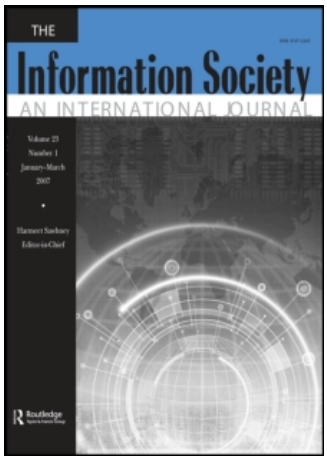

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PERSPECTIVE

Accessibility and Product Ecosystems

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Products, including assistive and accessible technologies, do not exist in isolation. They are all part of rich product ecosystems; they inhabit specific niches of economics, functionality, and technology, and they interact with other products. The concept of product ecosystem goes beyond technological interoperability. For accessibility to advance, we must understand more about the interactions among products. This article sketches an explanatory approach that may be useful in understanding how accessible technologies thrive, survive, or fail within their ecosystems.

Keywords assistive technologies, design for all, economics, ecosystem, interoperability, universal design

INTRODUCTION

When we use a product, we tend to think of it in isolation: We turn on an electric shaver, use it, turn it off, and put it away. Similarly, corporate marketers may consider their new product as a bold and unique object. But surrounding and penetrating the human use of any product is a complex set of essential relationships: the plug (what country are we in?), the power (how is it generated and distributed?), the packaging, the cleaning brush, the oil, the manual, the case, the bathroom cabinet, the lights, the mirror, and others.

Using the concept of ecosystem[1] found in ecological science, a set of relationships among products can be called the *product ecosystem*.[2] In that context we understand that a specific collection of plants and animals may form a food chain; a plant may provide shelter for an animal; an animal may assist the pollination of a plant; a smaller animal may parasitize a larger one.

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Plants and animals, however, are living beings capable of more or less independent action. Products do not have much of a life independent of their human users (or at least we don't think they do!), so product ecosystems must be highly integrated with human behaviors, such as design, market activities, information seeking and sharing, usage habits, preferences, expectations, etc.

This article examines how the concept of product ecosystems relates to accessibility,[3] universal design,[4] and assistive technologies (AT).[5]

PRINCIPLES OF PRODUCT ECOSYSTEM

All Products Interact with Other Products

As mentioned in the example in the Introduction, all products interact somehow with other products and the environment in which they are created and used. Even the simplest, seemingly most autonomous product is merely a temporary artifact of a broad network of design, production, distribution, use, and disposal, all of which processes involve the use of other products. Cookies have packaging that must be opened. A cell phone must connect to a wireless network; a mouse must connect to a computer. Any of these use-oriented relationships may pose problems for people with disabilities. We examine the accessibility implications as we explore the concept of product ecosystems.

Product Ecosystems Include Elements of Primacy

A television may be the dominant or primary product in a household's video product ecosystem: Without it, there is no such ecosystem. There's no point in subscribing to cable service if you do not have a TV. But such primacy may not be absolute: The availability of high-definition programming from the cable service provider may motivate a household to purchase a new HD-compatible television long before the old one wears out. However, people rarely

make such a decision because the new television has a better remote control. There are hierarchies of potential primacy.

A product may be primary in one ecosystem and secondary in another. A battery is a secondary product in the television remote control ecosystem, because the consumer will buy whatever battery the remote requires. However, batteries are primary in the battery charger ecosystem, which is why battery chargers are designed to fit all sizes of batteries.

Similar relationships exist in the world of operating systems and applications: Some consumers will continue to use the operating system (OS) that best supports the applications they most need. Video game platforms compete frantically to secure exclusive licensing for the most compelling games.

Some Important Relationships Occur Outside of Typical Use

Although we are most concerned with the accessibility of products during their use, other relationships affect accessibility as well. Take a simple example regarding manufacturing: the nib required on the "5" key of a phone. Users want the nib to be in the center of the key. However, some manufacturing processes use a plastic insert of another color to show the key's numeral, rather than printing the numeral, which would soon wear off. The insert cannot have a nib; this precludes the nib being in the center of the key. Other designs or manufacturing technologies may arise to resolve this problem, but it is unlikely that the requirement for the nib itself will drive that process.

Installation and maintenance are important "rites of passage" in a product's life outside of everyday use; these often involve special product relationships. For example, software may need to be installed from a CD; replacing a cordless phone's battery may require opening a hidden compartment.

A person who is unable or unequipped to perform the required task may be blocked from full use of the intended product. The otherwise accessible software application may not serve its intended users if some of them cannot manipulate the CD or operate the CD drive. The otherwise accessible cordless phone may not serve its intended users if some of them cannot find the battery compartment. For universal design to succeed, it must be extended far beyond the "boundaries" of the product itself during its normal usage, to embrace all the product's interactions during its life cycle.

Product Ecosystems and "Value Chains"

Product management theorists developed the concept of the *value chain* (Porter, 1985), an expression of the fact that suppliers, manufacturers, distributors, retailers, and customers may all affect the value of a product. For example, a customer who complains about a problem with the product may cause the manufacturer to use a different component from a supplier, resulting in an improved, more valuable product.

The value chain concept makes sense from the firm's perspective. The better a manufacturer understands its suppliers and distributors, not to mention its users, the better it can economize and plan. Knowing the capabilities and motivations of potential partners and competitors gives a company insight into its opportunities and limitations. The product ecosystem concept presents similar relationships from a user's perspective,[6] because it incorporates all the conceivable ways that a user could choose to perform a particular function.

Consider someone shopping for a television. Our shopper is confronted by an enormous array of choices—a jungle, really. The shopper will make a single selection, using criteria based on his/her own television product ecosystem. What will fit the cabinet? Which models have enough of the right kind of connectors? Can I use my DVD's remote (my favorite) to control the TV instead of adding to my clutter? Some of these criteria may be mild preferences, while some are essential.

SPECIFIC IMPLICATIONS OF THE PRODUCT ECOSYSTEM CONCEPT FOR ACCESSIBILITY

Accessibility Requirements Depopulate the Product Ecosystem

This distinction between essential and preferential criteria is fundamental to accessibility. For any given person with a disability attempting to perform a given function, there may be one or more criteria that are essential for him/her, while preferential for a non-disabled user.

Let's resume our shopping trip in the television store. Consider that one of our shopper's criteria has to do with accessibility; let's say our shopper is hard of hearing and lives with other people who are not hard of hearing. For effective use and the peace of the household, the television must have a headphone jack on the front and a closed caption button on the remote. Instead of a dozen models, we may be left with only one—or none. Our jungle has become a desert. With these two additional requirements, the television ecosystem is narrowed down to a dangerous level. Our shopper has become the equivalent of an organism that can only feed on one species.

Assistive Technology De-populates It Also

When we consider assistive technology (AT) products, we see a similar effect on the richness of the product

ecosystem. An electric scooter may fit into only some cars, which fit into only some garages. An alternative input device for a computer may only work on one operating system.

Assistive technology products essentially add another link to the value chain, but with a difference, from the product ecosystem's perspective. Instead of adding value, the additional link can only jeopardize the existing value.[7] At best, compatible assistive technology maintains the product's value. An incompatible product, or one that often fails or requires maintenance, reduces the value.

In addition, AT itself is a sparse ecosystem. There are usually only a few models for each product type. In some cases only one company manufactures all models within a product category, or has an overwhelming market share. The net effect on consumer choice is radical: A truly unique AT product comes to dominate the consumer's product ecosystem. Our shopper must enter the marketplace with the AT's compatibility requirements—its "needs"—foremost in mind!

Product Availability Is Not Uniform in Time or Space

Just as in the organic world of plants and animals, products have life cycles and geographic concentrations. They are not available forever and everywhere.

Companies remove even successful products from the market on a periodic basis, to encourage new rounds of consumer spending. They may replace the old model with something functionally identical, or just similar. If the new model unintentionally lacks a specific feature, it may no longer be as accessible. For example, in the 1970s a particular tape recorder was sold with an indexing feature: While recording, the user could press a button and have a special tone encoded onto the tape. The tape could be played back in a mode that sought out these indexing tones. This feature was very useful for people who are blind, as it let them "highlight" a passage in a lecture. After a few years the company withdrew the product[8] and did not offer a comparable one.

If the accessibility is provided by an AT product, the mainstream product may change so that it can no longer interoperate with the AT product. For example, Windows 95 was not compatible with some screen readers at the time it was released. This jeopardized the business of screen reader companies and the integration of users. It took several months to develop compatible versions, and several years for users to upgrade. This phenomenon of unsynchronized development cycles persists.

Similarly, products and services do not distribute themselves evenly over the surface of the world. France's Minitel offered some useful functionality for people who are deaf or hard of hearing, but it was not extended to or duplicated in all other countries. As another example, the antenna lights on mobile phones, whose flashing indicated an incoming call, could be found in Japan as early as 10 years ago, but were not available in North America until 2002.

Low availability of products and services further restricts the richness of the product ecosystem. Rural areas, developing countries, and impoverished communities often have narrower ranges of choices.

Whole Product Ecosystems Evolve, Also Jeopardizing Accessibility

It is not only individual products that change form over time: Whole ecosystems appear to evolve, either as a response to a market-driven change in a primary product or as part of a fundamental change in technological capabilities. The entire wireline telephony ecosystem is in the midst of evolving from analog to digital. Analog text telephones ("TTYs") cannot connect directly to digital lines, but they can be connected through an analog-to-digital adapter. Currently there are many available adapters, because there are many analog fax machines in use. The need for adapters for text telephones is not large enough to sustain the adapter market. As users migrate away from fax, or to digital fax servers, the market for adapters will erode and may eventually disappear. Unless TTYs also evolve, text users may be jeopardized.

Universal Design Is Proposed As a Solution to Constricted or Rapidly Evolving Product Ecosystems

Universal design can be proposed as a solution to all of these problems. If more mainstream products contain features that enhance accessibility, the depopulating effects on the product ecosystem of the accessibility criteria are lessened, as is the user's dependence on adapters or AT. Similarly, it is argued, once designers are made aware of the principles of design-for-all, they will never need to be reminded again of the need to avoid exclusionary barriers.

In an extreme vision of a fully realized designed-for-all world, every television would have a headphone jack on the front and a closed caption button on the remote. But even the most ardent universal design (UD) enthusiasts realize that it would not be technically feasible to add every possible accessibility feature to every model of every product. That is why realistic supporters of UD refer to it as a direction in which design should move, not an absolute goal.

Universal design's detractors add that, feasible or not, it would not be economically optimal to include all such features. They argue quite correctly that there would be some

wasted investment, as non-disabled people were forced to pay for features they did not need or could not use. They point to text telephones, which cost the telecom industry millions of dollars a year just in compatibility testing, as an example of such a waste. Additionally, they argue that the more required or standard features there are, the less products can distinguish themselves in the market, and that such distinctions—product mutations—are the source of overall improvements in the product ecosystem.

Of course, such analyses only make sense when applied to a specific product. We know that ramps (part of the wheelchair product ecosystem) pay off their investment when handtrucks, baby strollers, and skateboards use them. We are less sure that Braille markings on a drive-up bank machine[9] pay off. Unfortunately, for now at least, we seem to lack the tools to analyze the total costs and benefits of universal design decision options.

CONCLUSIONS

We believe that the product ecosystem approach both enlivens and enlightens the discussion of accessibility, universal design, and assistive technology. It puts accessibility in the context of other domains where product interactions are important.

We would like to be able to analyze how to rationally enhance accessibility, but we are far from able to perform the necessary economic analyses regarding optimal accessibility. We are farther still from being able to authoritatively assign responsibility to the diverse participants in the ecosystem: Which should change, the mainstream product or the AT product?

However, we do think that the product ecosystem concept does provide some elements of near-term good guidance for enhancing accessibility:

- Accessibility evaluations should take into account all the relationships in the product ecosystem.
- Points where the ecosystem is sparsely populated should receive more attention.
- "Technological horizon scanning" may be able to identify where new accessibility opportunities and barriers may arise.
- Better coordination between mainstream and AT companies may be able to enhance accessibility by comanaging the evolution of product ecosystems.

NOTES

1. An ecosystem is the dynamic and interrelating complex of plant and animal communities and their associated non-living environment." (Biology Online, 2006).

2. Although there are some current references to this term, there is no fundamental definition available, and little theoretical work appears to have been done to clarify its meaning. In some cases it is used to refer to a single company's line of related products rather than a set of relationships. Where it is used to refer to relationships, it almost always refers to comarketing of products or relationships between major manufacturers and smaller entities.

3. "Accessibility" is defined as the "usability of a product, service, environment or facility by people with the widest range of capabilities" (International Standards Organization, ISO/TC 16027, 2001).

4. "Universal design" ("UD") or "design for all" is defined as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design, 1994).

5. "Assistive technology" has been defined as "technology used by individuals with disabilities in order to perform functions that might otherwise be difficult or impossible" (National Center on Accessible Information Technology in Education, 2006), or, more formally in the Technology-Related Assistance for Individuals with Disabilities Act, as "any item, piece of equipment or product system, whether acquired commercially off the shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." The term is used here to refer to products that interoperate with mainstream, "nonassistive" products to permit disabled users to perform the functions of the mainstream products.

6. Less relevant for this discussion is the "product's-eye view" of the ecosystem, but it is important nevertheless. Cable-ready televisions "migrate" into markets when cable service is available; universal remote controls "prey" upon single-device controllers. The product view of the ecosystem principally influences the availability of products and features; users can only adopt available products, no matter what their needs and preferences are.

7. Of course, from the disabled user's view, the AT product provides essential value! Without it, there is no accessibility.

8. The indexing functionality later returned to the market, and many new recorders have it. But it was unavailable for more than 10 years.

9. These are implemented in the United States for the benefit, it is said, of blind taxicab riders who do not want to share their PINs with the driver.

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