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PERSPECTIVE

The Changing World of Home Technology: A Microsoft Case Study

Pam Heath

Consumer Prototyping and Strategy, Microsoft Corporation, Redmond, Washington, USA

Nancy Bell

Customer Design Center, Microsoft Corporation, Mountain View, California, USA

We have entered the "digital decade," when advances in technology will become deeply woven into home life. But how will technology evolve from an experience that is technologically challenging to an experience that is intuitive and fun? This article reviews new technologies and related possibilities that Microsoft is envisioning in the context of home life. As a specific example of the impact of home technology, we review lessons learned from the adoption and integration of a home Internet device from a user experience perspective. Looking ahead to the next decade, we then take a look at Microsoft's vision for the home of the future, examining new directions.

Keywords home of the future, Microsoft's vision, smart devices, user-centered experience, wireless connectivity

We have entered a period when advances in technology will become deeply woven into home life (Dholakia et al., 1996; Harper, 2000; Turrow & Kavannagh, 2003; Kraut et al., 2006; Wellman & Haythornwaite, 2003). But how will home technology evolve from an experience that's technically challenging to an experience that's intuitive and fun? What changes can we expect to see in how technology will affect our daily lives over the next decade?

This article examines these questions from an industry perspective, looking at the evolution of the personal computer and other related technologies in the home. As the Internet has become indispensable in many people's lives (Hoffman et al., 2004), we focus on the following three questions:

1. *Where are we at present and where are we heading in the development of consumer technology?* We discuss how consumer focus has evolved over the last decade, and review trends and directions that are likely to deeply affect daily life in the next decade.
2. *What are the challenges of developing home products?* We review lessons learned from the adoption and integration of a home Internet product from a user experience perspective.
3. *How do you make the future real?* Finally, we describe the role that prototyping plays in developing a vision for future consumer products, and describe some future-oriented prototypes.

EVOLVING CONSUMER FOCUS

In the early 1990s, the consumer vision was often described as "A PC [personal computer] on every desk." However, as technology changed and improved, steadily until the mid-1990s and rapidly since, a more comprehensive and experiential vision began to take over: "Empower people through great software—any time, any place, and on any device." Based on some recent trends reported in the literature (Dutton et al., 2005), we can say that four fundamental developments have driven this change in vision:

The proliferation of smart and connected devices, such as personal digital assistants (PDAs), phones, cameras, game players, watches, and tablets.

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Address correspondence to Nancy Bell, Microsoft Corporation, 1065 La Avenida, Mountain View, CA 94043, USA. E-mail: nancyb@microsoft.com

From "atoms" to "bits." We now see the conversion of analog media to digital media. Although we still have physical media storage such as compact and digital video discs, the fundamental shift from analog media has occurred. Digital cameras are rapidly replacing film cameras and DVDs are replacing VHS tapes.

Broadband roll-out. Fast connections make the online experience not only more pleasant, but more practical as well, with fast and fluid media streaming, software downloading, online shopping, sharing photos with family and friends, and many other common activities.

Wireless connectivity. What just a few years ago seemed a novelty has since moved quickly from convenience to necessity for an increasing segment of consumers. It is also increasingly ubiquitous, as a trip to the corner Starbuck's makes clear.

Where will these developments take us in the next several years? We believe that these four developments taken together lay the foundation for the products and services of next decade, and for *increasingly highly integrated, personalized, consistent, and immersive experiences.*

According to the prevailing view, computing becomes not only ubiquitous but also invisible in the sense of being utterly taken for granted by typical users (Shih & Venkatesh, 2004). Consumers' attention will be focused on what they are doing, not merely on the technology that makes it possible.

These can be captured in the following trends:

- *Software working seamlessly with services*. Web services integrate deeply into interfaces. We do not go to the web for services; rather, web-based services integrate with our daily activities as accessed by whatever device we are using.
- *Hardware fits the situation and needs of the user*. There will be both multipurpose and single-purpose devices available. Some convergence occurs, but the need for more limited devices remains.
- *Content and information becomes ever more personalized and integrated*. We say, "Information gets smarter." It is not enough to be able to access information. In order to avoid "information cacophony" and overload there is a need to design software that puts the right information before people in the right way at the right time, and to create a user experience that is consistent across a range of devices, for example PCs, PDAs, and cell phones.
- *Connectivity is everywhere*. Soon we will be unable to imagine a life without connecting to all our information and services wherever we are, on whatever device is at hand.
- *Pervasive and "active" personal communication*. Pervasive connectivity implies pervasive communication. But beyond that, imagine a more personal and active communication model in which interlocutors choose their own communicative mode and tools. For example, an employee in a meeting might want notification of a voice call to appear visually on her laptop or tablet. If she takes the call, she may communicate via text rather than voice, while the caller communicates by voice. Each is using the method that works for him or her at that moment.
- *A truly user-centered experience*. Merely having information is not in itself empowering. Getting the right information in smart ways on devices that meet one's specific needs is. While great strides in user-centered design and usability have been made in the past 20 years, the design challenges of the next ten are perhaps much more formidable. Tomorrow's designs will accommodate consistent interface experiences across a variety of devices, as well as very integrated, personalized, and immersive experiences.
- *The global economy is rewired*. Seamless computer-to-computer interaction creates a new kind of connected economy where new businesses and business models emerge. A great deal of attention has been paid to online, web-site-based commerce, subscription models for music and other kinds of content, micro payments and other payment approaches, and the like. We think these examples are just the beginning of a shift in focus, in technological direction. Today we think in terms of web sites as destinations; we go to this or that web site to buy any variety of products or to get information or to use other services (such as online banking). Tomorrow we would expect a very different content- and service-based model. Imagine taking that information and service and integrating it with the rest of the computing experience. Going to a web site in the future will be an unusual occurrence, a quaint throwback to the early, unsophisticated days of the Internet. *The web site is not important, but the information associated with that web site is*.

Today, this vision is reflected in its extensive consumer offerings, consisting of not only software that runs everything from PCs and laptops to watches, cell phones, gaming devices, and even appliances (embedded operating systems). It also covers a range of consumer products, services, and applications as well, such as MSN, Office, Xbox, and the Media Center PC.

THE CHALLENGE OF DEVELOPING HOME PRODUCTS TODAY

How do we learn about how consumers use technologies? Researchers have employed a wide range of methods using a variety of data sources to get a deep understanding of users and how they use technological products (Dutton et al., 2005; Venkatesh et al., 2006). In addition to traditional usability lab testing, surveys, focus groups, ethnographic participant observations, longitudinal usage studies, and international cross-cultural studies are also used to help us gain insight into the behaviors of current and potential customers. This research is undertaken to ground products in the reality of the user and to base their design and development on our users' actual practices, habits, and needs.

Focusing on the home technology user experience, we now examine the deployment of a Microsoft consumer product, the MSN TV Internet terminal, that has allowed us to understand how home technology is adopted and actually used in the home and how its use and users have evolved over time.

MSN TV is a TV set-top box that provides Internet service via a dial-up connection to the television. The device effectively turns the television into an "Internet terminal" that allows users to send and receive e-mail, browse the web, and use other Internet features from the comfort of their living room sofa. The first Internet terminal (then called WebTV) was first deployed in 1996. A second WebTV Internet terminal, WebTV Plus, was introduced in 1997 and offered integrated TV features such as interactive TV, VCR controls, picture-in-picture, and an electronic program guide. The prices of these Internet terminals range between $100 and $200, making them a low-cost alternative to a PC. In effect, MSN TV has attracted many subscribers who could be considered Internet novices or beginners with little previous computer or Internet experience, as well as many older and lower income users. Consequently, MSN TV has become an affordable, easy-to-use means of Internet access for these user groups who would not necessarily have had the opportunity to go online.

A Few Lessons Learned About Home Internet Terminals and Their Users

Studying the MSN TV user experience not only has allowed us to learn firsthand how new technology is integrated into the home but also has given us the opportunity to gain a better understanding of low-end beginning Internet users who have managed to cross the digital divide. We briefly discuss a few lessons learned over the past 7 years.

1. Users don't necessarily buy or use the product as intended. While WebTV Plus has been successful as a product, user research discovered that its TV features were underutilized, with many users not taking full advantage of the TV functionality offered by this product (Lee, 2000). An analysis of user data revealed that setting up the TV features (e.g., connecting the VCR to the TV) presented technical challenges to many users who had difficulties setting up the set-top box correctly. It soon became apparent that technological expertise and know-how cannot be assumed on the part of targeted users, especially novice users. Another insight into the understanding of the underutilization of the TV features of WebTV Plus emerged when we examined MSN TV users' perceptions of television and the Internet. We found that many MSN TV users perceived TV viewing primarily in terms of a passive experience with nontangible emotional benefits. For example, the TV was viewed as a source of familiar comfort, as a loyal companion, or as an escape from reality. In comparison, using the Internet was perceived as a cognitive experience with the user being in control. MSN TV users were therefore faced with the paradox of engaging in a user experience that required active engagement, which was superimposed on the TV platform whose user experience was perceived as essentially passive. Both of these experiences were seen as a source of entertainment by our users. However, the lack of TV feature use on WebTV suggests that TV viewing and Internet use had not been fully integrated on the device for some users.

2. Existing technology can act as a bridge to new technology. MSN TV is navigated with an infrared keyboard and remote control. Usability studies found that using a wireless keyboard was a novel learning experience for many users. However, the remote control presented no such challenges, as most MSN TV users were habitual TV viewers and were quite adept and comfortable using remote controls in their daily life. It was therefore not surprising to discover that our users could easily transfer their expertise with remotes to MSN TV's navigation system, which facilitated their use of the MSN TV service. In effect, the remote became an anchor from which they could explore and learn what could be done with the product. However, we observed in usability testing that the remote could also reduce discoverability of features and functions for some users. These users initially assumed that a feature or function was not available because they could not find an associated remote button. Thus, we found that while experiences with other home electronic devices can act as a bridge between familiar and new technologies, this same experience can also act as a barrier to device use.

3. The physical, social, and technological integration of devices in the home context is key to their successful adoption. The introduction of new technology evidently impacts daily home life. It also holds true that the home context plays a significant role in the appropriation of this technology. Venkatesh, Kruse, and Shih

(2003) have conceptualized the home in terms of "living space" that includes three structural components: the social space (household members and their interactions and activities), the physical space (the spatial organization of the home), and the technological space (configurations of home technologies). The relationships between these three spaces contribute to the successful adoption of technology in the home. In a field study of MSN TV users, Lee (2000) observed that family dynamics in the existing social, physical, and technological spaces in the home influenced levels of acceptance of MSN TV; at the same time, the introduction of MSN TV in the home impacted the social and physical dynamics of these spaces.

Looking at the impact of the physical space on successful adoption of MSN TV, we found that the device has to fit into existing configurations of home electronics as well as adapt to the physical space of the home. For example, we found that the configurations of existing electronics posed problems for the installation and use of MSN TV. Many customers' living spaces were already cluttered with VCRs, cable boxes, stereo equipment, speakers, etc., which presented additional challenges when trying to integrate the set-top box into the array of electronic devices that surround the TV set.

An Internet device must also be integrated into the social context of the home, which requires coordinating use with family members in multiuser households. For MSN TV, this device coordination is further complicated by the fact that the MSN TV device is connected to the primary television set, which is most often found in the living or family room. This places MSN TV in direct competition with household TV viewing demands, making it a source of conflict for some families. The fact that MSN TV is usually located in the main living space in the home also creates problems for family members who want exclusive access to information and communications, raising the issue of privacy in a shared space. However, at the same time, the public location and display of MSN TV (i.e., MSN TV is usually located in socially shared space and is displayed on a TV screen that can be viewed by more than one person) facilitates co-usage, enabling families to engage in cooperative Internet use (e.g., write e-mail, view photos, and browse the web).

The successful adoption of an Internet device requires taking into consideration existing points of Internet connection in the home. A small but growing number of MSN TV customers also have a home PC with Internet access in their homes. The coexistence of MSN TV and PCs presents users with the challenge of integrating and coordinating the use of these two similar Internet devices. We have found that this device coordination has resulted in a diversity of user routines and practices that serve as modes of integration of the two devices in MSN TV households. Observed device integration practices include:

- *Differentiation of devices:* Some MSN TV users clearly separate their Internet activities and practices undertaken on MSN TV from activities accomplished on the PC and attribute different roles to each device. For example, some users see MSN TV as their "fun" Internet device where they can "surf in the comfort zone" of their living room sofa, whereas they use their PC for task-oriented activities such as banking and taxes, reflecting a representation of the PC as "work."
- *Differentiated use by family members:* In some households, MSN TV and PC use is differentiated by household user, with certain family members preferring to use MSN TV as their primary or exclusive Internet access, often for reasons of ease of use and convenience, while other family members, often with more advanced technical needs, opt for the PC.
- *Interchangeable use by family members:* In other households, family members use the PC and MSN TV interchangeably with no attributed roles or device ownership, adopting a "first come, first served" approach to access and device use.

We have learned from observations of integration and appropriation of MSN TV that it is essential to take into consideration the totality of the physical, social, and technological spaces, as domestic technologies are deeply embedded in the home environment.

4. Users and their expectations evolve over time. Internet novices (i.e., users with little or no previous computer Internet experience) have always been an important part of the MSN TV customer base, but we have found that this user group has changed over time. Not only has the percentage of subscribers who have no previous Internet experience decreased, but also novices themselves have evolved. We now find many novices who have higher level of awareness of computers and the Internet even though they have never used the Internet. These customers have become familiar with Internet jargon and have developed assumptions about how the PC and the Internet work by passive assimilation of ambient knowledge and social representations about computers and the Internet in the media. They have also benefited from peripheral learning in their environment (e.g., watching a family member go online).

We have also observed that the social identity of MSN TV users has evolved over time, as users define themselves in relation to the dynamic of the Internet community at large. At the time of the first deployment of MSN TV, many new users were often the first of their family and social groups to get online and consequently were regarded as a technological trendsetter of sorts. With the significant increase of Internet use in American society, MSN TV users now report feeling social pressure to "get into the

21st century" and "not be left out of the loop," reflecting the social belief that Internet access is a requirement in daily life and the computer is now an essential household device.

One consequence of increased PC penetration and Internet use is that MSN TV users are placed in the position of justifying why they are not using a computer for Internet access. Some users report that family members and friends perceive their Internet access device as inferior to the PC and encourage them to "upgrade" to superior technology. Thus, when users are asked why they use MSN TV, we find explanations that are phrased in part as justifications of why they are not using a computer (e.g., they do not want to deal with viruses, they do not need the extra features, etc.). The evolution of the social identity of MSN TV users reminds us of the importance of understanding not only how Internet technologies are used but how they are perceived as well.

As the Internet has become more technically sophisticated, MSN TV users have become more Internet savvy, with a consequent increase in their technological expectations. Thus, it becomes our responsibility not only to support current use of a consumer product but also to plan for the future by anticipating our customers' needs.

Future Challenges for the Home Technology Experience

Looking at lessons learned so far from the adoption of home technologies, we can identify some future challenges for the planning and development of the next generation of home consumer electronics:

- How do we develop consumer products that integrate technologies and seamlessly fit into physical spaces and social practices of the home?
- How can technology help improve people's daily lives? What everyday problems families face that technology can help solve?
- How will the Internet be absorbed into everyday life? How will technology be integrated into daily routines? How do people want to use this technology?

HOW DO YOU MAKE THE FUTURE REAL?

Role of Scenario-Based Prototyping Efforts

With these questions in mind we turn to the exploratory process that will look into solutions to consumer needs and, in doing so, extend home technology. In the previous section we have seen how user research provides insights that can become the foundation and context for the development of future consumer technologies. In this section we focus on a key step in this vision development process: the role scenario-based prototyping can play in making the future real. As an example of consumer prototyping process, we examine Microsoft's immersive prototype, the Microsoft Home.

Role and Method of Scenario-Based Prototyping

Scenario-based prototypes are one special technique adopted by technology-oriented companies. Recent studies have addressed the success of such techniques in industry environments (Frye, 2003). These are designed to give the audience a real *day in the life* view into the technology or idea that we are trying to express. This is in contrast to a technical or proof of concept type of prototype that one might expect from a research laboratory or product team.

Typical prototype deliverables can take many forms and include:

- Fully networked "immersive" environment (such as the Microsoft Home).
- Interactive PC-based prototype.
- Engineered hardware (such as the networked microwave in the MS Home).
- Slide decks.
- White papers.
- Detailed storyboards illustrating topic concepts.

Prototyping Method

The flow chart in Figure 1 outlines the major steps in a common prototype developed by the Consumer Prototyping and Strategy Team.

Scope. In this phase, research into the prototype topic is conducted and requirements are developed. The initial document is prepared, outlining goals, customers, messages, requirements, deliverables, features, and a rough schedule. This document will get completed and then subsequently updated throughout the project as the project becomes more defined, or as elements change.

Brainstorming is also important during this phase. Input from all interested parties is welcome and should be

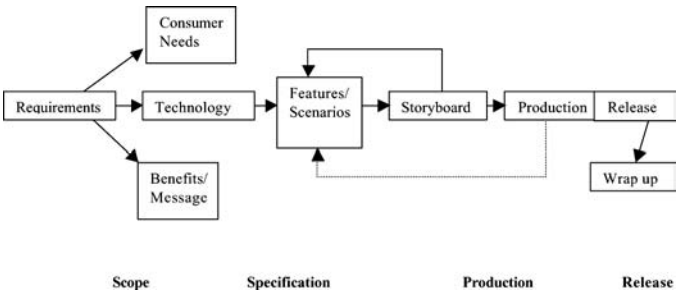

FIG. 1. Flow chart for prototype development.

solicited on all topics. All ideas and perspectives should be considered.

Specification. Once the scope is clear, it becomes possible to begin the development of a list of demo features, the ideas that are important to include. Scenarios (basically the script or plot or story treatment) of the demo are developed, reviewed, and refined. Detailed storyboards tend to fulfill the role of the detailed specifications for graphic designers and developers. They show all elements of each screen, the "click-through" script sequence, and dynamic and static elements. It should also be noted that this phase is highly iterative.

Production. This is the heads-down-and-get-it-done phase. It can also be iterative.

Release There is a standard release process. It includes managerial buy-off and a checklist of required documents. A prototype only becomes truly viable and useful if it is (1) stable, (2) easy to set up and maintain, (3) forgiving of presenters' errors (presenter-proof), and (4) well documented.

Evolution of the Home Control Interfaces

The Microsoft Home is Microsoft's premier venue for communicating its vision for home technology. It brings together under one roof a broad range of technologies, products, and services to illustrate how home life can be made easier and more enjoyable with the help of new technologies. The Microsoft Home features real home environments—including kitchen, family room, and dining and entertainment rooms—providing a glimpse of the way people may live, work, and play at home in the near future, and at the same time, enabling Microsoft to utilize this valuable environment to collect input from consumers and partner companies.

The current Microsoft Home facility was opened in 2000 (the original Microsoft Home opened in 1994) and has seen several user interface revisions. Over this time the focus has been to evolve user interfaces to keep pace with technology trends.

Demonstrations in the facility are of two types:

- *Home control interfaces*. These illustrate how a consistent user experience might be created using multiple control types—including voice, touch screen, remote control, mouse and keyboard—and displayed on PC, TV, "room controllers," and other display surfaces.
- *Single-purpose prototypes*. The home experience extends beyond mere home controls to illustrate ways in which technology in a highly networked environment might be used for other common household activities.

FIG. 2. Microsoft Home user interface, circa 2000.

Home control interface, version 1. The goals for the first version (Figure 2) were to:

- Create a compelling, realistic, and most importantly consistent user experience across multiple devices.
- Enable information, such as media content, family calendar, and home status, to be shared seamlessly and updated across all devices and displays in real time.

Although goals were straightforward, design was not. No design guidelines existed for creating a multidevice user experience. Through the design process, we first determined what types of information we wanted to be able to access and control within the Microsoft Home. Four broad information categories were identified: "*Media*" (which included guides and transport controls for television programming, music, and photos), "*Environment*" (lighting and heating controls), "*Information*" (the family messages, calendar, shopping, contacts, and to-do lists), and "*Security*" (the home alarms and security camera views). We also included a category called "*Main*," which aggregated the most desired features from each category. Unique "Main" screens were established for displays in each room of the Microsoft Home.

Additionally, we established other universal interface elements always accessible on all displays. These included a "*Map View*" (enabled the user to select controls for a room other than the one she or he was in), "*Notifications*" (alerts from the Microsoft Home system for such things

as appliance status or malfunction or incoming calls), and "Search."

In the example that follows, the "Main" screen for the kitchen shows the universal elements of the design, plus the content customized for that display. We see such things as the family inbox and calendars, a security camera view, and the local traffic conditions. The interfaces are web based. Clicking on any of these elements takes the user to an expanded view of that element, and surfaces all its functionality. In effect, the user opens the application, although in the Microsoft Home's world the distinction is unimportant.

Visual designs were then tailored for the requirements of each type of display. PC displays, driven by mouse and keyboard, were rich, with flexible navigation. Plasma screens ("TVs") controlled by remote and viewed from several feet away had other design requirements, such as large type and a simple tabbing model of navigation. Room controllers had touch-screen interfaces, requiring buttons large enough for fingers while still exposing the functionality available on the larger displays.

Home control interface, version 2. As is plain from the image in version 2 (Figure 3), the look and feel of the home's interface changed markedly from version 1. Our design goals were to (1) give the interface elements a sense of relationship and context, and (2) do that by creating a sense of dimensionality within the interface. We had neither the time nor the budget to create a polished three-dimensional (3-D) interface (an essential requirement for creating a compelling and realistic experience), but used two dimensions to convey a sense of depth and shape. We moved to a more visual, rather than text-driven, interface—for example, using icons rather than text to identify the primary information categories.

Categories shifted a bit as well. "Security" was absorbed into "Environment." "Information" was broken into two categories, "Information" and "People" (contacts and communication), to better illustrate some new concepts.

FIG. 3. Microsoft Home user interface, circa 2002.

With version 2, requirements for a consistent user experience across multiple device types were readily understood, so we could focus on additional features and concepts. One notable feature was "Identity." In version 1, there was only one identity mode or view. Anyone using the interface had the same experience. In contrast, the default view of any display in the public areas—kitchen, family room, dining room, and entertainment room—is "Family" view. Anything that is accessible within Family view is appropriate for all family members and any guests present in the home. For example, "Media" guides in Family view might not list any mature or adult content, or might require some type of authentication to prove that a viewer has permission to access such content. The second identity view is "Personal." In that case, a family member chooses her/his profile, and her/his subsequent experience is completely tailored for her/him. "Identity" affects all aspects of the experience within the version 2 interface.

A striking change between version 1 and version 2 was apparent in the reactions and responses of visitors. Version 1 was primarily about integrated home control. Visitors found the ability to control lights, find and view a television program from a guide, or access a universal inbox, all from the same interface, impressive. But most could not quite imagine what else a networked environment, with devices sharing information seamlessly, might mean for them. Expectations were modest.

Two years later, version 2 provided a much more personalized and rich experience, full of features and web-based services coming into the home as a tightly integrated experience. We discovered that visitors' expectations had caught up with the speed of technological change, and their responses were much more sophisticated. They asked more technical and what might be called "buying decision" questions. What technology makes all this happen? Can I get this in my home today? How much would it cost? Is it easy to maintain? Can it also do X or Y? What would happen if the power went out? What about security of my personal information?

Based on our experiences with versions 1 and 2, we are currently developing version 3.

Single-Purpose Prototype Examples. In addition to exploring home control features and interfaces, the Microsoft Home has additional demonstrations that explore future possibilities for networked home environments. These serve as ways to explore emerging technologies and ideas, and provide opportunities for discussion with visitors. Each of the examples that follow vividly leapfrogs visitors beyond today's realities into tomorrow's possibilities.

Smart kitchen counter. We wanted to explore ways that an aware home environment could better determine what a family member might be trying to do and respond accordingly. A home that is aware of family members, activities, and objects might be able to offer a richer experience to families than is possible today. The home could be, in effect, smarter and more helpful.

Such intelligence and awareness could be implemented by fairly simple means. For our prototype, we assumed a home where every item is either connected to the network or identifiable by it. We fitted a bag of flour and a mixer with radiofrequency identification tags (RFID). In the demonstration, we place first the mixer and then the bag of flour on the kitchen counter. The network recognizes the two objects and, recognizing that both are used for cooking (presumably from data included on the RFID tag), uses the Home's speech system to ask, "Would you like some assistance?" The host replies, "Yes," and a list of options is displayed on the kitchen counter (from a projector in the ceiling). From there, using voice controls to select from displayed options, the host can choose a recipe, watch ingredients being checked off as items are added to the counter, and have recipe steps read aloud.

Digital memory device. With the proliferation of smart devices, we expect new form factors will arise. This prototype displays family photos on an unconventional surface, a curved piece of opaque plastic. When a series of images is projected within it, the skewed and moving shapes create a charming and unexpected effect. The interface is simple. Unless someone is close to the device, a simple, nonchanging abstract image is displayed (the effect is a bit like a Lava Lamp). When the device is approached, it begins to display a series of images that move across the surface. The images could be random, or might be displayed because of connections to calendar events (metadata, such as date/time or location cross-linked with the family calendar, for example). They could also be used as visual reminders of upcoming events. For example, 2 weeks before a wedding anniversary, the device displays a couple's wedding or honeymoon photos a few times a day. As the anniversary gets closer, wedding photos are shown with increasing frequency. For those of us prone to ignoring digital calendar reminders, this implementation is appealing.

Storytelling. One comment that we are hearing more frequently in the Microsoft Home is that it seems alive, thankfully not in an unpleasant way. Because the environment is responsive and behaves in what seems to be an intelligent way (meaning as visitors expect it to), it is perceived as aware, and hence "alive." This prototype, in part, plays off that idea.

The host sits down in a comfortable corner with a children's book. Speaking to the Microsoft Home, she tells it to "enhance this story." She says the title of the book. The room responds by dimming the lights, displaying an appropriate image on the screen, and playing appropriate background sounds. As the book is read, the room responds accordingly. For example, in the book *Goodnight Moon*, the first line is "In the great green room." When read aloud, the room turns green (provided by an installation of LED lighting). The second line, "there was a telephone," brings the sound of a phone ringing. The third line, "and a red balloon," brings a red shape on a nearby wall. As the story continues, the whole room continues to respond.

We believe that the prototype illustrates the kinds of services that might be available to families in the future. In this case, we assume a subscription service of entertainment features that provide new movies, music, games, and even enhancements for popular children's books to the home network, for enjoyment throughout the home.

Perhaps the most important point of this prototype touches upon the social impacts of technology. In our view, the point of technology is not to replace experiences that we already enjoy today with our families. Sitting a child down with the interactive video of *Goodnight Moon* is not as satisfying as a parent and child enjoying the book together. Rather, we believe that technology should support or enhance experiences that you already enjoy or engage in today, but in new ways. In this case, new services available to the home leverage the technology already in the home to enhance a typical family activity.

It should be noted that while the Microsoft Home does not do usability testing, we did test this prototype with a 3-year-old. The subject's responses were positive, even enthusiastic. The test was discontinued when subject's repeated requests of "Again!" outlasted the usability engineer's ability to read the story ad infinitum.

SUMMARY: PUTTING IT ALL TOGETHER

In this article we tackled the future of consumer technology by first looking at lessons learned from its past and present as well as from the insights gained from understanding the home technology user experience. Using this knowledge as a social context, we then turned to the process of constructing visions of the home of the future by discussing the scenario-prototyping process as examined by the Microsoft Home. As we now face the future, what are the developments and the challenges ahead? What solutions will we need to make the future real? A few trends we can foresee include:

- Devices and software working seamlessly with services: It will be increasingly easy and affordable to network share services around your home. Home networking will become a richer and deeper experience. However, much needs to be done

before home networking can realize the possibilities that we imagine (e.g., standardization of network protocols).

- Hardware and devices that fit users' situations and needs: Home technology will converge, providing an increasingly integrated experience. It will also integrate with mobile devices and technology outside the home context. However, we need to be wary of overloading the consumer with technological complexity, and we need to remain attentive to the need for simple-to-use devices and services.
- Connectivity everywhere: People will be easily able to access their communications, information, and entertainment, on any device in an "anywhere, anywhere" world as connectivity becomes ubiquitous.
- Personalization of content and information: People want their technology to be personally meaningful. The development of "smart" services and devices will be able to respond to consumers' growing expectations of their consumer experience and home technology to be "all about me and my family."

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