Introduction: A Cultural Approach to Interaction Design

We are, in sum, incomplete or unfinished animals who complete or finish ourselves through culture.

—Clifford Geertz (1973)

The Collective Process of Design

This book is meant for anyone whose work involves shaping new **digital artifacts** and the systems of behavior in which they are embedded, not just for those with designer in their job title. It aims to complement expertise in related fields such as graphic design, industrial psychology, or programming by providing lead designers and other team members with a set of common principles and a common design vocabulary to aid in the collective **design** process. Unlike other useful books in **HCI** (**human–computer interaction**) or **interaction design**, this book is written from a humanistic rather than a social science or industrial design perspective. One of the most important characteristics of humanistic inquiry is that it accommodates multiple frameworks of interpretation, a habit of mind that is a good fit for the design process, which never has a single right answer and is strengthened by an expanded palette of possibilities.

From a humanities perspective, the design of digital objects is *a cultural practice like writing a book or making a film*. **Culture** is the name we give to the infinite web of meaning that human beings have been weaving for millennia. We participate in culture when we imitate one another's behaviors, adopt common values and practices, share symbolic codes like language, music, or the latest dress style. To see any **artifact** (i.e., any human-made object) as part of culture is to understand how it becomes meaningful through the social activities, thoughts, and actions of the people who engage with it. Humanists understand that cultural objects and practices can be meaningful in many ways. For example, a digital telephone can be understood as a neutral piece of business equipment, a stylish status symbol, an intrusive disruptor of family rituals, or a lifeline between an isolated individual and a distant community. *The humanist designer aims to see as much of this larger web of meaning as possible in order to*

understand the context and connotations of particular design choices. This book provides a method for invoking this wider view of design possibilities, a vocabulary for identifying and characterizing design elements, and a set of principles for making choices within this expanded **decision space**. In referring to this practice as "inventing the medium" I am asserting three foundational design principles:

All things made with electronic **bits** and computer **code** belong to a single new **medium,** the **digital medium**, with its own unique **affordances**.

Designing any single artifact within this new medium is part of the broader collective effort of making meaning through the invention and refinement of digital media **conventions**.

When we expand the meaning-making conventions that make up human culture, we expand our ability to understand the world and to connect with one another.

This book is an effort to support the creation of an expanded range of meaningful cultural artifacts by clarifying the task and providing a unifying framework for many disparate but related efforts.

The design of digital artifacts is very young (a matter of a few decades), compared to the design of alphabets and pencils (measured in millennia), printed books (over five hundred years), or sound and image recording (over a century). Until the invention of the PC around 1980, computers were mostly used as mainframe number crunchers, while only a handful of researchers, educators, and game designers were tentatively exploring the larger symbol-manipulating potential of the machines. Yet now, in the second decade of the twenty-first century, the once-restricted bitstream of numbers has become a global floodtide of images and sounds, flowing across rapidly expanding broadband and wireless networks, and the new generation of digital natives are fluently integrating computer-based devices into their daily lives. In fewer than thirty years we have moved from the cumbersome, colorless, command-driven desktop machine that had to be coaxed into processing simple spreadsheets and text files, to the multitasking and pervasive miniaturized processors that power our indispensable laptops and mobile devices, and are embedded in everything from the walls of banks to the dashboards of cars to the human body.

Digital artifacts pervade our lives, and *the design decisions that shape them affect the way we think, act, understand the world, and communicate with one another*. But the pace of change has been so rapid that technical innovation is outstripping design. We are making too many new things too quickly, with the result that as users of the devices we often feel overwhelmed and unable to take appropriate advantage of the opportunities they offer us. The icon bar of a photo-editing program, word processor, or role-playing game can be as complicated as the cockpit of an airplane. This wealth of possibilities raises our expectations, but the functions are so mysteriously offered or

so compromised by unintended secondary consequences that we can find ourselves spending hours in frustrating trial and error in order to accomplish simple tasks, such as formatting a text document or adjusting the privacy setting in a social networking application. Vital information like a beloved family photo in a personal archive, a credit card number in an online account, or the name of a terrorist in a government database is stranded in an outdated format or falls into the wrong hands, or cannot be retrieved in the right context, with disastrous results. In order to get the benefit of the new digital environment in which we live, we will have to do a much better job of designing it.

This book offers a new framework that I believe can help to speed the process of useful and lasting design innovation by focusing on *the collective cultural task of inventing the underlying medium.*

Designing the Unfamiliar

Designers in established fields are often engaged in a process of *refinement,* creating slightly improved or distinctive versions of a familiar artifact; for example, modifying the familiar metal toaster with cooler ceramic sides or larger bagel-sized slots (figure 0.1). The digital designer is more often inventing something for which there is no standard model, like word processing in the age of the typewriter, or video games in the age of pinball.

There are three problems associated with this situation that differentiate digital design from other design practices.

First, we are dealing with an immature medium, which is much more diffuse and has much cruder building blocks at its disposal than a mature medium like print. Designers can draw on many standardized conventions to make a new history book, newspaper article, magazine layout, or romance novel without much thinking about how it will be produced, distributed, or navigated by the end-user. Any established medium has diverse, elaborated formats and genres that reflect a long collective process of trial and error, offering the designer many generic and specialized components to draw upon in creating a new work.

In some ways it is easier to be innovative in an established domain of practice because of this larger and more differentiated repertoire of components. Stable media provide a reliable framework on which to experiment with useful and pleasing variations. Architecture, furniture, and clothing are always active areas of design innovation because human beings have been sheltering and clothing themselves for millennia, providing a well-stocked cultural inventory to match the range of material possibilities that arise from developing technology and crafts. Similarly, some media formats are old enough and stable enough to be open to innovation without confusion. Print magazines, for example, are a productive area of design because their basic

Figure 0.1
Toasters are composed of known, stable elements that are open to refinement by designers. Ivo Vos's concept toaster on the bottom right is calibrated to propel the toast onto the plate.

components are unchanging but open to stylistic variation. For example when *Wired* magazine appeared in the early 1990s it did not have to invent the table of contents or the page numbering system or the grid-based page layout; it was startlingly innovative by merely restyling familiar elements in a manner that reflected the energy and plasticity of the new digital world. And the stable conventions of magazines are also available for simple **remediation** into digital form (figure 0.2).

But in the digital sphere we have often had to invent the building blocks of design while we are designing the specific artifact. In fact, much of the achievement of the first decades of digital design has been the establishment of such building blocks: the joystick game controller, the point-and-click mouse and cursor, the hypertext link, the search engine,

Figure 0.2
The FlipBoard application for the iPad platform rearranges web content, mimicking the layout of a magazine.

the navigation bar, the online shopping basket, the TV remote control with scrolling channel display. But despite their wide adoption and usefulness, all of these design conventions are now stretched beyond their capacity, outpaced by the exponentially increasing quantities of online information and the escalating demands of users for more functionality and less frustration. Once the pop-up electric toaster was invented in 1919, it could be routinely improved for several decades without drastic change of form or function. Web pages and cell phones, in contrast, have incorporated wholly new functionalities and required new formal conventions almost every year since the mid-1990s. Designers need to become more aware of the process of design as the invention and refinement of media conventions in order to move more quickly toward more mature, coherent, and expressive digital genres.

Second, digital designers inherit too many building blocks that are quite familiar and practical, but suited to legacy media formats, and in conflict with one another. When newspaper editors and television producers work together on a news site should they be thinking in terms of soundbytes or headlines? or both? or neither? Design processes are often stalled by such unproductive attempts to apply legacy conventions to new digital frameworks.

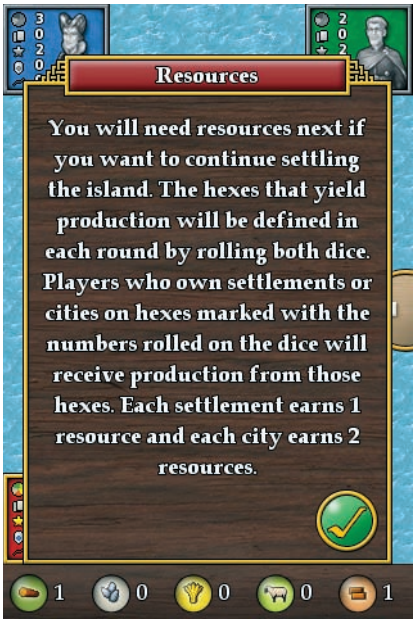

Figure 0.3
Before playing Catan: The First Island, the iPhone version of the popular and appealing board game Settlers of Catan, the player must page through several consecutive screens of dense text like this one to learn the rules.

A robust digital media design process should pay attention to the values of all the relevant design disciplines and media traditions. But designers cannot merely transpose the design criteria of these contributory disciplines onto digital practice. Pages of text that read well in a board game manual can be irritatingly long-winded on a computer or mobile device screen, where the **interactor** expects to be in command of information (figure 0.3). The scrolling text of a news ticker, whose pace and size perfectly suited a billboard in Times Square in 1960, is much harder to follow when compressed at the bottom of a television newscast (figure 0.4). In order to avoid making such mistakes, developers need to become more aware of principles of design specific to digital media, such as the need to establish conventions of semantic segmentation for text in interactive environments.

Third, though we have a well-developed design protocol for user need analysis and user testing of industrial products, users cannot tell us how to resolve problems that require new design strategies. Consumers of digital artifacts often cannot think past the familiar conventions of existing devices and applications, and may even claim to prefer more limited functionality because it is more familiar. Industrial design and the social

Figure 0.4
Right-to-left scrolling text on a television screen creates disturbing gaps in information. If we tune in at this moment we see mention of a bombing, and viewers may not have any way of rewinding to find out where it happened. The convention that remedies this problem displays complete, shorter headlines refreshed with vertical wipes instead of horizontal scrolls.

sciences have methodologies for framing design questions by analyzing the needs and expectations of user communities. But if a needs assessment team had asked people what they wanted a computer to do in 1970 they would not have elicited a desire for the personal computer, let along the iPod or GPS-enabled cell phone. Innovation in digital media design is often driven by a small group of technologists consulting their own desires and targeting user communities that do not yet exist and cannot yet be studied. Sometimes a design team has to get ahead of the expressed desires of users, relying on a prototype to introduce potential users to new possibilities. In such circumstances it is useful to think of the individual project in the larger context of trends that run across the entire digital medium, in order to indentify kindred efforts that may not be immediately visible. For example, the makers of search engines might have paid more attention to online photo albums and digital video archives in the late 1990s if they had recognized the common thread of encyclopedic aggregation of information that was going to make searching as relevant for still and moving images as it already was for text.

If users are unreliable, legacy conventions are inappropriate or conflicting, and existing digital conventions are often inadequate to the task at hand, how can designers make good choices? How do we know what is worth making that has not been made before?

How (Not) to Talk about Design

Design problems involving computer-based interactive artifacts must be solved by bringing multiple forms of expertise to bear, including the very divergent fields of programming and graphic design. But digital design has been hampered by the lack of useful common vocabulary to express common design goals, a problem that this book (and its Glossary) addresses by drawing on multiple fields within a unified approach. But before we begin the conversation we have to clear the air by looking at some common misconceptions about the goals and values of good design.

New Media/Digital Medium

Before we identify how we should design something we need to know what it is that we are designing. Academic departments and even some textbooks have used the blanket term "new media" to refer to the Internet, videogames, computer-based installations, mobile phones, and other artifacts that have been made possible by the rapidly increasing power and decreasing size of computers. The virtue of the term is that it puts computer-based artifacts into the category of **media**, which are aimed at complex cultural communication, in contrast to the instrumental view of computational artifacts as tools for accomplishing a task. "New media" also has the advantage of not specifying a particular application like games or hypertext, and of automatically including whatever is invented in the future. *But the vagueness of the term encourages sloppy thinking about design by suggesting that novelty is the salient property of these phenomena.* Video games and word processors have been around since the 1970s, but they pose design problems that are also found in the most cutting-edge robotics or virtual reality installation. Calling objects made with computing technology "new" media obscures the fact that *it is the computer that is the defining difference not the novelty.* After all, a newspaper printed on a cereal box would be a new medium if it were to appear tomorrow, but no one would refer to it as "new media" because it is not computer based. It can also be confusing to think about media **convergence** or **transmedia** properties, though older media are certainly migrating to digital formats, and entertainment and information products are indeed being linked across platforms. But these are secondary effects of the foundational change that is the arrival of a wholly new form of representation: the networked, programmable computer.

Therefore, throughout this book I argue for the advantage of thinking of digital artifacts as parts of a single new medium, which is best understood specifically as the **digital medium**, the medium that is created by exploiting the representational power of the computer.

Focusing on computation allows us to see all of these disparate artifacts—games, web pages, cell phones, music players, interactive TV shows—as belonging to a single

evolving medium, in which formats that we once thought of as fixed and separate, like spoken and written messages, books and games, movies and file cabinets, television and telephones are being deconstructed into their component parts and reconfigured for interactivity. It also allows us to identify the distinct effects of the **inscription** of information on electronic bits rather than clay tablets or printed books, and its **transmission** across space and time through binary codes rather than analog waves. Most of all, as we will be exploring in detail, it allows us to focus on the *four representational properties* of digital environments (the **procedural**, **participatory**, **spatial**, and **encyclopedic** affordances) that provide the core palette for designers across applications within the common digital medium.

Intuitive/Transparent

"Intuitive" is by far the most abused word in digital design and it is one that should perhaps be banned for a decade or so until it can once more be employed meaningfully. Properly used, intuitive means drawing on our unconscious expectations about how things behave, expectations that come from experience and from ideas about the world that we have internalized so deeply that we don't think about them consciously. Intuitions about the world are often based on repeated experience (like our intuitions about balancing things, based on our repeated experiences with gravity) or established conventions (like our intuition that a big red button on a device will turn it on and off). As Donald Norman pointed out in his classic work *The Design of Everyday Things* (Norman 1988), we expect doors to open when we push or pull them, and if something new looks like a door we will look for the design cues that we should push it or pull it, without consciously reasoning. Intuition is also acquired by expert practice, becoming **tacit knowledge** that is hard to transmit because a skilled practitioner does not employ it consciously; for example, we are able to intuitively apply the rules of grammar in our native language without being able to explicitly state them. It is an appropriate design strategy to exploit the interactor's unconscious expectations and knowledge to cue their interaction with a new artifact or process, making the experience feel "intuitive" rather than difficult to understand or hard to learn. But the designer or critic of the design should be able to name the conventions that make the **interface** seem familiar and to identify the reason why it works. For example, a trash can icon provokes an "intuitive" response that it is for deleting files because it looks like something that serves a similar function in the real world and because it has become a standard symbol in computer interfaces. Swiping to the right also feels "intuitively" right as a way to delete an email on an iPhone because it mimics the gesture of flicking something off a physical surface and the left-to-right orientation mimics the progression of western text.

It is important not to confuse a desire to give the interactor a satisfying experience that feels intuitive because it is so well thought out, with a magical faith in the designer's creative

intuitions. While it is essential to encourage creativity and exploration in the design process, intuitive design is rarely the result of lucky guesses. In order to make truly intuitive interfaces, designers must be hyperaware of the conventions by which we make sense of the world—conventions that govern our navigation of space, our use of tools, and our engagement with media. Furthermore, designers must be able to distinguish among the many possible conventions that can be employed in any application and decide which one is best suited to the artifact they are making. Intuition is a poor way to make that judgment, since we have so much unconscious knowledge to bring to any situation. Should a device that is combining the functions previously performed with a telephone, a typewriter, and an appointment book draw on our intuitions from one or all of these?

A better design value than intuitive is **transparent**: a good interface should not call attention to itself, but should let us direct our attention to the task. Interfaces can be immediately transparent, like a conventional light switch in a room we have never been to before, or easy to learn like the mouse pointer was when first introduced. Both of these examples are intuitive because they provide immediate **feedback** when we manipulate them, and because they exploit the ease with which we absorb binary relationships like up/down, on/off, left/right, and the close mapping between hand and brain. Once we have learned how to use a light switch, we have a strong, taken-for-granted expectation that flipping the switch turns the light on. If we encounter a new object with an up/down switch, such as a digital sound mixer, we will intuitively assume that the up position is the on position because we will be drawing on our tacit experiential knowledge of the world. Instead of trying to create a magically intuitive interface by an unspecified process, designers should consciously exploit the user's preexisting knowledge by looking for familiar interaction patterns that will be easy to learn and will quickly become transparent.

Interface Design/Interaction Design

Interface is a convenient but imprecise term for the outward appearance, the visible control and feedback apparatus, for interactive devices. The interface is what the user sees and operates; it sits between the machine and the person, like the knobs and dials on a toaster, or the icons on a computer screen. In industrial design, psychologists and graphic designers have long worked on creating interfaces like control panels for machinery or home appliances with the object of making them easier to operate and more "usable." Similarly, in the early days of digital design, graphic designers were often brought in at the end of the development process and asked to create visually appealing "user-friendly" interfaces to wrap around the functional but unsightly code created by a separate team of programmers. This model has been replaced by a more inclusive design process and a focus on the **interaction** between the human being and the automated system.

The design of any computer-based object or environment goes beyond the outward appearance to include the architecture of the code and the expectations of the user. Although it is still useful in some contexts to refer to an interface, and to think about the interface design as a distinct part of the design process, **interaction design** is the more appropriate term for capturing the many aspects of the system that have to be the subject of coordinated design decisions, including social and cultural elements as well as technical and visual components.

Interaction design can be applied to any system of behaviors, and need not involve digital artifacts. Although this book emphasizes the specific affordances of the digital medium, it is consistent with design programs that employ a transmedia approach to interaction design, resting on the same premises: the primacy of interaction and the interpretation of artifacts as part of larger social and cultural systems.

User/Interactor

In HCI research we often refer to the human being as the **user.** This is another convenient but narrow and somewhat outdated term like "interface," reflecting a model of the computer as a tool that we put to use. We might think of someone as a user when they are setting a digital alarm clock or entering data in a spreadsheet program, but it seems much less appropriate for someone flying over a virtual landscape in a social networking world or shooting zombies in a cell phone video game. In this book we will refer to the "user" from time to time because it is a convenient and well-understood term, but we will always think of the human being more inclusively as the **interactor,** someone who is not so much using a device as acting within a system. Interactors focus their attention on a computer-controlled artifact, act upon it, and look for and interpret the responsive actions of the machine. A user may be seeking to complete an immediate task; an interactor is engaged in a prolonged give and take with the machine which may be useful, exploratory, enlightening, emotionally moving, entertaining, personal, or impersonal. Interactors are also engaged with one another through the mediation of the machine, and with the larger social and cultural systems of which the automated tasks may only be a part. By designing for interactors rather than users we remind ourselves of the larger context of design beyond mere usefulness.

Content/Information

Starting in the 1990s as CD-ROMS and the Internet become widespread, those seeking to develop products for the new digital **platforms** started to talk about "content providers" and "content" as separate from the "technology." The problem with this way of thinking is that there is no such thing as content without form. Everything we put into the digital medium has to be explicitly shaped for it. Otherwise we are just using the computer as a fat telephone wire for shipping old-fashioned media artifacts around

the world. When we think of digital artifacts as content that is transported by technology we lose sight of an important focus of design, which is the medium: the point of intersection between the logical patterns of the technical layer and the cultural web of meaning in which human beings live. *When the technical layer changes, the possibilities for meaning making change as well.* The agenda for filmmakers in the beginning of the twentieth century was not to get better and better at photographing plays, but to figure out how to use the camera and the plasticity of film to invent movies. Attempts in our era to use computers to imitate books or television sets are equally shortsighted. Content is not a useful concept for designers because digital design is not about filling a neutral technical container with a preexisting package; digital design is about shaping interaction within new combinations of the **format** and **genre** conventions that make up a new medium.

Information is a more useful term than **content** for what media convey, because it points us toward issues of **information design,** such as how best to label and organize media segments so that we can retrieve and navigate them Thinking of legacy genres as information rather than content also allows us to focus on the organizational features of the **legacy media** that we otherwise take for granted, such as the division of television shows into thirty- and sixty-minute segments with commercial breaks, or books into pages and chapters, or newspaper articles into headlines and leads, and how these genre conventions reflect the affordances of analog broadcast or ink on paper and the social and economic arrangements that support them. As designers we should be looking for ways to restructure legacy formats to create satisfying interactions and more expressive genres by exploiting the affordances of the digital medium.

Interactivity/Agency

As we will be discussing in chapter 2, **"interactivity"** is an overused term that can be confusing when invoked as the goal of design. Properly understood, interactivity refers to the combination of the procedural and participatory properties of the digital medium: the structures by which we script computers with behaviors that accommodate and respond to the actions of human beings. Interaction cannot be a design goal in itself since there can be good and bad interactions between computers and humans. Although designers and others often praise a piece of software or a new device as "highly interactive, " the appropriate design goal for interactive environments is not the degree of interactivity, but whether or not the system creates the satisfying experience of **agency** for the interactor. Agency results when the interactor's expectations are aroused by the design of the environment, causing them to act in a way that results in an appropriate response by the well-designed computational system. This matching of the interactor's participatory expectations and actions to the procedural scriptings of the machine creates the pleasurable experience of agency. Bad design frustrates

the interactor by creating confusing or unsatisfiable expectations, or by failing to anticipate actions by scripting the machine with appropriate responses.

Creating the experience of agency does not mean always giving interactors what they want. An archive may not have the item they are seeking; a game may make it hard to level up. But interactors will still experience agency if the limits of the archive are made clear, and the difficulty of the game is conveyed as an intentional challenge rather than as faulty misdirection. Agency is much more helpful than the vaguer value of interactivity as a focus for design decisions, such as choosing an implementation platform, weighing conflicting professional values, assessing the importance of legacy media conventions, or prioritizing proposed features. *The most appropriate elements for a design are always those that increase rather than obstruct the agency of the interactor.*

Artifact—Environment—Application—Device—System

As you will have noticed by now, throughout this book I refer to the objects we design in a general way, as artifacts, environments, applications, devices, systems, and so on. This is because the design method of this book is meant to apply to anything made of bits. If you find this confusing I suggest you substitute something familiar. For example, when I say that agency is "the characteristic pleasure of *interactive environments*" you can substitute "word processors" or "video games" or "cell phones" or "websites" for the more general term. The examples and exercises in each chapter are meant to be helpful in pointing out the connections between the general principles and specific design environments. But since the digital medium is still evolving and the artifacts and systems that designers are working on today are not the ones they worked on ten years ago or the ones they are likely to be working on ten years from now, it is good to get in the habit of thinking of the methods and principles of design *abstractly*—as separate from specific formats and genres, and therefore more likely to be useful to you over the course of a long career.

Media Expand the Scope of Our Shared Attention

Inventing a medium is a collective process as old as human culture. Media are important building blocks of culture: they form the basis of communication and knowledge transmission across time and space. Culture—the web of shared meaning in which we understand our lives and our world—is conveyed in large part through symbolic representations of various kinds—alphabetical writing, paintings, movies—and through the performance of symbolic rituals closely associated with media documentation, such as legal and religious ceremonies. Human beings, unlike other animals, are able to endow inscriptions, utterances, and performed actions with meaning because our minds can handle symbolic thought. Our media allow us to organize those shared symbolic meanings into more complex and expressive forms. New media technologies

are attractive to us because they offer new opportunities for the defining human activity of symbolic expression.

Before the invention of language, human beings communicated through gestures, and built up cultural patterns through imitation and synchronized behaviors like clapping and dancing (Donald 2001). This delight in imitating one another is apparent in babies and grows out of the recognition that other people have consciousness and intentionality just as we do. Cognitive scientists have identified a fundamental milestone in the cognitive development of children at around nine months of age when they start to point at things. It marks an awareness of the caretaker's attention as something that can be directed by the child. Other primates do not spontaneously point in this way, although they can learn to point for the benefit of humans. The human baby's pointing takes place in the context of the **joint attentional scene.** A baby, a caregiver, and a toy make up a joint attentional scene if the baby and the caregiver each know that the other is looking at the toy. The caregiver may hide the toy and make it appear again. The baby may repeatedly throw the toy out of the crib and make clear that he expects the caregiver to pick it up again. This common experience of **shared attention** lays the groundwork for language, since once we share attention with another person we can establish shared patterns of cultural behavior, and agree to associate particular gestures or sounds with specific meanings (Tomasello 2001).

This ability to use shared attention to externalize what we think in symbolic form—the ability to communicate by inventing and elaborating media of representation, starting with gesture and spoken language—has been the deciding factor in human achievement, differentiating us from other primates and allowing us to share our experiences with one another and to pass on knowledge from generation to generation.

All of human media can be seen as an elaboration of the baby's gesture of pointing at something in order to draw the caregiver's attention to it. Media conventions extend our ability to point across time and space. For example, associating objects with uttered sounds—naming things with words—allows us to share the idea of something even if it is not physically present. Spoken language allows us to focus shared attention on events that have happened in the past or that we imagine might happen in the future. But oral culture puts great demands on memory, leading to the development of new media genres, such as poetry and song, which make words more memorable by arranging them in repetitive patterns of rhythm and rhyme and engage groups of people in the shared task of preserving knowledge. With centuries of collaborative effort, memory specialists in oral cultures can create and transmit encyclopedic works like the Homeric epics or the Indian oral epic the Mahabharata, which is composed of 100,000 two-line stanzas that in written form covers 3,000 pages.

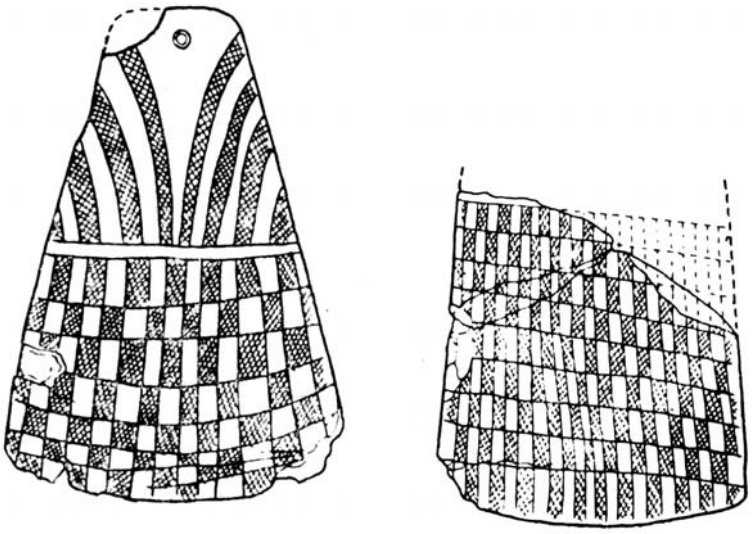

Figure 0.5
Engraved slate plaques from around 3000 BC Iberia are thought to have represented family lineage (Lillios 2003).

Oral cultures often rely on inscription technologies such as representational drawings or symbolic markings on tally sticks or engraved stones (figure 0.5) to externalize and fix knowledge. **Writing** expands the amount of information that can be accessed without the need for memorization because we only need to remember where to look it up. It allows us to organize information as lists and tables, and to fix contracts with one another that can be consulted in the future. With the invention of alphabets capable of transcribing complex utterances, we can record discourse containing complex arguments and study it at a distance from the person who is the source of the information. Writing also increases the power of structures of social control. Laws can be carved in stone; orders can be transmitted to distant colonies; births and deaths can be tracked, taxes can be levied and payment recorded. The invention of a new form of external media augments our capacity for shared attention, potentially increasing knowledge, but also increasing the possibilities for imposing fixed ideas and behavior and for proselytizing for disruptive causes. *Media can augment human powers for good or for evil; and they often serve cultural goals that are at cross purposes,* as literacy served both the Roman Empire and the rise of Christianity.

As with the development of language and manuscript writing, the invention of the printing press in 1455 augmented human cognition, by supporting new formats for our focused attention: scientific treatises and comic novels, personal letters and public newspapers. And as with other great advances in media technology, the rise of print

culture has expanded the range and power of constructive and destructive ideas by exponentially increasing our ability to share ideas and coordinate behavior across time and space.

The advent of the computer may mark the beginning of a cultural change of similar magnitude to the advent of language, writing, or print. We now have the power to make every book, every museum piece, and every university lecture available to anyone on earth who can receive a telephone call or a radio broadcast. We can engage a hundred thousand people in playing the same shooting game at the same time, or induce tens of millions of people to make donations to distant earthquake victims with an instant text message. The challenge for designers is how to make such an abundance of information coherent and how to coordinate such massive participation in interactive environments so that it best serves human needs.

The Medium Is the Method

Our media make us human by externalizing symbolic thought so it can be shared. Media of representation extend the range of shared attention, providing us with an enormous repertoire of behaviors and ideas, and with a wide range of strategies for preserving them and sharing them with one another. In an oral culture we are dependent upon memory; in a written and print culture we can sustain longer thoughts, share them more widely, and record a greater variety of human experience. Now the cultural practices supported by print culture have led to the advent of another new and powerful medium of representation. *By inventing and refining the format and genre conventions of the emerging digital medium, we are widening the circle of shared attention, and participating in the ancient project of expanding human cognition and enlarging human culture.*

Media conventions are important because they are part of the shared cultural patterns that allow us to make sense of complex information. The cognitive system of human beings can be thought of as a giant pattern-recognition and pattern-generating machine. We recognize objects in the world by the perceptual patterns associated with them (how they look and sound) and by the behavioral patterns they exhibit (the bird flies away as we draw near). Human beings can find coherence in a wider range of experience than bees (or any other living creature) because of our more extensive pattern-making abilities. Most important, we make symbolic patterns, patterns that do not directly correspond to what is immediately before our senses, and we assign them meaning by using them in the same way. Human beings routinely create patterns to refer to things not present (a dead ancestor) and things that do not exist (a magical tool). We can abstract general patterns from multiple specific experiences (kinds of animals, categories of food, the platonic idea of a chair), or apply patterns from one kind of experience to another (metaphorically thinking of the future as "in front of" us, or of earth as a spaceship). We can make up seemingly arbitrary

transmission patterns like the written alphabet or Morse code or the 00s and 11s of computer bits and assign interpretations to them. *We are born with the ability to make meaningful patterns out of experience and we spend our lives acquiring, refining, elaborating, and reinventing these patterns.*

Although we are constantly processing information at both the symbolic and literal level, most of our pattern-recognition activity is automatic, below consciousness, as free of thought as a bee's dance. The bees do not have to reinvent their dancing every time they find a new pollen source. They just have to adapt it to the current stimuli. Similarly, we do not have to relearn what a kitchen is every time we enter a house we haven't visited before. We have a general pattern of expectations for the concept of a kitchen, and then we are free to pay attention to where the sink and refrigerator are, or to whether there is a gas or electric stove. Patterns of meaning in cognitive science are called **schemas.** A schema is an abstract model of experience or beliefs into which we can fit new experiences. Just as we have generalized cognitive schema for a house, a kitchen, a college course, or a blind date, we have media schema for a newspaper, a television show, and a website. *Media formats and genres are externalized cognitive schemas,* strategies for making us smarter by standardizing complex repeated experiences into recognizable patterns. They are part of the **distributed cognition** by which culture is propagated and shared: We do not have to figure out how to drive a car every time we get into one, because the placement of the steering wheel, ignition, gas pedal, and brake remain the same each time, reminding us of what to do. We do not have to figure out how to read a newspaper every time we consult one because the function of the front page, headlines, photo captions, and lead sentences remain the same, reminding us of how to find the most important story of the day. Design **conventions** are important parts of this elaborate, expanding, system of distributed cognition, the familiar organizing features of the world that provide consistent cues for individual intelligence (Minsky 1986; Lakoff 1987).

To be a designer is to deal with the external patterns that correspond to existing cognitive schema or form the basis for new schema. Our job is to create the media **templates** that make new media artifacts understandable in the same way that new kitchens are understandable. A paper newspaper is a well-established template that we know how to map to cognitive schema so that we can take in the multiple stories it is telling us through media conventions like headlines, columns, and lead paragraphs. The templates of online news can potentially contain much more information—moving images, original documents, previous stories, interactive visualizations, reader comments, recommendation systems—but we have yet to establish a stable media form comparable to the paper newspaper (figure 0.6). Creating the templates and conventions that will organize this expanded universe of news reporting is an ongoing collective task for digital designers.

Figure 0.6

Home page of the *New York Times* online, from 1996 and from 2010. The first screen of the newspaper is equivalent to the area "above the fold" of the print paper: the area where the most important news is communicated. In 1996 the designers aimed to reproduce online the authority and familiar look of the printed newspaper. By 2010 they had many more digital conventions at their disposal—grid columns, menus, tabs, popularity indexes—to support complex navigation and a more dense display of information.

The argument of this book begins with the insight that *everything made of bits is part of the same digital medium,* because it shares the substructure of computation, which offers a unique combination of properties that can be used for symbolic communication. By understanding the affordances of the digital medium—its procedural, participatory, encyclopedic, and spatial properties—we can exploit them appropriately to develop more coherent media conventions, the digital formats and genres that will expand the scope of human expression. This book is an exploration of those properties and of the methods that designers can use to maximize them in the service of individual projects as well as the larger collective goal of advancing the expressive resources of the digital medium.

Part I of this book describes the basic components of the design process: the framing and **reframing** of design questions in terms of the core human needs served by any new artifact, the assembling of a palette of existing media conventions, and the search for ways to more fully serve the core needs that may lie beyond these existing conventions. It surveys the four **affordances** of digital media and key concepts drawn from diverse fields of study that can contribute to exploiting each of these affordances. Part I concludes with a framework for innovative thinking based on examining individual projects within a grid of possibilities.

Parts II–V deal in detail with each of the four affordances, exploring foundational models that provide useful conventions and strategies for the design of digital artifacts.

Part II focuses on the procedural affordance of the medium, and on the powerful strategies of **abstraction** by which we can describe objects and behaviors with computer code. It presents key concepts for the design of digital artifacts such as **modularity**, **encapsulation**, **instantiation**, and **state**; and it presents methods for representing conditional processes and complex systems that facilitate communication between programmers and other team members.

Part III surveys basic strategies for exploiting the spatial affordance of the medium in order to create meaning, in geographical virtual landscapes including Second Life that are inhabited by avatars and also in abstract information spaces such as the World Wide Web. It covers foundational building blocks of spatial design such as tables, containers, landscapes, maps, and places, and methods for establishing coherent navigation and fostering the **collocation** of like information, taking the library as a physical model for digital information spaces.

Part IV covers the encyclopedic affordance of the digital medium, focusing on the **database** and the **structured document**, two foundational models of information design in digital formats. The database is perhaps the oldest established digital genre of information organization, based on the fundamental principle of semantic segmentation, and offering designers many challenges and opportunities for expressive aggregation, juxtaposition, and visualization of information. The structured document is

the basis of the World Wide Web, the model for the creation of meaning with metadata, and the foundation of next-generation information design including the **Semantic Web** envisioned by Tim Berners-Lee. The design of structured documents and structured archives will be crucial to the development of entertainment and information applications in the coming decades.

Part V covers four foundational models for structuring the participatory affordance of the digital medium, all of which can be present within any single design problem. When we think of the computer as a **tool** we emphasize transparency of operation, and the support of virtuosity through direct manipulation that is an extension of the hand. When we think of the computer as a **machine** we value **visibility** of its internal workings and strategies for giving the interactor feedback and control over the automated processes it performs. The sense of the computer as a **companion** is a powerful model for interaction, but designers have to avoid triggering the pervasive fantasy of the magical mind-reading servant, while appropriately and politely anticipating the interactor's needs. Finally, the **game** is a vital genre of digital media and also a powerful model for interaction in general, and especially for synchronizing the behavior of large groups of interactors and for structuring engagement with digital artifacts as sustained exploratory play.

Each chapter of this book includes a set of Design Explorations that provide practice in the habits of analysis that lead to good design. Design can only be learned by focusing on particular artifacts, and these explorations offer the opportunity to apply the ideas in each chapter to specific design problems, starting with the close observation and critique of existing designs, and moving toward the design of original projects. Student responses to these assignments may be diagrams, essays, slide presentations, or interactive artifacts, depending on the students' skill level and instructor's course goals. The design explorations are meant to provide practice in important strategies for communicating design ideas such as flowcharts, storyboards, pseudocode, and rapid prototyping, and to serve as starting points for larger projects.

Instructors should feel free to pick and choose among the suggested exercises to suit the particular course, to modify them to suit time and resources, and are encouraged to use them as starting points for inventing your own design activities. However they are used, the most important result is that the students engage in focused discussion of the design of specific artifacts, and that the discussion be based on explicitly defined design values. It is important to encourage students to be constructive and critical in their assessment of one another's design responses, to use specific language, and to refer to specific details of a design.

The practicing designer reading this book mid-career may also want to read through these Design Explorations, using them as thought experiments to increase awareness of the possibility space for design. I encourage designers to spend time with the explorations that involve areas in which you have not yet had a chance to work,

in order to keep your thinking ahead of the curve of converging formats and evolving genres.

Throughout this book, the emphasis is on connecting the design of individual artifacts with the larger cultural project of inventing the medium. Media of representation shape our understanding of the world. They do not just contain information; they also determine what can be communicated. They provide the loom on which we can weave the fabric of human culture. A stone tablet is a good medium for inscribing fixed laws of behavior. A multipage volume is a good medium for fixing the contents of a single consciousness over a long period of time. A television broadcast is a good medium for witnessing events at a distance as if they were happening near at hand. The computer combines elements of all of these, as well as its own unique affordances. It offers us a larger and more complicated cultural loom, one that can contain the complex, interconnected patterns of a global society, and one that can help us to see multiple alternate interpretations and perspectives on the same information.

As a designer of interactive media who is also a student of literary history, I believe in the power of new genres of representation to expand our powers of understanding and our capacity for empathy with one another by expanding the circle of our shared attention. A printing press is just a mechanical device, but a scientific journal is a means of bringing our shared attention to the task of explaining the mysterious universe, a newspaper is a way of focusing our collective political thinking, and a novel is a means of changing the soul. A computer is just an electrical device, but when we exploit its affordances for symbolic expression we make possible new genres that hold a similar possibility for changing what we can know and what we can share with one another. That is why I have written this book. It is my hope that those who use it will find it helpful in our collective effort to invent the medium, to put the vast power of the computer to the task of expanding the boundaries of human understanding and deepening the ties of human connection.