CHAPTER

16 Designing the Ecology and Pervasive Information Architecture

Highlights

- Designing for ecological needs.
- Creating an ecological design.
- Example: An ecology for a shopping application within a pervasive information architecture.

16.1 INTRODUCTION

16.1.1 You Are Here

We begin each process chapter with a "you are here" picture of the chapter topic in the context of The Wheel, the overall UX design lifecycle template (Fig. 16-1). In this chapter, we describe how to design for the foundational layer of the human needs pyramid—the ecology.

In Section 12.3, we discussed how ecological needs are about the overarching and encompassing requirements, constraints, and activities of the work practice beyond just the product or system being designed. In this chapter, we go about designing the ecology to satisfy those needs of users.

Pyramid of user needs

An abstract representation as a pyramid shape with the bottom layer as ecological needs, the middle layer as interaction needs, and the top layer as emotional needs (Section 12.3.1).

16.2 DESIGNING FOR ECOLOGICAL NEEDS

16.2.1 Ecological Design: Foundational Layer of the Needs Pyramid Often Overlooked

In the setting of UX design, *the ecology is the entire set of surrounding parts of the world, including networks, other users, devices, and information structures with which a user, product, or system interact*s. Designing for ecological needs is one of the

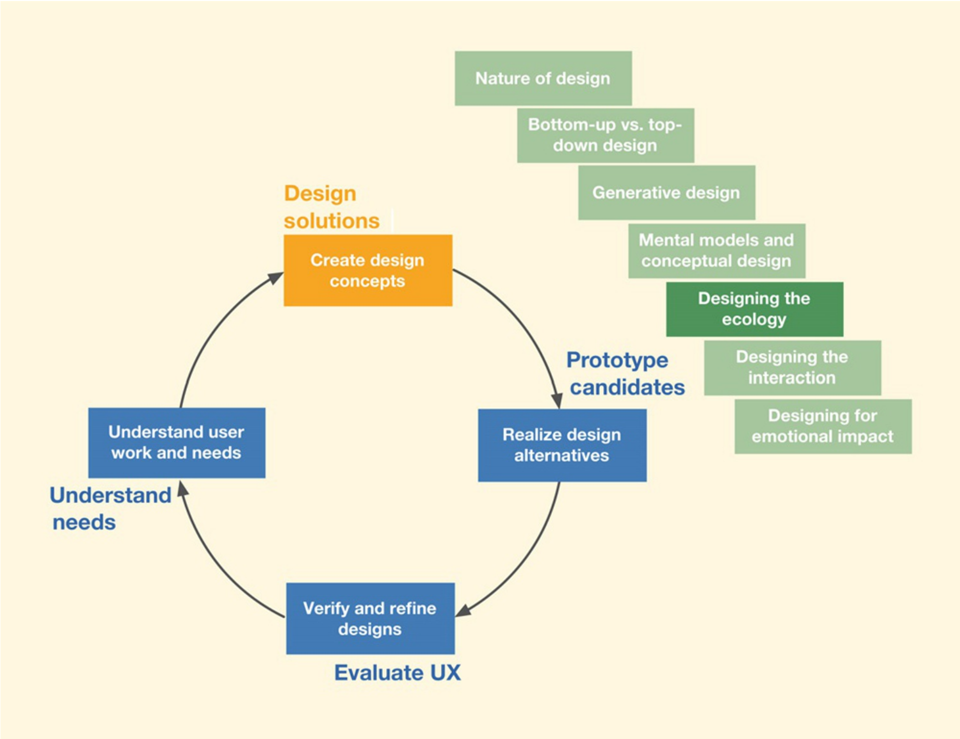

Fig. 16-1

You are here in the chapter describing designing the ecology within the Design Solutions lifecycle activity, in the context of the overall Wheel UX lifecycle.

most overlooked aspects in UX practice. The lure to get a sense of progress by diving right into interaction design (screen and visual designs) is often strong because it is easier to translate the tactical needs of the user at a task level to corresponding widgets or patterns in the UI. However, in order for users to be productive in the work practice, they need to first:

- Understand the broader ecology.
- Be able to participate in it.

Designing the ecology forces us to think about the overall system and how it addresses broader work activities.

Example: iTunes: Satisfying Ecological Needs First

Consider the "work" practice of listening to music. If a user is handed a brand-new music device such as an iPod and asked to listen to their favorite song, she will not be able to do that directly without first understanding how the Apple ecology works and doing some activities to set it up.

Understanding the ecology entails determining how to participate in Apple's ecosystem by accumulating, organizing, classifying, manipulating, sharing, listening to music, and syncing various devices to the user's music library.

She might start by setting up an Apple account and Apple ID if she doesn't have one. Then she links her iPod to iTunes through her Apple ID. Then she needs to look for her favorite song in her existing music library or in a music streaming service if she has one. If she doesn't, she needs to browse or search for it on Apple's or some other compatible music store, then buy and download or stream that piece of music. Interacting with the iPod to listen to music only happens after these ecological needs are satisfied.

In this example, the ecological needs are complex and can be a significant barrier to the desire to listen to music. But that is the nature of this work activity because of a variety of ecological requirements and constraints ranging from legal (music industry's antipiracy requirements) to platform (Apple's convoluted ecosystem requiring you to deal with iTunes, Apple ID, Apple Music) to device (iPod's connectivity Wi-Fi or cellular capabilities) to user (existing music library saved in a device vs. subscriptions and playlist setup on streaming services).

16.2.2 Designing the Ecology is about Usage Context

Designing the ecology is about envisioning and planning how work gets done in the broadest context of the user and system. This means looking at all the different:

- Devices users employ to get work done.
- Variations in their form factors and capabilities (e.g., watches, phones, tablets, laptops, desktops, wall displays, and ambient sensors).
- Usage contexts (e.g., usage while sitting at a desk vs. on the move).
- Infrastructure constraints (e.g., with connectivity vs. without).

16.2.3 Pervasive Information Architecture

Pervasive information architecture is a structure for organizing, storing, retrieving, displaying, manipulating, and sharing information that provides ever-present information availability spanning parts of a broad ecology.

UX design for the ecology almost always depends on pervasive information architecture, which provides ever-present information availability across devices, users, and other parts of a broad ecology. This allows users to interact with the same information, perhaps in different forms and accessed and displayed in different ways, on different devices at different times and in different places.

16.2.4 Ecological Design Spans Multiple Interaction Channels

An interaction channel is a means, mode, or medium through which users and parts of a system interact and communicate, including sensory modes such as visual communication as well as voice and tactile interaction. The concept also includes devices such as desktop computers, smartphones, and system-oriented channels such as the Internet, Wi-Fi connections, and even Bluetooth.

Ecological design is sometimes referred to as cross-channel information design or pervasive information design (Resmini & Rosati, 2011) (in the information architecture community) or multiplatform user interfaces (Pyla, Tungare, & Pérez-Quiñones, 2006) or continuous user interfaces (Pyla, Tungare, & Pérez-Quiñones, 2006) (in the human-computer interaction community).

When we are working at a computer, we are essentially doing single-platform computing. When we add in working on our tablets and smartphones, it extends to multiplatform computing.

In an ecology, a single service and the associated pervasive information architecture can be spread across multiple platforms, all of which are required to make it work (Houben et al., 2017). As an example, your bank sends a text message referring to a transaction you started online but have to come into the bank to finish.

The work on ubiquitous computing (Weiser, 1991) and tangible (Ishii & Ullmer, 1997) or embedded interaction has been a strong influence on making information available pervasively. Information objects have abilities to exhibit behavior and act according to external conditions. Also, the environment itself has the capability to act upon information objects.

For more about ubiquitous computing (interaction with transparent technology embedded in our everyday surroundings), tangible interaction (interaction that involves physicality in user actions), and embedded interaction, see Section 19.3.

Information object

An internally stored structured or simple article, piece of information, or data that serves as a work object. Often data entities are central to work flow, being operated on by users; they are organized, shared, labeled, navigated, searched and browsed for, accessed and displayed, modified and manipulated, and stored back again, all within a system ecology (Section 14.2.6.7).

Ubiquitous computing/interaction

Technology (and interaction with that technology) that resides almost anywhere in a user's ecology, including in appliances, homes, offices, stereos and entertainment systems, vehicles, roads, and objects they carry (briefcases, purses, wallets, wrist watches) (Section 6.2.6.2).

16.2.5 A Single Platform in an Ecology Can Have Multiple Interaction Channels

Sometimes, within the same platform there is a need to consider different channels. While this is technically an interaction design concern (the focus of our next chapter), we discuss it here for continuity. Consider a user interacting with a typical laptop computer where interaction channels include:

- Text entry channel via a keyboard.
- A touch channel accessed via a touch pad or "joystick."

- A touch channel if the screen is touch-enabled.
- A tactile channel if the touch pad can provide that kind of feedback.
- An audio channel through the computer's speakers.

16.2.6 For the User, the Entire Ecology Is a Single Service

Consider this example of how an extensive ecology provides a single user service. Suppose a user orders something online using a computer and the Internet, opting for free shipping to the local store. Shortly thereafter, the user gets an automated email with a purchase confirmation and a copy of the invoice. Sometime later, the customer gets an email saying that the item had been shipped, giving a tracking number. The user clicks on this tracking number a few times in the next day or two and sees the progress of the shipment.

An email and a text message later announce the arrival of the item at the store and soon the person goes to the store physically to pick it up. The user takes a copy of the email on his smartphone and the person at the store scans the barcode. The user signs a tablet at the store, confirming pickup. Sometimes another email confirms the pickup and closes out the transaction. Lots of different interactions, platforms, and devices, all serving one user transaction.

While we might think of goods and services as separate things, Norman shows how the real value in a product or service is to offer a great experience to the customer/user. Norman (2009) calls us to systems thinking, what we call ecological design, to provide that value to users.

Example: A Flawed Ecological Design Can Cause User Frustration

A good ecological design empowers users to perform whole activities in the work domain (high-level support to work activities) and not just specific work flows or tasks. A flawed ecological design results in inconsistent experiences for the users as they navigate the work domain in the ecology. Consider this issue we recently encountered that illustrates the difference between thinking about ecology versus just interaction, in the context of Apple's ecological design.

A user's ecology in the Apple world contains desktops, laptops, tablets, phones, and smart watches. Depending on the context of interaction, the user may use any one of these devices to access their information. When Rex wanted to look for some details from a previous doctor's appointment on his iPhone, the search came up with no results. He was surprised because he knew all his annual appointments for medical checkups are tracked in his calendar application. Just as a check, he tried the calendar on his desktop and, surprise, it was there.

It so happens that, by the default setting on his iPhone, only appointments from the last one month are saved and his last appointment fell out of that window. There was no indication on the search results page that this was the case; this constraint on the search results is hidden somewhere many levels deep in the device settings. On the desktop calendar application, however, there is no such restriction. The designers at Apple probably made this choice because of the limited storage available on the iPhone.

The problem is not with that choice but the way designers failed to reflect it or explain it. It appears the designers responsible for the iPhone search capability just focused on the interaction design on the phone (how search results are handled and the default calendar scope). But from the user's perspective, the phone was not different from the desktop when it came to their calendar information. It was supposed to be just a different device in the same ecology and, for the user, complete calendar information should have spanned that ecosystem.

This is a small example that clearly illustrates the difference between designing for the ecology and designing for just the interaction. If Apple designers thought of the ecological design, they would have supported the search task more effectively while still taking into account the constraints of the smartphone device. Perhaps they could have offered an option along the lines of "No search results found in the last 30 days. Continue the search on the server?" or something similar.

16.3 CREATING AN ECOLOGICAL DESIGN

The ecological perspective. The ecological design perspective is a viewpoint that looks at how a system or product works within its external environment. It is about how the system or product is used in its context and how the system or product interacts or communicates with all the components of its environment.

Representing ecological design. An ecology's design is usually represented using a concept diagram that looks like a flow model, identifying:

- System entities.
- Work roles.
- Propagated information.
- User tasks.
- Ecology boundaries.
- External dependencies.

- A description of the underlying metaphor or theme of the concept (e.g., a central mothership-like service coordinating a set of connected mobile devices).
- How they all fit together.

Start by identifying the subsystems by work role. In Section 9.6.7, we talked about work roles and how the work flow of certain work roles has little or no overlap with those of others. In many systems, these parts of the overall design are almost mutually exclusive, allowing for a logical partitioning of the target system.

For example, in the MUTTS work practice, the nature of work done by a ticket buyer is different from that of the event manager. They rarely, if ever, interact within the ecology of MUTTS. Each work role can be thought of as associated with a subsystem or an ecology in itself. This means, the overall ecology of the work practice can be thought of as having a set of ecologies, one for each subsystem. This separation provides us a way to reduce overall design complexity through a divide-and-conquer approach.

The subsystems themselves are connected via information exchange (for example, through a central database) and specialized work roles responsible for that exchange at their boundaries. For example, there are work roles such as systems or IT engineers responsible for ensuring that the ticket information from event vendors is correctly stored in a database that is available accurately and reliably to ticket buyers.

Proceed with generative design. Using ideation and sketching techniques we discussed in Chapter 14, synthesize ideas for what the ecology is, what it contains, including devices and channels, features, capabilities, and most importantly, a conceptual design to explain how it works. The goal is to create as many ideas as possible for the overall theme or metaphor of the ecological conceptual design. After the ideas are generated and captured as sketches, the team will critique each idea and concept for tradeoffs.

Establish a conceptual design for the ecology. For example, maybe the ecology will feature a "mothership" concept where there is a central entity that acts as the brain and information exchange for all other entities and devices in the ecology. Or is the ecology better served by a peer-to-peer architecture without a central repository concept? How will such a concept address the breakdowns, constraints, or other deficiencies in the work practice?

As part of this phase, you should also come up with ideas on the pervasive information architecture.

The issue of self-sufficiency. An ecology's self-sufficiency comes down to how the ecology is structured and whether it provides everything the user needs to thrive in the ecology without depending on other ecologies.

Metaphor

An analogy used in design to communicate and explain unfamiliar concepts using familiar conventional knowledge. A central metaphor often becomes the theme of a product, the motif behind the conceptual design (Section 15.3.6).

MUTTS

MUTTS is the acronym for Middleburg University Ticket Transaction Service, our running example for most of the process chapters (Section 5.5).

Pervasive information architecture

A structure for organizing, storing, retrieving, displaying, manipulating, and sharing information that provides ever-present information availability spanning parts of a broad ecology (Sections 12.4.4 and 16.2.3).

As an example, Norman (2009) cites the Amazon Kindle—a good example of a self-sufficient ecology. The product is for reading books, magazines, or any textual material. You don't need a computer to download or use it; the device can live as its own independent ecology. Browsing, buying, downloading books, and more is a pleasurable flow of activity. The Kindle is mobile, self-sufficient, and works synergistically with an existing Amazon account to keep track of the books you have bought through Amazon.com. It connects to its ecology through the Internet for downloading and sharing books and other documents. Each Kindle has its own email address so that you and others can send lots of materials in lots of formats to it for later reading.

A self-sufficient ecology has fewer dependencies and because it fully encompasses the users, gives more control to curate the experience. In contrast, gated ecologies like Apple's tend to come with their own tradeoffs with respect to how users can operate within the ecology.

Example: Conceptual Design for the Ticket Kiosk System Ecology

For the Ticket Kiosk System, we envision a central control system that acts as a hub for all transactions. This is necessary to keep track of ticket inventory and for managing temporary locking of tickets while users are in the middle of a buying transaction. If the transaction was abandoned or times out, those tickets will be released for other customers. One downside of this concept is that the central hub can become a single point of failure. If there is a breakdown, all kiosks and websites would go down together.

Ecological perspective

The design viewpoint taken from the ecological layer at the base of the pyramid of user needs, which is about how a system or product works within, interacts, and communicates with the context of its external environment. It is about how users can participate and thrive in the ecology of the work domain (Section 12.3.1).

In Fig. 16-2, we show an early conceptual design sketch for the Ticket Kiosk System from the ecological perspective. All transactions from all kiosks and the website where tickets are sold are served by the control center. Users bring their own personal ecologies into the overall flow when they use laptops, tablets, and phones to search, browse, and buy tickets. At least some of these user devices can be used to contain e-tickets in lieu of physical tickets. This means that each ticket must have an ID number that can be scanned by the Ticket Kiosk System devices at event venues.

The team came up with other ideas such as smart tickets that were aware of a venue's layout (Fig. 16-3.) During the critiquing phase, several feasibility issues were brought up with available technology. The idea was then modified to put small "seat location finder" kiosks at the entrance of the venue. These finder kiosks scan the ticket and show a path on the screen for the location of the seats.

In Fig. 16-3, we show ideas from an ecological conceptual design for the Ticket Kiosk System focusing on a feature for a smart ticket to guide users to seating.

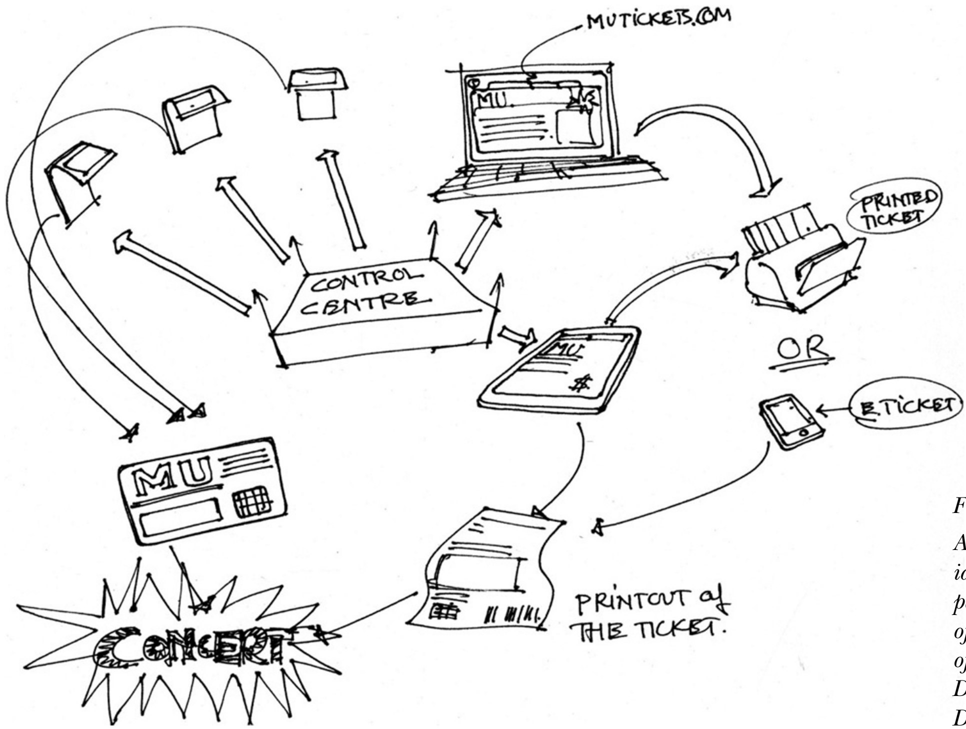

Fig. 16-2

An early conceptual design idea from the ecological perspective (sketch courtesy of Akshay Sharma, formerly of Virginia Tech Department of Industrial Design).

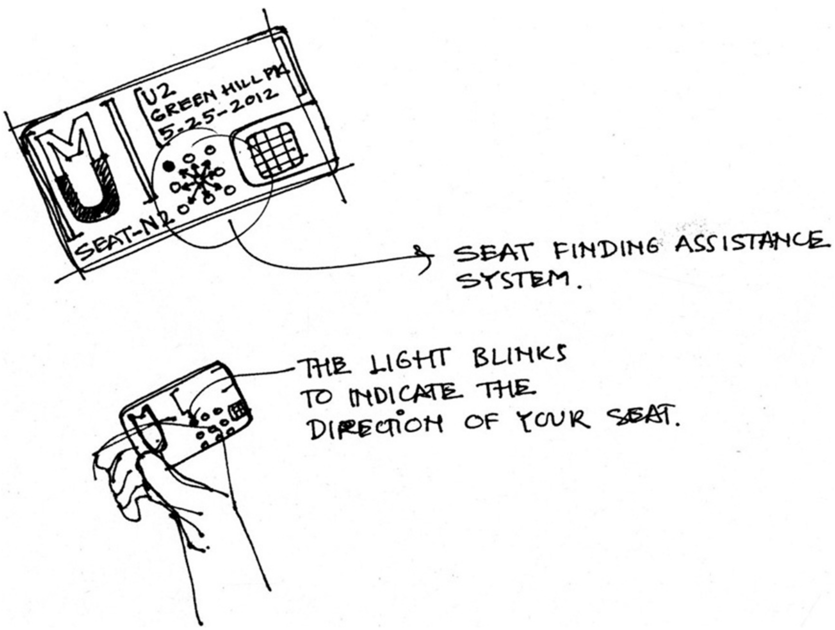

Fig. 16-3

Ecological conceptual design ideas focusing on a feature for a smart ticket to guide users to seating (sketch courtesy of Akshay Sharma, formerly of Virginia Tech Department of Industrial Design).

In Fig. 16-4, we show ecological conceptual design ideas for the Ticket Kiosk System focusing on a feature showing communication connection with a smartphone. You can have a virtual ticket sent from a kiosk to your mobile device and use that to enter the event.

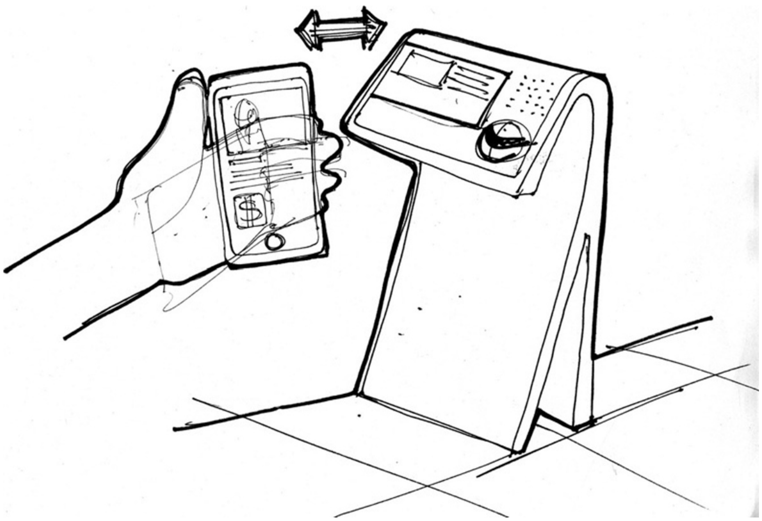

Fig. 16-4
Ecological conceptual design ideas focusing on a feature showing communication with a smartphone (sketch courtesy of Akshay Sharma, formerly of Virginia Tech Department of Industrial Design).

Ecological perspective
The design viewpoint taken from the ecological layer at the base of the pyramid of user needs, which is about how a system or product works within, interacts, and communicates with the context of its external environment. It is about how users can participate and thrive in the ecology of the work domain (Section 12.3.1).

In Fig. 16-5, we show an ecological conceptual design idea for the Ticket Kiosk System focusing on the features for communicating and social networking to share information about event attendance.

Exercise 16-1: Conceptual Design for the Ecology of Your System

Think about your system and contextual data and envision a conceptual design, including any metaphors, in the ecological perspective. Try to communicate the designer's mental model, or a design vision, of how the system works as a black box within its environment.

16.4 DESIGNING AN ECOLOGY TO INFLUENCE USER BEHAVIOR

Beale (2007) introduces the interesting concept of slanty design. "Slanty design is an approach that extends user-centered design by focusing on the things people should (and should not) be able to do with the product(s) behind the design."

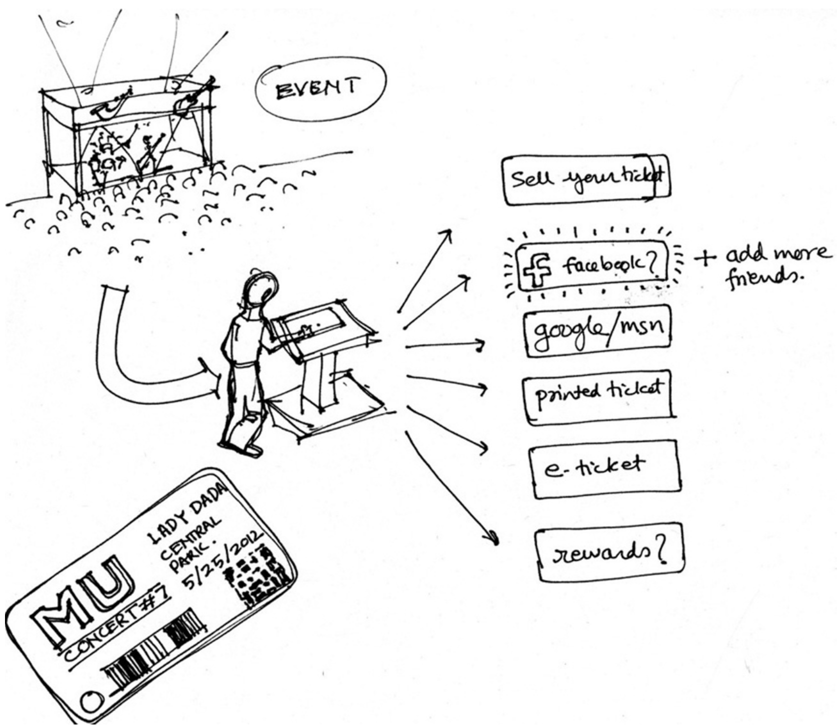

Fig. 16-5

Ecological conceptual design idea focusing on the features for communicating and social networking (sketch courtesy of Akshay Sharma, formerly of Virginia Tech Department of Industrial Design).

Design is a conversation between designers and users about both desired and undesired usage outcomes. But user-centered design, for example, using contextual inquiry and analysis, is grounded in the user's current behavior, which is not always optimal. Sometimes, it is desirable to change, or even control, the user's behavior (Chapter 13).

One such idea is to make a design that works best for all users taken together and for the enterprise at large within the ecological perspective. This can work against what an individual user wants. In essence, it is about controlling user behavior through designs that attenuate usability from the individual user's interaction perspective, making it difficult to do things not in the interest of other users or the enterprise in the ecological perspective, but still allowing the individual users to accomplish the necessary basic functionality and tasks.

One example is sloped reading desks in a library, which still allow reading but make it difficult to place food or drink on the desk or, worse, on the documents. Beale's similar example in the domain of airport baggage claims is

Interaction perspective

The design viewpoint taken within the interaction layer of the pyramid of user needs, between the ecological layer at the base and the emotional layer on top. The interaction perspective is about how users operate the system or product. It is a task and intention view, in which user and system come together. It is where users look at displays and manipulate controls, and do sensory, cognitive, and physical actions (Section 12.3.1).

marvelously simple and effective. People stand next to the baggage conveyor belt and many people even bring their carts with them. This behavior increases usability of the system for them because the best ease of use occurs when you can just pluck the baggage from the belt directly onto the cart.

However, crowds of people and carts cause congestion, reducing the accessibility and usability of other users with similar needs. Signs politely requesting users to remain away from the belt except at the moment of luggage retrieval are regrettably ineffective. A slanty design for the baggage carousel, however, solves the problem nicely. In this case, it involves something that is physically slanty; the surrounding floor slopes down away from the baggage carousel.

Pervasive information architecture

A structure for organizing, storing, retrieving, displaying, manipulating, and sharing information that provides ever-present information availability spanning parts of a broad ecology (Sections 12.4.4 and 16.2.3).

This interferes with bringing carts close to the belt and significantly reduces the comfort of people standing near the belt by forcing people to remain away from the carousel and then make a dash for the bags when they arrive within grasping distance. This reduces one aspect of individual usability somewhat, but it works best overall for everyone in the ecological perspective. Slanty design includes evaluation to eliminate unforeseen and unwanted side effects.

16.5 EXAMPLE: AN ECOLOGY FOR A SMART SHOPPING APPLICATION

We conclude this chapter with an extended example of designing the ecology for a shopping application based on what the information architecture people call pervasive information architecture, which we adapted from Resmini and Rosati (2011). This is also a good example of an activity-based design.

Activity-based interaction

Interaction in the context of one or more task thread(s), a set of, or possibly sequences of, multiple, overlapping, and related tasks, often involving more than one device in an ecology (Sections 1.6.2 and 14.2.6.4).

16.5.1 Some High-Level Issues

Who is the client? It might seem we are designing for shoppers, and we are. But our client is the store management. We're designing to help our client's customers have a good shopping experience. You can't make an app to help customers unless the store participates in the ecology. And that can't happen unless store management is the client. Let's assume the store is onboard.

It's hard work to find things in a store. Even after shopping the same large store dozens of times, many shoppers don't feel they know where things are, and there is seldom enough staff on hand to assist. As a result of just this one factor, the experience of shopping in a large physical retail store can often be frustrating and exhausting.

The dilemma of impulse buying. The UX team came up with a design idea that makes it easy for customers to locate products within the store, an efficient customer shopping experience that should be welcomed by all. But you are probably aware that typical store management doesn't want shoppers to know where everything is—at least not immediately, without having to browse through the store to find it. As you may know, many large stores actually design their merchandise layouts to slow shoppers down, exposing them to impulse buying "opportunities"—displays of items they hadn't planned on buying, but might find interesting enough to buy anyway.

Also, the layout of some stores is deliberately changed periodically to offset shoppers learning about where things are. Even experienced shoppers are now forced to browse large portions of the store layout, including the impulse item "traps."

How can designers support the user need for efficiency in the face of this behavior by store management? The answer goes back to basics. During usage research, you have to explore the store perspective of the shopping activity. And, through usage research, your team might recognize that impulse buying is not necessarily always bad for the shopper. Customers might occasionally buy one of these items that is really nice, useful, or even fun—good for both customer and store.

So you need a design to sell store management on streamlining the shopping experience while still retaining impulse sales. Your design challenge is to:

- Replace the usual frustrating and exhausting shopping experience with one that is efficient and actually fun.
- Convince store management that this alone can bring customers back more often, offsetting any lost impulse sales.
- Find ways to include impulse shopping in other ways in our design.

16.5.2 Key Parts of the Design

The SmartFridge. We will be designing a shopping experience for a customer that starts with a smart fridge in the home, a fridge that knows about its contents and learns about user needs and food preferences. It can, for example, tell when the milk supply is dwindling and suggest putting milk on the shopping list. The ecology can include a smart pantry that notifies when the last item of a type is removed from its shelves.

Mobile device and app. We will assume that users savvy enough to be using a SmartFridge will almost always carry a mobile device, such as a smartphone. As part of our ecology, we will design a smartphone app, called SmartShop.

The SmartKart. A large part of this project is to design a SmartKart that helps the user find things in the store. The SmartKart will contain a built-in mobile device with a touchscreen display, connected to the store ecology via a special Wi-Fi setup. The SmartKart processor can also be used offline for mundane tasks such as doing price/unit (e.g., price per ounce) cost comparisons.

16.5.3 How it Works

Preshopping activities. These activities have to occur before the actual shopping can begin:

1. Accumulate a generic list of things to buy.
2. Match the generic items to specific products in the store:
   a. SmartShop app finds candidate matches.
   b. User mediates by selecting best match among the candidates.
3. Generate a specific shopping list.
4. Download the specific shopping list to the SmartKart at the store.

Accumulating a generic list. Step 1 of the process is the accumulation over time of a generic shopping list, expressed with as much or as little detail and specificity as desired. An example of a generic item is "orange juice." We will make it easy for users to grab the phone to do Step 1 and enter a new item into the current generic list in SmartShop whenever they think of something to buy (left-most in Fig. 16-6).

Matching generic list items to specific store products. In Step 2, SmartShop is used to match each generic list item to a specific product known to be in the store (lower left in Fig. 16-6) by:

- Step 2a: SmartShop searches for a generic item using inexact database matching, leading to a set of candidate-specific matches.
- Step 2b: User selects desired specific item from possible matches in search results.

For example, for a generic item of "orange juice," a specific product might be "UPC code = xxxxx, Green Valley brand, fresh (not from concentrate), one quart, with pulp."

Generate specific shopping list. As each specific product is selected, in Step 3 it is added to the accumulating specific shopping list in the app (bottom next to far right in Fig. 16-6).

Through usage research, we also learned that users occasionally look through online ads and emails from stores about sales, specials, discounts, or

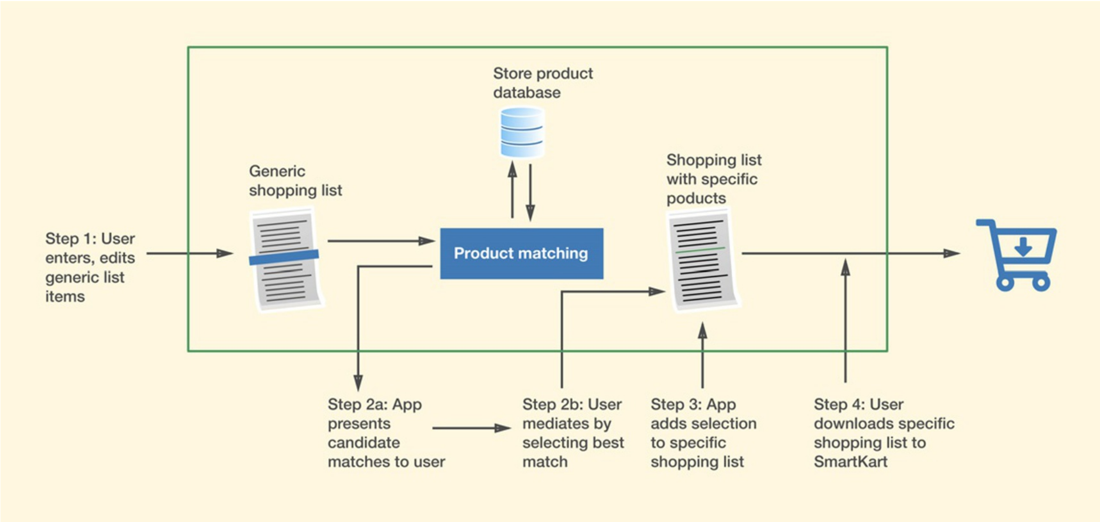

Fig. 16-6
Preshopping-trip activities.

coupons. Clicking on the Add to my shopping list button while viewing one of these items will add that item to the specific list in the app.

Download the specific shopping list to the SmartKart at the store. Upon arrival at the store, the shoppers perform Step 4 by launching the SmartShop app on a mobile phone and tapping the phone on the shopping cart. This establishes a connection to the built-in mobile device of the SmartKart, which automatically syncs to the current specific shopping list (extreme bottom right in Fig. 16-6), making the specific shopping list pervasive in the ecology.

16.5.3.1 Finding things in the store

If a design goal is to help customers locate items efficiently, where is the information needed to make that happen?

This is a good example of embodied information. Product-location information is embodied in the physical ecology of the store itself and in the items themselves. Each item could be aware of its location in terms of aisle, section, shelf, and so on. Conversely, each shelf could know what items are located there. Any number of existing technologies can capture this location information in a database.

> *Embodied interaction*
>
> Interaction with technology that involves a user's body in a natural and significant way, such as by using gestures (Section 6.2.6.3).

In-store location awareness of products on the shelf. SmartKart browsing (sensing products as you pass them in the aisles) could be enough to help the user find things in the store. But we can do better if somehow the shelves themselves are embodied physical devices that know something about the products they contain. Perhaps something involving RFID sensors and/or bar code scanners built into the shelves. Awareness by the shelves of their contents will provide us with the necessary accurate product location information, even if there are errors in stocking. In addition, of course, the shelves must now be able to communicate (via the special Wi-Fi) what they know to carts and to the store database system.

Shelf-awareness of products offers a bonus—a continuous capability for keeping inventory information accurately up to date, eliminating the expensive, inconvenient, and labor-intensive hassle of periodic store inventories.

Another potential benefit to the store is, as Resmini and Rosati (2011, p. 217) say in their grocery store example, that a product-location system will be liberating to the store. First, sales associates on the floor no longer have to help customers find things. Also, if the layout no longer has to be constrained by how customers find things in the store, it opens the door to innovative and dramatically different store layouts.

With these critical ecological design innovations, the act of moving the cart through the store can be mapped to moving the cart through items on the shopping list—almost.

Cart awareness of its location in store. The next capability we need is obvious: The cart has to know where it is within the store. This could be accomplished by shelf-to-cart wireless communication, but perhaps a more flexible solution is a capability within the cart processor somewhat analogous to a localized GPS system and an internal map of the store. The in-store location system won't be a real GPS, however, but will be implemented via some kind of locating network strung (perhaps in the ceiling) along each aisle. So this introduces into the store information architecture a key new information object: the current location of each cart.

Cart ability to find a product. Now we have what we need for matching cart location to the location of products on the shopping list. In our pseudo-GPS app, the screen on the SmartKart shows a map of the internal layout of the store, showing aisles as "roads" on which to "drive" the cart. The GPS display shows where the cart is within the store and it knows the "addresses" of each item on the shopping list. The GPS will treat each item on your shopping list as a "destination," dropping "pins" for your items on the store map and ordering the list so that each item can be found in a single pass through the aisles of the store.

As the cart approaches a store location containing an item on the shopping list, the cart display will indicate where to look to pick it up. As the item is put in the cart, it will be checked off the shopping list and a running total of the cost can be updated, using cost information obtained via the UPC bar code. All of this is the perfect cross-channel mapping from one device to another that connects customer needs to store services.

And, of course, it's starting to happen in reality. Walmart has recently (as of this writing) unveiled a self-checkout mechanism[1] that allows customers to skip the checkout lines by:

- Scanning items as you shop.
- Paying via a smartphone app.
- Showing your e-receipt on the way out.

Similarly, Amazon has been evaluating a grocery store technology in which the system logs items as they are put in the cart[2] so shoppers can avoid traditional checkout lines. The system senses when the customer leaves the store, totals the bill, and charges it to that customer's Amazon account. Cashiers are replaced by hundreds of cameras that track purchases.[3]

16.5.4 Impulse Buying

Remember our discussion of the dilemma of impulse buying and the difficulties it posed to helping shoppers find things in the store? We can brainstorm about how the SmartKart display can make shoppers aware of items on special as they push the cart past them on the shelves, bringing up special offers and alerting customers to discounts, sale items, promotions, additional coupons, and impulse buying opportunities as shoppers pass them with their SmartKarts.

By this same token, the SmartKart display can suggest buying additional items or accessories related to items on the list and expanding the shopping list accordingly. For example, if the shopper is buying a vacuum cleaner, this feature will serve as a reminder: Don't forget to get some extra vacuum cleaner bags. Not only is this a good marketing idea but it can be a helpful reminder to shoppers, too (as long as it isn't overdone or doesn't become annoying).

Customers will come back in droves because, at last, someone has done something to make their shopping experience fun and easy instead of a

[1] https://www.androidpolice.com/2017/01/09/walmart-finally-rolls-scan-go-app-android/
[2] https://www.geekwire.com/2016/amazon-go-works-technology-behind-online-retailers-groundbreaking-new-grocery-store/
[3] https://www.npr.org/sections/thetwo-way/2018/01/22/579640565/amazons-cashier-less-seattle-grocery-opens-to-the-public

brain-deadening, loathsome experience. Now, who is going to a store that doesn't have this service?

Exercise 16-2: Pursue this SmartKart Design Idea Further

This is definitely a group assignment. Engage your team in ideation, sketching, critiquing, designing, prototyping, and evaluation to come up with further innovative ideas for the SmartKart.