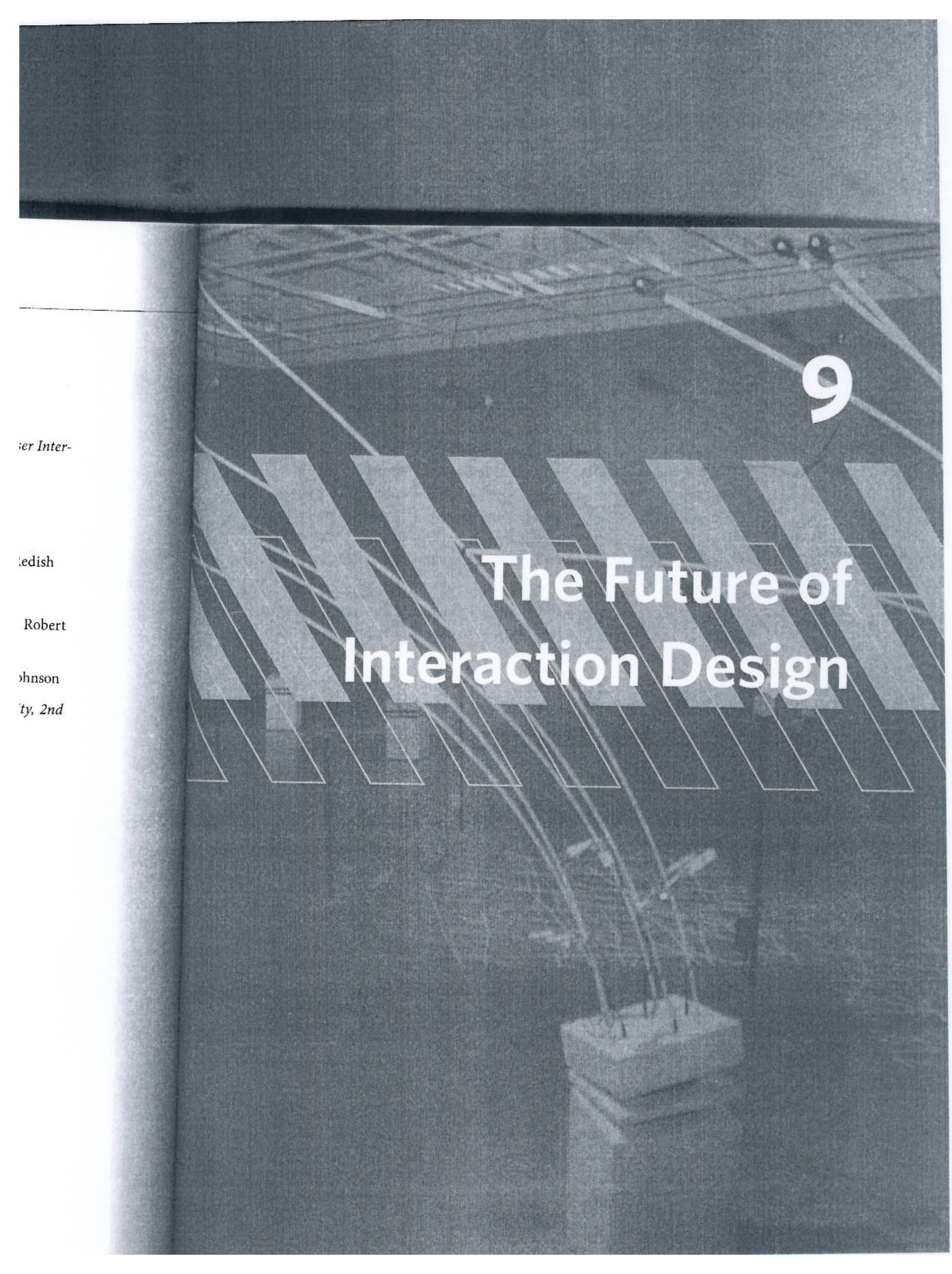


9

The Future of Interaction Design

The future of interaction design is being created now. Interaction designers on their own or at startup companies or huge organizations are devising products and services that will change how we interact with each other and with our world. It's not hyperbole to suggest that the next 20 years will see significant changes in almost all aspects of our lives: our healthcare experience, how we entertain ourselves, how we shop, how we get from place to place. How, when, and where we receive information will be completely transformed, and interaction designers will be there, to guide and design the products and services that will shape the future.

Interaction designers must take a role not only in creating the future of the discipline, but also in making sure that the future works well and is designed for humans to use and enjoy. The next decades will see some amazing advances, some of which are explored in this chapter. Interaction designers are at the center of all of it. It's an exciting time.

The Internet has moved from behind computer monitors to the objects and buildings that are all around us. Microprocessors, sensors, and networking capabilities such as radio-frequency identification (RFID) tags are being built into everyday objects, creating what many have called the **Internet of Things**. Indeed, we're rapidly moving away from thinking about the Internet less as a destination and more as a utility to be plugged into and used like electricity.

Wireless connections are beginning to blanket our cities (either through monolithic engineering projects or ad-hoc networks patched together by individuals and businesses), allowing for the ability to access information contextually, when and where it is needed, geo-located. We will be able to find people and things, and they will be able to find us.

Our products and services will better adapt to us, and we to them. Robots will perform tasks in our homes, schools, cities, and businesses. Intelligent agents will find information we need before we need it. We will wear our computers on our sleeves, if the computer isn't the sleeve itself.

The future will be what the future has always been: hopeful, scary, unknown, disorienting. Only more so.

The Next Five Years of the Internet

"I live in Walled City," he said.

"Mitsuko told me. That's like a multi-user domain."

"Walled City is unlike anything."

"Give me the address when I give you the emulator. I'll check it out."

The sidewalk arched over a concrete channel running with grayish water. It reminded her of her Venice. She wondered if there had been a stream there once.

"It has no address," he said.

"That's impossible," Chia said.

He said nothing.

—From *Idoru* by William Gibson

Over the next decade, there will be a wide range of products and services online, from highly structured to nearly formless. The more "traditional," structured products—blogs, home pages, marketing and communication sites, content sites, search engines, and so on—will have their form and content determined mainly by their designers and creators.

Less structured are rich, desktop-like applications, the more interesting of which, such as Twitter, are Internet-native and built to take advantage of the strengths of the Internet: collective actions and data (Amazon's "People who bought this also bought..."), social communities across wide distances (Yahoo Groups), aggregation of many sources of data (Google News), near real-time access to timely data (stock quotes, weather), and easy publishing of content from one to many (Facebook, Flickr). For many of these products and services, it is the users who supply the content (such as it is).

And there will also be a new set of products and services, many of which won't have associated Web sites to visit at all. Instead, there will be loose collections of application parts, content, and data that don't exist anywhere really, yet can be located, used, reused, fixed, and remixed. The content people will search for and use may reside on an individual computer, a mobile phone, or on traffic sensors along a remote highway. Users won't need to know where these loose bits live; instead, their tools will know.

Tools for the Next Web

These unstructured bits won't be useful without the tools and the knowledge necessary to make sense of them, similar to the way an HTML file doesn't make much sense without a browser to view it. Indeed, many of these bits will be inaccessible or hidden if a user doesn't have the right tools.

This is where interaction designers come in: creating tools for the next generations of the Internet. The tools we'll use to find, read, filter, use, mix, remix, and connect us to the Internet will have to be a lot smarter and do a lot more work than the ones we have now.

Part of that work is in formatting. Who and what determines how something looks and works? With the unstructured bits of content and functionality, perhaps only a veneer of form will remain. How something looks will be an uneasy mix of the data and the tools we use to engage with it. Indeed, visual design is becoming centralized in the tools and methods we use to view and interact with content, moving away from its decentralized locations on Web sites. Already, RSS readers let users customize the way they view feeds from a variety of sources, as do some plug-ins for the Firefox browser. Soon, expect to see this type of customization happening with bits of functionality as well as content.

Web browsers will probably be most affected by these new, varied experiences. Our current browsers were designed for navigating a hypertext content space—structured products and services, in other words. They are poor to merely adequate for Web applications and nearly useless for unstructured products and services. We will need new browsers—new tools altogether—and interaction designers need to be involved in creating them.

It would also be a mistake to think that most of these tools will be on laptop or desktop computers. The number of people online is expected to reach about 2 billion in 2010, and a large percentage of those people will be accessing the Web via mobile phones and devices. The shift away from desktop-like experiences will be profound and require incredible amounts of work from interaction designers to become a reality.

It is more important now than ever before that our digital tools have the characteristics of good interaction design baked into them. These tools will determine what we can do online and how we can do it and what it will feel like. Our online experience will largely be determined by how good these

tools are, in much the same way the first 20 years of the Web were shaped by the browsers we used to access it.

Intelligent Agents

Some of these tools will likely be software acting on our behalf. These "intelligent agents" will be a type of application that resides in (and sometimes follows its user between) digital devices. The duty of these agents will be to perform tasks that are impossible or too time-consuming for humans, such as finding, sorting, and filtering every blog post about interaction design ever posted, or constantly monitoring networks for problems. These agents will monitor our behavior and gather and use information for us before we need it. They will watch over our devices, our homes, and even our physical health.

What's being called the **Semantic Web** will help fulfill this prediction. Currently, Web pages are mostly designed to be read by people, not machines. The Semantic Web would change this, so that software including intelligent agents can use the Internet more effectively. The Semantic Web consists of online content understandable by computers, so that they can perform more of the tedious work involved in finding, sharing, and combining information. Using the Semantic Web, for example, an agent could find the restaurant closest to your current location and make a reservation based on your schedule.

Of course, having semi-autonomous agents roaming online doing things that the user may be only dimly aware of is a frightening prospect. Users will want to make sure that these agents aren't doing wrong things on their behalf. The interaction designers who will be involved in creating these agents will also have to design the means for users to supervise and control their agents. This is a design challenge still waiting to be fully explored.

Spimes and the Internet of Things

Novelist-cum-design-critic Bruce Sterling has said in his book *Shaping Things* (and elsewhere) that interaction designers will be creating and working with a type of object that he calls a **spime**. Spimes are networked, context-aware, self-monitoring, self-documenting, uniquely identified objects that exude data about themselves and their environments. Spimes reveal

every piece of metadata (their location, their owner, the date they were made, usage patterns, and so on) about themselves. They can be tracked through space (the "sp-" part of the term) and time (the "-ime" part) throughout their entire lifecycles, from their prototypes to their eventual destruction.

These spimes will likely have self-identifiers and networking capabilities that allow them to communicate. Using sensors and wireless technology, they will communicate with each other and the Internet like a swarm. Spimes, and other objects similarly enabled, will be able to be located and have information added to them, such as "These are my shoes."

Spimes will create an informational Web—the Internet of Things—the uses (and abuses) for which boggle the mind. Imagine having a list of every item in your house, down to the smallest pack of matches. Lose your mobile phone in a taxi? Simply find where it is in real time.

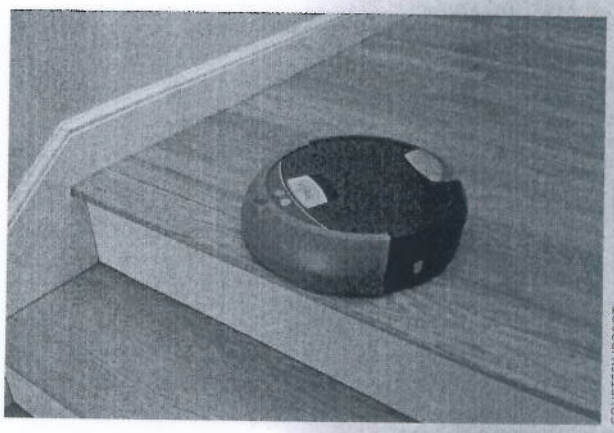
> NOTE *Of course, the privacy issues related to an Internet of Things boggle the mind as well. Imagine thieves being able to find all the most expensive items within several blocks, or governments being able easily and instantly to know everything about you, down to what you have in your refrigerator.*

The data that this Internet of Things will reveal will be fascinating and frightening. Sterling uses the example of tennis shoes. Spime tennis shoes, over time, could reveal what happens to their rubber soles at the end of their life cycle: are they being recycled into playground coverings or are they becoming aerosol carcinogens? Using this data, we will be able to see with clarity the impact of products on our world. Spimes offer the possibility of accountability in products.

As designers such as Adam Greenfield (see the interview later in this chapter) have noted, what is missing from the idea of an Internet of Things (or at least from the nomenclature) is *people*. How do people work with, understand, and affect an Internet of Things? While things may have meaning in and of themselves, they derive an additional layer of meaning when used by people. How interaction designers place human beings into the Internet of Things is a challenge for the future.

Human-Robot Interactions

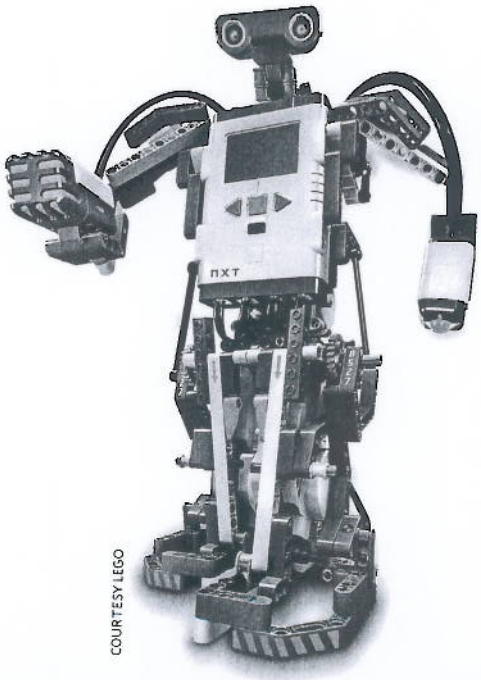
Robots are no longer the science-fiction machines of yore, nor are they used only to create cars in factories. Robots—broadly defined as programmable machines that can perform specific physical tasks—are among us, likely for good. A robot, however, is more than just an object. It is both a product and a service.



COURTESY IROBOT

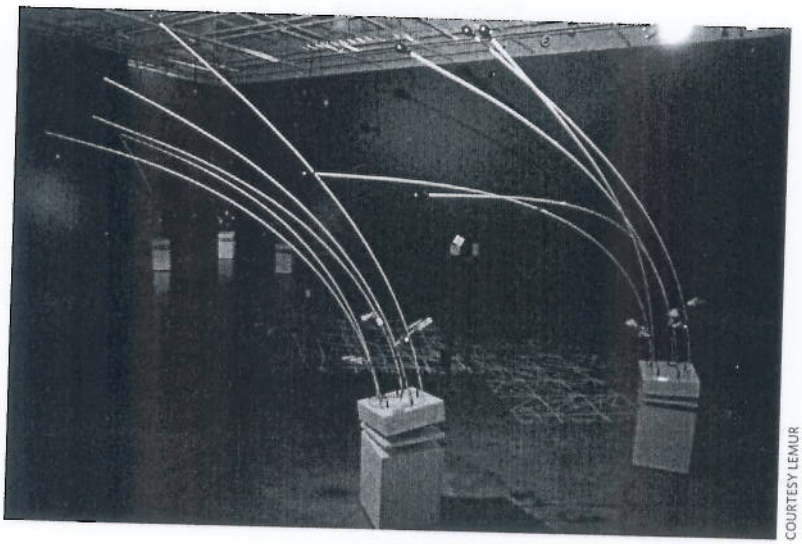
Figure 9.1
iRobot's Scooba is a floor-washing robot that can prep, wash, scrub, and dry hard floors, all at the touch of a button.

Robots are being designed and built all over the globe: as floor cleaners (**Figure 9.1**), toys (**Figure 9.2**), musical instruments (**Figure 9.3**), and more. Because of the complex issues surrounding robots, from the emotional to the technical, interaction designers need to become more involved in their creation and use.



COURTESY LEGO

Figure 9.2
Lego Mindstorms allow children and hobbyists to create sophisticated robots easily.



COURTESY LEMUR

Figure 9.3

ForestBot is a robotic installation by the music/technology group League of Electronic Musical Urban Robots (LEMUR). ForestBot is a collection of 25 ten-foot stalks that each have an egg-shaped rattle mounted on the free end.

Figure 9.4

Carnegie Mellon's roboreceptionist gives directions, answers the phone, and even gossips about her "life."

Interaction designers need to be aware of two factors when designing robots: autonomy and social interaction. Autonomy gives the robot the ability to act on the user's behalf without direct external control. Robots like those from Lego Mindstorms have very little autonomy, but some "robots," such as pacemakers and artificial hearts, have full autonomy—their human users don't have to tell them to work. Similarly, there are robots, like the toy Furby, that engage in little reciprocal interaction, and others, like Carnegie Mellon's Valerie, the robot receptionist (**Figure 9.4**), designed specifically to interact with humans.

Robot designer and professor Jodi Forlizzi has outlined three main design issues with robots[1]:

- **Form.** Does the robot have a humanlike appearance? How big is it? What are its physical characteristics, such as size, shape, scale, and material?
- **Function.** How does the robot communicate and express itself? Does it use sound, motion, gesture, light, color, or scent?
- **Manner of behavior.** How does the robot behave and in what situations? How does it go about its activities and how does it interact with humans? How social is it?

1 See her design work with robots at http://goodgestreet.com/research/ppr.html

COURTESY LEMUR

Carl DiSalvo on Designing for Robots

Carl DiSalvo is an assistant professor at Georgia Tech University whose work focuses on the existing and potential uses of emerging technologies such as robotics, sensing, visualization, and mapping in the urban environment. Previously, Carl worked as a designer for MetaDesign and as a consultant for the Walker Art Center's New Media Initiatives. In 2006, he received a Ph.D. in Design from Carnegie Mellon University. As a graduate student, he worked as a design research associate on the Project on People and Robots at the CMU Human-Computer Interaction Institute.

Briefly describe the realm of robots. What type of robots are being made or planned?

We can make some distinctions among robots, but none of them are mutually exclusive. A robot could, and often does, fall into two or more of categories. For example, there are social robots, service robots, and field robots. Many of these distinctions actually relate to the research question at hand more than to a kind of consumer product. This of course reflects the fact that outside of a few domains and a few choice examples, robots still are primarily research endeavors.

The most common domains for contemporary robotic products are military or industrial settings. Robots are also beginning to be used in medicine and scientific exploration. And of course toys. Robots for the home consumer, such as the Roomba, are still uncommon. For example, there are a handful of vacuum and lawn-mowing robots, but other than that, except for toys, there aren't really robots, as we commonly think of them, in the home.

What type of design work is being done with robots now?

All kinds. This is what makes robotics so exciting. The challenges and opportunities of robotics sweep across every field of design. Perhaps the most obvious is the work in industrial design in creating the visual form of the robot. The industrial design of a robot is an example of styling visual form with significant impact on interaction. In fact, it's difficult to separate industrial design from interaction design in robots. Because of the newness of robotics and the public's unfamiliarity with robots, the visual form of the robot often takes precedence in shaping our expectations of the robot and how we interact with the product.

Carl DiSalvo on Designing for Robots *(continued)*

In addition to designing the visual form of the robot, there is a lot of interface design involved with robots: interfaces for tele-operation as well as interfaces for direct interaction. These interfaces might be screen-based, physical, voice, or some combination of the three. Because we have yet to arrive at any standards for, or even common experiences of, interacting with a robot interface, interaction design for robotics is open to broad inquiry and invention.

How is designing for robots different from designing other products?

Robots are hyperboles of the products contemporary designers are challenged with. That is, they are an exaggeration of the contemporary products because robots are "everything all at once": complex embodied technological artifacts that require significant design knowledge of industrial, communication, interaction, and service design, potent cultural icons, and, too, the most mundane of gadgets.

All of the diverse elements of a product are brought together and amplified in a robot. This presents a nearly unique challenge and opportunity. Designing robots requires a level of synthesis not often encountered in other products.

What will be the role of interaction designers in this field in the future?

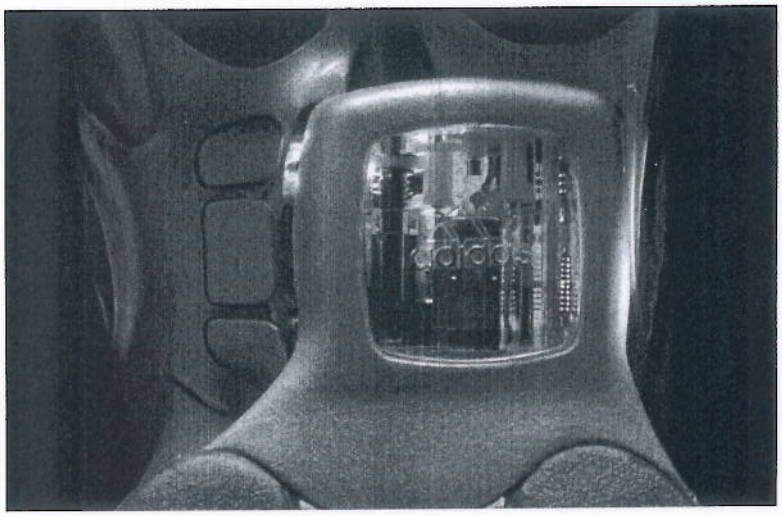
In many ways, robots are still fictional entities, at least when it comes to common consumer products. Interaction designers have the opportunity to invent what these new products of the future might or should be like. This comes along with significant responsibility to shape these products in ways that are not merely seductive but appropriate.

One of the most pressing needs concerning the design of robots, concerning design in general, is to consider how these nascent technologies become products, and in the process to take up the opportunity to critically engage these technologies, rather than simply striving forward with unreflective novelty.

Wearables

Your next computer might be a size 10.

Although the idea of wearable computing has been around since the early 1960s, it wasn't until 2005, when Adidas introduced Adidas_1 (**Figure 9.5**), a running shoe with a microprocessor that adjusts the cushioning of the shoe based on its use, that the idea of wearables reached the public consciousness. Likely, Adidas succeeded because the Adidas_1 looks stylish, unlike many previous attempts at wearables: clunky pieces of gear awkwardly strapped to some geek's body.



COURTESY ADIDAS

Figure 9.5
The Adidas_1 shoe has a magnetic sensor in the heel that senses the level of compression. This compression level is sent to a microprocessor in the shoe that adjusts the cushioning via a motor-driven cable system, making the shoe softer or firmer as needed.

Designers of wearables take as their starting point the fact that the thing most people have with them most of the time is their clothes. Why not, then, use clothing as a platform for technology so that we have things that we need with us all the time? Computers in clothing can adjust the clothing to project messages, react to other devices, or change according to the weather or the wearer's mood (**Figure 9.6**).

COURTESY CUTECIRCUIT

Figure 9.6
F+R Hugs ("The Hug Shirt") is a shirt that allows people to send and receive the physical sensation of a hug over long distances. Embedded in the shirt are sensors that feel the hug's strength, the skin's warmth, and the heartbeat rate of the sender. Actuators re-create those sensations in the shirt of the distant loved one.

Of course, wearables don't have to be clothing per se. BodyMedia's GoWear products (**Figure 9.7**) are small devices that strap on an arm and monitor the wearer's health. Wristwatches have been a basis for wearables, such as Fossil's WristPDA.

COURTESY BODYMEDIA

Figure 9.7
The GoWear® fit Armband uses a multisensor array to collect continuous physiological data directly from the wearer's skin. Users can monitor their energy expenditure (calories burned), duration of physical activity, number of steps taken, sleep/wake states, and more.

The challenges for interaction designers working with wearables are many, as are the opportunities. Designers have to pay particular attention not only to functionality, but also to form. Wearables, unlike devices that sit on a desk or slip into a pocket or purse, are meant to be, well, *worn*. And things worn on the body for long periods of time need to be durable, stylish, and unobtrusive. Their context is anywhere that humans are, and that is an extremely broad and varied set of environments. The opportunity with wearables is that peo-

ple don't need to be concerned about "another device to carry." Users won't have to carry anything except the clothes they wear or something strapped to their bodies like a fashion accessory. Information and functionality move with the user, available when needed, and data is captured from the user's body and location that might never be captured otherwise.

Wearables also allow interaction designers to take advantage of more parts of the body than they are used to engaging. A glove with sensors might unlock doors with a flick of a finger. A sleeve might become a screen for projecting images, and a necklace, like Microsoft Research's SenseCam,[2] might take thousands of pictures a day, allowing users to replay their days visually if they choose.

Ubiquitous Computing

Over the past 60 years, the ratio of humans to computers has radically changed. In the early years of computing, the ratio of humans to computers was many to one: many people worked on one mainframe computer. Then came the era of the personal computer, and the ratio changed to one to one: people who used computers had their own on their desks. Recently, however, and in the future this will be even more true, the ratio has changed so that one person now has many "computers" under his or her control: a laptop, digital camera, MP3 player, mobile phone, car, microwave, television, and on and on. In the words of Mark Weiser, the Xerox PARC scientist who wrote the seminal papers[3] on the subject, most of these computers are "invisible, yet all around us."

The era of ubiquitous computing (or **ubicomp**) has, like so much of the "future" technology in this chapter, already started; it just isn't widespread yet. As microprocessors and sensors grow ever cheaper and also more powerful, it isn't a stretch to imagine the ratio of humans to computers becoming one to thousands. Most of these "computers" will be embedded in the products we own, and aside from the behavior they afford, they will be imperceptible to us. We won't be controlling them via a keyboard and mouse either. As described in Chapter 7, these interfaces will often have no faces; we'll engage with them using voice, touch, and gestures.

2 http://research.microsoft.com/en-us/um/cambridge/projects/sensecam/

3 Such as "The Computer for the 21st Century" in *Scientific American* Special Issue on Communications, Computers, and Networks, September 1991

Interaction designers have a major part to play in the design of ubicomp systems, and it is an exciting and interesting time. While you get ready in the morning, your bathroom mirror might show you your calendar, the weather report for the day, and perhaps e-mail from your friends. The bus stop might indicate when the next bus will arrive and how crowded it is. The bus itself might have digital notes on it left by passengers ("This seat is broken"). At your office, a wall might be your monitor, turning on simply when you tell it to. Meeting rooms might automatically record what is said and drawn on digital whiteboards. Any room you are in throughout the day might play music of your choice and adjust to the temperature you like based on the clothes you are wearing.

This scenario sounds to us now like science fiction or those AT&T "You Will" commercials from the early 1990s,[4] but it likely isn't too far off, and each of these moments will need the skills and talents of interaction designers to make them easy to use, fun, and appropriate. How do you change the bathroom mirror from displaying the weather report to displaying e-mail? How do riders leave or see messages left on a bus? The incredible range of design opportunities is apparent.

Frankly, the stakes are simply too high in ubicomp for interaction designers not to be involved. In a typical interaction with a digital device right now, users are in control of the engagement. They determine when the engagement stops and starts. They control how the computer (and through the computer, others) sees and experiences them. Users' bodies, except for their hands and eyes, are for the most part irrelevant. None of this is true in ubicomp.

Users may step into a room and unknowingly begin to engage with a ubicomp system—or many systems. The thermostat, door, light fixture, television, and so on may all be part of different systems, wired to respond to a person's presence. Where users are in the room—even the direction they are facing—may matter. Standing near the television and facing it may trigger it to turn on, as could a particular gesture, such as pretending to click a remote control in the air. But because users may not know any of this, they have no way of controlling how they present themselves to the system. Perhaps they don't want the room to know they are there!

4 Watch them online at www.youtube.com/watch?v=TZb0avfQme8

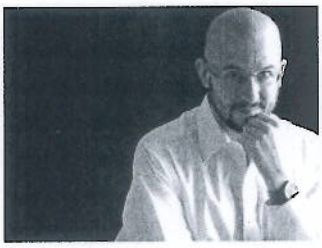
The implications of ubicomp are profound, and it will be up to interaction designers to make these systems discoverable, recoverable, safe, and humane. Like robots, ubicomp systems are often both products and services, so all the skills, methods, and techniques discussed throughout this book (and more) will be needed to design them in a way that works for humans. One can easily imagine how ubicomp systems could get out of control, embarrassing and annoying us. Our privacy will be impinged upon every day, and ubicomp is hard to see without signage systems and icons on objects and in areas to let us know we are in an ubicomp environment. We will need to know what is being observed, and how, and where, but without filling our rooms with signs.

Interaction designers need to design ways for people not only to understand these systems, but also to gain access to them if problems occur. When problems happen—the system keeps switching off the TV every time you sneeze!—how can they be corrected? Is it the lamp that controls the TV or is it the wall?

Another challenge in designing for ubicomp is that most ubicomp systems will likely be **stateless**, meaning that they will be much more moment-to-moment than current systems are. Users won't be able to refer to an earlier moment and revert to that, or at least not easily, making it harder to undo mistakes—"Wait, what did I just say that caused all the windows of the room to open?" or "Pretend I didn't just walk into this room." Interaction designers will need to take this feature of ubicomp systems into account and design without the benefits of Undo commands and Back buttons.

It is incumbent upon interaction designers to instill meaning and values into ubicomp more than any other system. When the things around us are aware, monitoring us and capable of turning our offices, homes, and public spaces into nightmares of reduced civil liberties and insane levels of personalization ("Hi Sarah! Welcome back to the bus! I see you are wearing jeans today. Mind if I show you some ads for Levi's?"), interaction designers need to have compassionate respect for the people who will be engaged with them, some of them unwillingly and unknowingly.

Adam Greenfield on Everyware



Adam Greenfield is an internationally recognized writer, user experience consultant, and critical futurist. Before his current position as head of design direction for service and user-interface design at Nokia, he was lead information architect for the Tokyo office of Web consultancy Razorfish; prior to that, he worked as senior information architect for marchFIRST, also in Tokyo. He's also been, at various points in his career, a rock critic for SPIN *magazine, a medic at the Berkeley Free Clinic, a coffeehouse owner in West Philadelphia, and a PSYOP sergeant in the U.S. Army's Special Operations Command.*

What do interaction designers need to know about ubiquitous computing, what you call "everyware?"

Probably the single most important thing that we need to wrap our heads around is *multiplicity*.

Instead of the neatly circumscribed space of interaction between a single user and his or her PC, his or her mobile device, we're going to have to contend with a situation in which multiple users are potentially interacting with multiple technical systems in a given space at a given moment.

This has technical implications, of course, in terms of managing computational resources and so on, but for me the most interesting implications concern the quality of user experience. How can we best design informational systems so that they (a) work smoothly in synchrony with *each other*, and (b) deliver optimal experiences to the overburdened human at their focus? This is the challenge that Mark Weiser and John Seely Brown refer to as "encalming, as well as informing," and I think it's one we've only begun to scratch the surface of addressing.

How will the interactions we have with digital products now differ from those in the future?

The simple fact that networked information-processing devices are going to be deployed everywhere in the built environment rather strongly implies the inadequacy of the traditional user interface modalities we've been able to call on, most particularly keyboards and keypads.

Adam Greenfield on Everyware *(continued)*

When a room, or a lamppost, or a running shoe is, in and of itself, an information gathering, processing, storage, and transmission device, it's crazy to assume that the keyboard or the traditional GUI makes sense as a channel for interaction—somewhat akin to continuing to think of a car as a "horseless carriage." We're going to need to devise ways to interact with artifacts like these that are sensitive to the way we use them, biomechanically, psychologically, and socially. Especially if we want the systems we design to encalm their users, we're going to need to look somewhere else.

Voice and gestural interfaces, in this context, are very appealing candidates, because they so easily accommodate themselves to a wide variety of spaces and contexts, without taking up physical space, or preventing the user from attending to more focal tasks. They become particularly interesting given the expansion in the number of child, elderly, or nonliterate users implied by the increased ambit of post-PC informatics.

You've spoken about "design dissolving into behavior." How can interaction designers accomplish that?

Well, that's a notion of Naoto Fukasawa's, that interactions with designed systems can be so well thought out by their authors, and so effortless on the part of their users, that they effectively abscond from awareness.

Following him, I define everyware at its most refined as "information processing dissolving in behavior." We see this, for example, in Hong Kong, where women leave their RFID-based Octopus cards in their handbags and simply swing their bags across the readers as they move through the turnstiles. There's a very sophisticated transaction between card and reader there, but it takes 0.2 seconds, and it's been subsumed entirely into this very casual, natural, even jaunty gesture.

But that wasn't designed. It just emerged; people figured how to do that by themselves, without some designer having to instruct them in the nuances. So I'd argue that creating experiences with ubiquitous systems that are of similar quality and elegance is largely a matter of close and careful attention to the way people already use the world. The more we can accommodate and not impose, the more successful our designs will be.

Summary

"The best way to predict the future," said Alan Kay, the Xerox PARC scientist who came up with the idea of a laptop computer, the Dynabook, in 1972, "is to invent it." The future arrives, second by second, whether we want it to or not, and it is the job of interaction designers to invent it, or at least to make it more humane. The sheer number of products and services, augmented by new technologies, that will become widely available in the next decade and their likely effect on the world will be staggering. Between the advancing technology and the people who will use it stand interaction designers, shaping, guiding, cajoling the future into forms for humans.

But forget the future—the present is complicated and sophisticated enough. The skills required to use the technology that is available now are far beyond those of most people. Not only are our devices too difficult to use, it is too challenging to tap into the available technology to do something personal. We need tools for making tools.

Interaction designers need to find ways to make the already amazing technology we have available *right now* to the billions of people who don't yet have a way to make this technology their own, to create things that, because of their personal nature, have little or no commercial value but great human value. Interaction designers need to make sure that the already wide so-called digital divide between those who have and can use technology and those who thus far cannot gets no wider. Those people—and we are surrounded by them every day—need the tools to make technology relevant to them and their lives.

For Further Reading

Everyware, Adam Greenfield

Shaping Things, Bruce Sterling

How To Survive a Robot Uprising: Tips on Defending Yourself Against the Coming Rebellion, Daniel H. Wilson

The Big Switch: Rewiring the World, from Edison to Google, Nicholas Carr

Tomorrow Now: Envisioning the Next 50 Years, Bruce Sterling

Wired for War: The Robotics Revolution and Conflict in the 21st Century, P. W. Singer