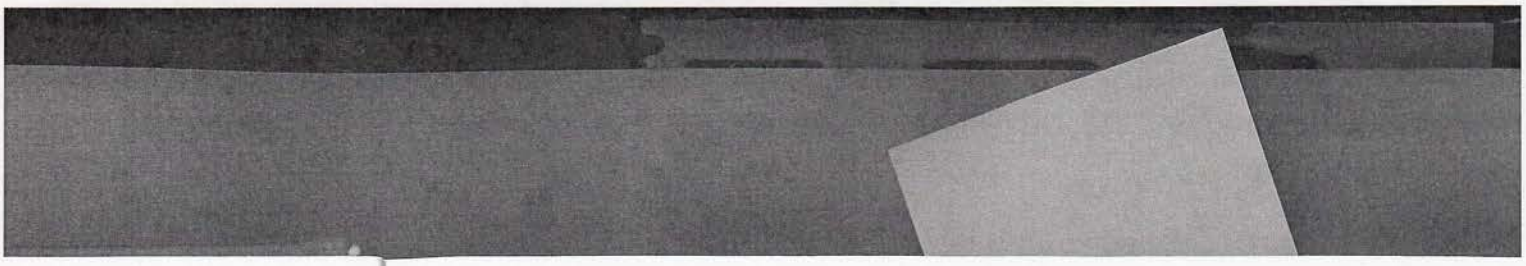


INVENTING THE MEDIUM

Principles of Interaction Design as a Cultural Practice

Janet H. Murray

The MIT Press
Cambridge, Massachusetts
London, England

For information about special quantity discounts, please email special_sales@mitpress.mit.edu

This book was set in Stone Sans and Stone Serif by Toppan Best-set Premedia Limited. Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Murray, Janet H.
Inventing the medium : principles of interaction design as a cultural practice / Janet H. Murray.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-262-01614-8 (hardcover : alk. paper) 1. Human-computer interaction. 2. Digital media—Design. 3. Social media—Design. 4. Intercultural communication. I. Title.
QA76.9.H85M87 2012
004.1'9—dc22

2011007751

10 9 8 7 6 5 4 3 2 1

For my mother, Lillian

2 Affordances of the Digital Medium

Think of the computer not as a tool but as a medium.
—Brenda Laurel (1993)

The Four Affordances

All **digital** artifacts are made of a common substance: programmable **bits** that can be used for symbol manipulation. As a result, we can think of digital artifacts as part of a common medium, rather than as a diffuse collection of multiple "New Media." Looking at the **computer** as a single new medium of representation, we can see its defining representational affordances: The computer is **encyclopedic, spatial, procedural,** and **participatory** (Murray 1997). These four properties constitute our design space, the context for all of our design choices. Individual projects will be located at various points in that design space, exploiting one property more than another. But thinking of the potential for any project to more fully exploit each of the four properties can help us to discover new directions that we may have previously overlooked. *In approaching interaction design as a cultural practice our aim is always to make an object that is satisfying in itself and that advances the digital medium by refining or creating the conventions that best exploit these four affordances.* This chapter provides a brief overview of these four properties as well as the most important contributory disciplines that designers can draw on to maximize the expressive potential of individual digital artifacts and of the larger digital medium.

The Computer Is a Procedural Medium

The biggest difference between the computer and earlier media of representation is its procedural property, its ability to *represent and execute conditional behaviors.* As I have argued elsewhere, one of the most striking early signs that the computer was a new expressive medium was Joe Weizenbaum's Eliza, an interactive program that was widely mistaken for an actual person (box 2.1). Eliza was experienced as real even

Box 2.1
Dialog with Eliza

Men are all alike.
IN WHAT WAY
They are always bugging us about something or another.
CAN YOU BE MORE SPECIFIC
Well, my boyfriend made me come here.
YOUR BOYFRIEND MADE YOU COME HERE
He says I am depressed much of the time.
I AM SORRY TO HEAR YOU ARE DEPRESSED
It's true. I am unhappy.
DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY
I need some help, that much seems certain.
WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP
Perhaps I could learn to get along with my mother
TELL ME MORE ABOUT YOUR FAMILY
(From Weizenbaum 1966)

though there were no images or sound track to reinforce the illusion. The program played the role of a nondirective psychotherapist responding to free text input (unrestricted words typed in ordinary natural language) into a Teletype terminal. Eliza had no understanding of what was said to her, but looked for keywords like "depressed" or "mother" and applied cleverly formulated rules of response, including the use of simple grammatical inversions to echo back statements. Despite her many inappropriate replies, and to Weizenbaum's dismay, many interactors believed she was an actual person. She was animated by the power of her procedural design, by the ingenuity of the rules of behavior that determined her reactions to novel input (Weizenbaum 1966, 1976; Murray 1997; Wardrip-Fruin 2009).

Draw on Computer Science Concepts and Conventions

The discipline most relevant to procedural design is of course computer science. *Even for those who will not be doing the coding, understanding how computer science describes objects and processes is crucial to making sound design decisions.* A key element of this process is **abstraction.** Computer science strives to master **complexity** by creating abstract representations that describe elements of systems in the most general terms that most accurately describe their most salient features. For example, to describe the items [apples, bananas, grapes] in a single abstraction we might choose fruit, food, or groceries depending on the context. Of these three terms, fruit would be the best term

for limiting the category ar
perishability. If those qualiti
we want to add other items
food would be a good choice.
between hardware store and
computational frame of mind
tion systems such as this.

Most important, programr
of code they conceptualize th
set of instructions and rules
process at its most generalize
and condition can also be acc
flexible a program should be, h
is an important part of the de
more powerful and widely us

Legacy media practices li
sequences that are always exe
a **timeline**, and some compute
nizing framework (figure 2.1).
tendencies toward **linear** or
legacy media and present un
ticularly well suited to more
and navigated in more than o
entities as **variables** that can
conditional statements that h
form can have multiple **instan**
ples of a common pattern. Cc
ferent **states.** When we make
single version of an object or e
tions. Computational artifacts
though we may think of then
by conditional rules.

By harnessing the procedur
cesses we can create **simulatior**
with controlled variations and
in natural and social systems
Such systems are made up of
whose complex interactions
predictable in advance. Althou
tational structures as a **branch**

for limiting the category and establishing common qualities such as sweetness or perishability. If those qualities are not relevant to the task we are performing and if we want to add other items such as [bread, meat, cereal] to the system later on, then food would be a good choice. And if we are making a shopping **list** and distinguishing between hardware store and supermarket items then groceries might be best. The computational frame of mind sees the world as composed of multiple alternate abstraction systems such as this.

Most important, programmers abstract *behaviors*. Before a programmer writes a line of code they conceptualize the processes the computer will be executing as an abstract set of instructions and rules known as an **algorithm**. A useful algorithm describes a process at its most generalized level but in such a way that every important variation and condition can also be accounted for and responded to appropriately. *Deciding how flexible a program should be, how many possibilities it should anticipate and accommodate is an important part of the design process.* The more possibilities it encompasses, the more powerful and widely useful it will be, but also the more challenging to design.

Legacy media practices like animation and film editing specify unconditional sequences that are always executed in the same order. They are often represented in a **timeline**, and some computer-based authoring systems also use timelines as an organizing framework (figure 2.1). The problem with this approach is that it reinforces our tendencies toward **linear** or **unisequential** design. Programmable bits can imitate **legacy media** and present unisequential **documents** and film clips, but they are particularly well suited to more complex **multisequential** objects that can be assembled and navigated in more than one order. Computational structures allow us to describe entities as **variables** that can have different values at different times, and to make **conditional statements** that have more than one possible outcome. Objects in digital form can have multiple **instantiations**, existing as identical copies or as variant examples of a common pattern. Computational systems change over time, exhibiting different **states**. When we make something with computer code we are creating not a single version of an object or event, but many possible versions with interesting variations. Computational artifacts exist not as fixed entities, like books or movies (even though we may think of them that way), but as a set of easily altered bits governed by conditional rules.

By harnessing the procedural power of the computer to represent objects and processes we can create **simulations**, working models of complex systems that can be run with controlled variations and that aspire to reproduce the complexity we recognize in natural and social systems like the human body or the global financial markets. Such systems are made up of multiple independently operating **objects** or **agents**, whose complex interactions produce results too numerous and multicausal to be predictable in advance. Although many beginning programmers see the core computational structures as a **branching tree**, in fact the inner workings of computer code

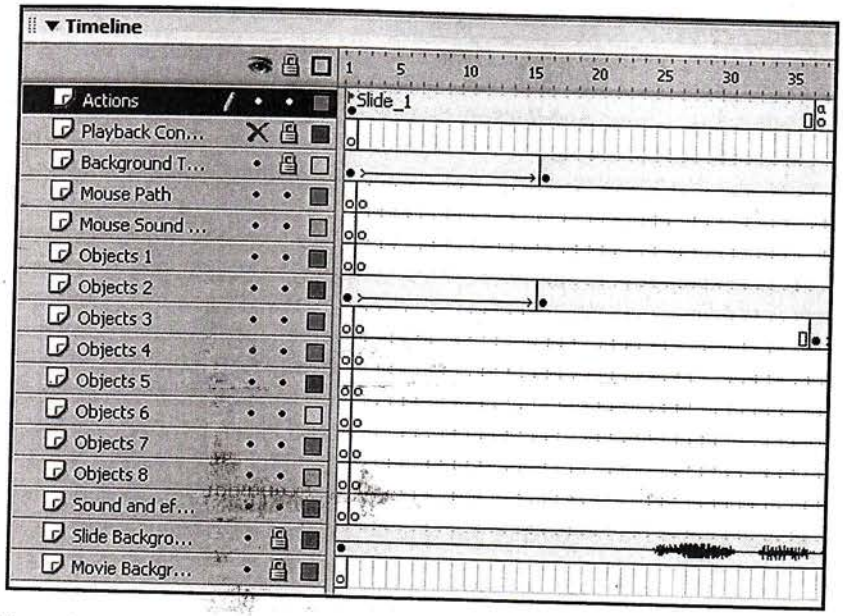


Figure 2.1
Timeline from Adobe Flash authoring environment, which is based on the **metaphor** of a movie. Flash also includes object-oriented scripting for more fully exploiting the procedural and participatory affordances of the medium.

have been growing more interactive: more like the ecology of a pond rather than the command structure of an army. Systems are now written that exhibit **emergent behavior,** behavior that is more than the sum of its parts, and therefore can be seen as similar to life forms.

Computer programs are judged by how efficiently and reliably they perform. Programmers aim for **robustness,** for not failing under a variety of error-inducing conditions, including coping with unpredictable user input and portability to multiple systems; and for **scalability**, for being able to accommodate more users, more data, more related procedures without having to be reengineered. The programmer values predictability and formula, aiming for the most generic, reusable solution that is also the most adaptable. The digital media designer, like the computer scientist and the programmer, should think of the process of representing meaning on the computer as a process of abstracting objects and behaviors as efficiently as possible, and should be aware of the possibility of representing complex systems as composed of multiple abstract actors in multivariable configurations.

In part III we will be lookir
tifying ways in which designe
tion for the purposes of desc
expressive manner.

The Computer Is a Participatc

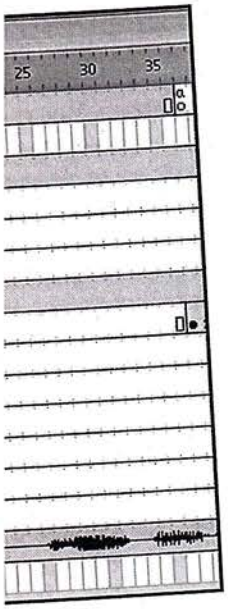
It is surprising that the Eliza
it now seems so primitive in
for people to assume that co
are is often referred to as "
element of Weizenbaum's d
merely script the machine; by
as the highly conventionalize
scripting the interactor. His cha
tory affordance of compute
affordance.

The relationship between t
and open to frustrating misco
so that the actions of humans a
script is quite rigid, as in a t
customer service system. Suc
choice answers, where there
each one taking few steps to
like the decision-tree diagno
frustrating.

Sometimes the script is mc
which to improvise their pa
processors or role-playing ad
that they script us in a **transp**
text box is a transparent cue
website cues us to the presen
of application windows cue u
is selecting the appropriate con
that the human interactor can

Because the computer is a
that they will be able to m
response to their actions. Th
they are not allowed to act.
through a keyboard, mouse,

logies, Lasting Innovations



ed on the **metaphor** of a movie.
ting the procedural and partici-

gy of a pond rather than the
hat exhibit **emergent behav-**
erefore can be seen as similar

d reliably they perform. Pro-
riety of error-inducing condi-
and portability to multiple
odate more users, more data,
ered. The programmer values
, reusable solution that is also
ıe computer scientist and the
ng meaning on the computer
ciently as possible, and should
stems as composed of multiple

In part III we will be looking more closely at the procedural affordance and identifying ways in which designers can make use of the power of computational abstraction for the purposes of describing objects and processes in the most coherent and expressive manner.

The Computer Is a Participatory Medium

It is surprising that the Eliza program fooled people when it first appeared, since it now seems so primitive in its ability to simulate a conversation that the tendency for people to assume that computer programs are more capable than they actually are is often referred to as "Eliza effect." But Eliza also owed her success to an element of Weizenbaum's design that is often overlooked: Weizenbaum did not merely script the machine; by framing his experiment in natural language processing as the highly conventionalized and familiar scenario of a therapy session he was also *scripting the interactor.* His character was successful because it exploited the participatory affordance of computer environments as much as it did the procedural affordance.

The relationship between the interactor and any digital artifact is reciprocal, active, and open to frustrating miscommunication. *The designer must therefore script both sides so that the actions of humans and machines are meaningful to one another.* Sometimes the script is quite rigid, as in a touchscreen ATM machine or a phone-based automated customer service system. Such rigid systems work best with screen-based multiple-choice answers, where there are a limited number of routine transactions, with each one taking few steps to complete. When used for more complex transactions, like the decision-tree diagnosis of a consumer problem, they can be maddeningly frustrating.

Sometimes the script is more flexible, offering the interactor an array of props with which to improvise their part of the exchange, like the iconized tool bars of word processors or role-playing adventure games. Some digital conventions are so familiar that they script us in a **transparent** way. For example, a blinking insertion point in a text box is a transparent cue to type in information; blue or underlined text on a website cues us to the presence of a link; arrows at the left edge or bottom-left corner of application windows cue us to the possibility of scrolling. *A large part of digital design is selecting the appropriate convention to communicate what actions are possible in ways that the human interactor can understand.*

Because the computer is a participatory medium, interactors have an expectation that they will be able to manipulate digital artifacts and make things happen in response to their actions. They will therefore become frustrated and impatient when they are not allowed to act. The responsiveness of digital media, whether accessed through a keyboard, mouse, joystick, touchscreen, scroll wheel, or gesture sensor,

excites our desire to do something, to see what will happen if we drag something around, click on an underlined word, or otherwise poke at the environment.

Participation in digital media increasingly means social participation. Previous mass-communication technologies provided either one-to-one (telephone) or one-to-many (books, television) **transmission** channels. The computer provides one-to-one (e.g., email) and one-to-many (e.g., DVDs) communication. It also provides new forms of many-to-many communication, most notably on the **World Wide Web**, which provides the same potential distribution to an album of baby pictures as it gives to CNN.com's coverage of a presidential inauguration, disrupting the media conventions for both. New participatory **genres** such as chat rooms, bulletin boards, discussion lists, blogs, wikis, instant messaging formats, virtual environments (Second Life), social networks (Facebook, Myspace, Twitter), and media-sharing technologies (Flickr, YouTube) convene communities of participants in discussions that are **synchronous** and **asynchronous**, spoken and written, individual and collective. They also quickly assimilate the functions of one another, posing new design challenges in providing coherence to a sustained collective conversation (see figures 2.2, 2.3).

Mass participation in digital environments has also raised questions of security and privacy. Designers have the power to capture input from users without their intentional action, and even without their knowledge and consent. As citizens of a digitally enabled world we are subject to many kinds of monitoring. Digital cameras record our images, digital networks record our purchases, and global positioning technology in our cars or cell phones pinpoints our personal location (figure 2.4). We are open to photographic and sound recording through portable devices that were once the domain of superspies and are now available at mass consumer prices. This capacity can be reassuring, as in devices that allow the elderly to call for help even if they are far from a telephone; or it can be menacing, as in spyware programs that surreptitiously record our key

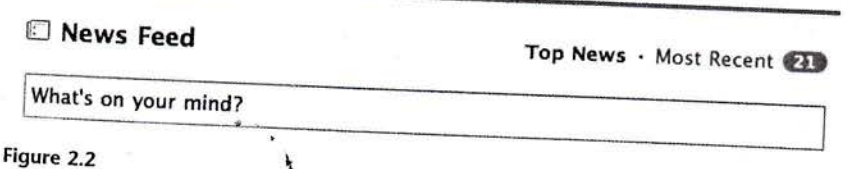


Figure 2.2
Status line on Facebook. The status line, cued here by a generic question, is a convention that has been widely accepted as a way of formatting participation in large common spaces. The box provides a constrained container (even when longer posts are allowed) that focuses contributions so they can be composed easily, distributed widely, and collected in lists that can be scanned quickly by the recipient. This simple convention—a limited size, rapidly posted container for messages that can be targeted at one or many recipients—has created new, globally accessible channels of communication for personal and organizational use.

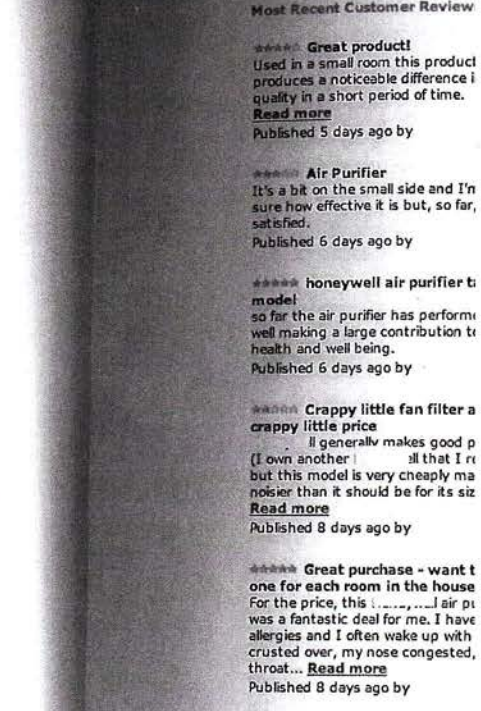
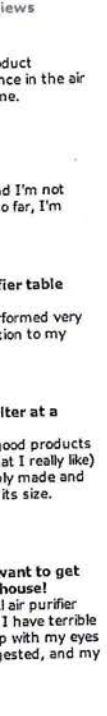


Figure 2.3
It has now become stanc
customer review utility c
links, live chats, Frequent
and the invention of new
for decades to come.

unwanted advertising.
has led to new kinds o
possession of data abo
purposes of many soc
information we have i
tion and to give interact
being collected and used

The participatory na
enterprises. Media now


Most Recent Customer Reviews

Great product!
Used in a small room this product produces a noticeable difference in the air quality in a short period of time.
Read more
Published 5 days ago by

Air Purifier
It's a bit on the small side and I'm not sure how effective it is but, so far, I'm satisfied.
Published 6 days ago by

honeywell air purifier table model
so far the air purifier has performed very well making a large contribution to my health and well being.
Published 6 days ago by

Crappy little fan filter at a crappy little price
...ll generally makes good products (I own another ...ll that I really like) but this model is very cheaply made and noisier than it should be for its size.
Read more
Published 8 days ago by

Great purchase - want to get one for each room in the house!
For the price, this ...... air purifier was a fantastic deal for me. I have terrible allergies and I often wake up with my eyes crusted over, my nose congested, and my throat... Read more
Published 8 days ago by

Figure 2.3
It has now become standard to provide a space for visitors to a website to talk back, like this customer review utility on Amazon.com. Other standard feedback conventions include email links, live chats, Frequently Asked Questions (**FAQs**), and polls. The refinement of these features and the invention of new ways to support participation will be a growing area of digital design for decades to come.

tiously record our keystrokes and page views in order to steal passwords or deliver unwanted advertising. The increasing mediation of our actions by digital technology has led to new kinds of counterfeiting, including the crime of identity theft in which possession of data about someone becomes the power to act as that person. For the purposes of many social transactions, we are identical with the sum of the digital information we have input. *Designers must therefore take care to limit access to information and to give interactors control over their own information and knowledge of how it is being collected and used.*

The participatory nature of the medium has also profoundly affected legacy media enterprises. Media now appears to us as something to be cut, pasted, reassembled, and

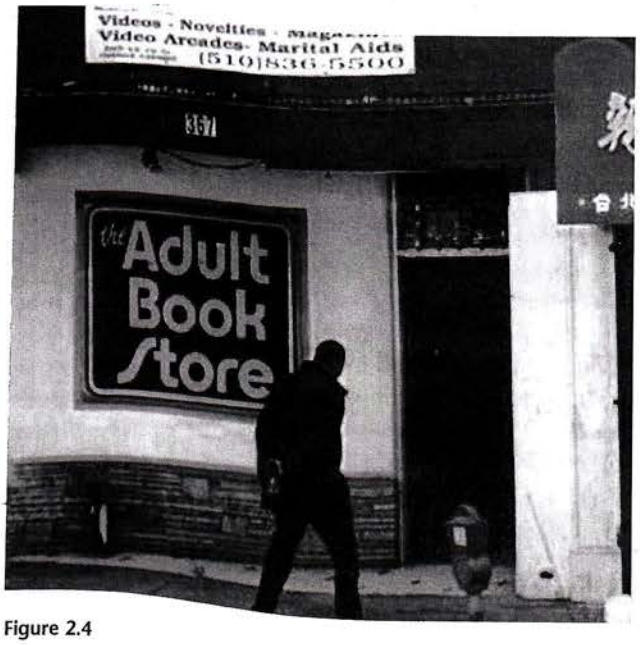


Figure 2.4
Google Map Street View of San Francisco includes a figure in a potentially embarrassing moment, an example of how once-private experiences are becoming publically—and even globally —visible.

distributed with ease. The music industry underwent a tremendous change starting in the late 1990s when users began trading digital music files over the Internet. As sales of CDs fell and threats of prosecution escalated, Apple Computer came up with a design solution that included a commercial solution: the introduction of the iTunes website and the iPod device gave users a legal method for collecting digital music files. As increasing bandwidth and memory make it easier to collect moving-image files, movies and television face similar challenges and the need for similar design solutions. *One of the key tasks for information designers is to satisfy increasing demand for access to media while preserving the property rights of those who create media artifacts.*

The production of entertainment is also becoming more participatory, with digital recording and editing equipment, and development platforms for interactive gaming, that were formerly the prerogative of studio professionals now available at consumer prices. One result is the exponential explosion of user-generated and self-published content, often indexed by other participants through popularity ratings (figure 2.5).

Participatory structures are increasingly being incorporated into legacy frameworks. In England, television viewers have access to a remote control with a special button for

Figure 2.5
YouTube displays us

interactivity, and i
every year, giving
letting them vote
in sync with a liv
(figure 2.6). As te
computing is incc
inventing new p
resources will exp

Draw on HCI Con

The discipline tha
human beings an
roots in industrial
designers, Donald
computer. Norma
importance of th
behavior of the ol
experience. For ex
also derive more

Figure 2.5
YouTube displays user-created videos based on popularity.

interactivity, and interactive enhancements are added to hundreds of television shows every year, giving viewers a choice of which tennis match or garden tour to watch, letting them vote for their favorite British person, inviting them to take an IQ test in sync with a live audience, or allowing them to participate in interactive stories (figure 2.6). As television merges with games and the Internet and more powerful computing is incorporated into media players of various kinds, the opportunity for inventing new participatory conventions for entertainment and for information resources will expand.

Draw on HCI Concepts and Conventions

The discipline that is explicitly concerned with the study of the relationship between human beings and computers is **human–computer interaction (HCI)**, which has its roots in industrial design. In fact, one of the most influential books for the interactive designers, Donald Norman's *The Design of Everyday Things* (1988), hardly mentions the computer. Norman, who began as a cognitive psychologist, called attention to the importance of the **mental model** formed by the user based on the appearance and behavior of the object. Mental models can derive from existing conventions and past experience. For example, we expect wall switches to turn on overhead lights. But they also derive more generally from what we perceive as the **affordances** of the artifact,