 9/1, 25-32.

Lee, M.K., Kiesler, S., Forlizzi, J., and Rybski, P. (2012a). Ripple Effects of an

Embedded Social Agent: A Field Study of a Social Robot in the Workplace. Proceedings of CHI12. New York, NY: ACM Press, 695-704.

Lee, M.K., Forlizzi, J., Kiesler, S., Rybski, P., Antanitis, J., and Savetsila, S. (2012b). Personalization in HRI: A Longitudinal Field Experiment. Proceedings of HRI12. New York, NY: ACM Press, 319-326.

Lee, M.K., Kiesler, S., and Forlizzi, J. (2011). Mining Behavioral Economics to Design Persuasive Technology for Healthy Choices. Proceedings of CHI11. New York, NY: ACM Press, 325-334.

Lee, M.K., Kiesler, S., Forlizzi, J., Srinivasa, S., and Rybski, P. (2010). Gracefully Mitigating Breakdowns in Robotic Services. Proceedings of HRI10. New York, NY: ACM Press, 203-210. Best Paper Award.

Lee, M.K. and Forlizzi, J. (2009a). Designing Adaptive Robotic Services. Proceedings of IASDR09. New York, NY: ACM Press, available on CD-rom.

Lee, M.K., Forlizzi, J., Rybski, P.E., Crabbe, F., Chung, W., Finkle, J., Glaser, E., and Kiesler, S. (2009b). The Snackbot: Documenting the Design of a Robot for Long-Term Human-Robot Interaction. Proceedings of HRI09. New York, NY: ACM Press, 7-14.

Lee, M.K., Forlizzi, J., and Kiesler, S. (2008). How do people snack? Understanding the context of a mobile robot snack service. Unpublished manuscript, Carnegie Mellon University, Pittsburgh, PA, 15213.

Manzini, E. (2011). Introduction In Design for Services, Eds. Anna Meroni and Daniela Sangiorgi. Burlington, VT: Ashgate Publishing Company, 1-6.

Morelli, N. (2002). Designing Product/Service Systems: A Methodological Exploration. Design Issues, 18, 3-17.

Nelson, H. G. and Stolterman, E. (2012). The Design Way (Second Edition). Boston, MA: MIT Press.

Nelson, H.G. (2003). The Legacy of C. West Churchman: A Framework for Social Systems Assessments. Systems Research and Behavioral Science Syst. Res. 20, 463-473.

Odom, W., Zimmerman, J., and Forlizzi, J. (2012). Investigating the presence, form, and behavior of virtual possessions in the context of a teen bedroom. Proceedings of CHI12. New York, NY: ACM Press, 327-336.

Polaine, A., Løvlie, L., and Reason, B. (2013). Service Design: From Insight to Implementation. Brooklyn, NY: Rosenfeld Media.

Reimann, R. and Cooper, A. (2000). About Face 2.0: The Essentials of Interaction Design. New York: Wiley.

Remen, R.N. (2003). In the Service of Life. Consciousness and Healing, Integral Approaches to Mind-Body Medicine.

Roam, D. (2008). The Back of the Napkin: Solving Problems and Selling Ideas with Pictures. London, UK: Penguin Books.

Selvadson, B. (2011). GIGA-Mapping: Visualization for complexity and systems thinking in design. Proceedings of NORDES 2011. http://ocs.sfu.ca/nordes/index.php/nordes/2011/paper/view/409, accessed November 3, 2013.

Shostack. G.L. (1982). How to design a service. European Journal of Marketing, 16, 1, 49-63.

Spinuzzi, C. (2002). A Scandinavian Challenge, US Response: Methodological Assumptions in Scandinavian and US Prototyping Approaches. Proceedings of SIGDOC02. New York: ACM Press, 208-215.

World Health Organization Obesity Fact Sheet, May, 2012. http://www.who.int/mediacentre/factsheets/fs311/en/, accessed September, 2012.