Yes,	But...
Computers are everywhere	Who asked for this?
Anytime-anyplace!	Equals nowhere
Objects will be smart	And they will force us to do something stupid
Anything can be on the internet	Do you need e-mail in a toaster?
Anything can get an interface	Will they all flash 12:00, like VCRs?
We can invent the future	But don't damage what already exists
Microchips are cheap	Dealing with them is expensive
Buildings get nervous systems	Inhabitants get nervous
You can monitor your family	Does that build trust?
Stuff becomes programmable	I don't have time
Stuff becomes programmable	I don't like the way someone else does it
Systems anticipate needs	And they assume we need entertainment
Tags can carry instructions	Mind the step; eat your vegetables
Systems respond to you	Hi!! You appear to be writing a letter!!
Smart conveniences	What, the curtains?
People won't tolerate this	Look how they took up mobile phones
Who could love a computer	Did the farmer love his plow?
Big brother is watching	Through terabytes of data smog
It's all about surveillance	And cars are all about emissions? bad side effects
Computers crash	So do cars, but we still use them
The net boom is over	Computers are not going away; quite the contrary
I'm against technology	Except my dishwasher

1.6 Common objections to pervasive computing

Interaction designers study how people learn, operate, and assimilate technology, especially information technology. They also study how technological mediation influences what people are doing. Sociologists, psychologists, and management consultants address such concerns as well, but at a more general level. In comparison to those disciplines, interaction designers emphasize the particular mechanisms of product usability. Increasingly, they do so in terms of work practices, social organizations, and physical configurations—in a word, context.

The use of the term interaction design instead of interface represents a cultural advance in the field. Recent mission statements by firms, schools, and publications commonly acknowledge this.[28] Interaction designers claim to know at least partly what is wrong with information technology, and that overemphasis on technical features and interface mechanics has been a part of the problem. By turning attention to how technology accumulates locally to become an ambient and social medium, interaction design brings this work more closely into alignment with the concerns of architecture.

Because architects and designers of noncomputer systems may be unfamiliar with the history of this field whose evolution now leads toward them, a brief overview of this progression may be helpful. If the current stage of computing becoming pervasive constitutes a milestone, it is worth comparing that stage with two others: first, the growth of machine interface design; and second, the achievement of machine interactivity.

In what is often cited as a starting point in the industrial design of interfaces, Henry Dreyfuss, a proponent of the new field (and incidentally a chief designer of Futurama) observed: "If the point of contact between the product and the people becomes a point of friction, then the industrial designer has failed. If, on the other hand, the people are made safer, more comfortable, more eager to purchase, more efficient, or just plain happier, then the design has succeeded."[29]

In contrast to present interests in software usability and participation in information flows, industrial interface design was more often addressed to automation. The early twentieth century imagina-

tion expected advances in interfaces to eliminate participation wherever possible.[30] This is relevant to us because early developments in information technology assumed that legacy. Symbolic processors are not actually moving mechanisms for the transfer of powered motion, but to this day we still call them "machines."

Interactivity changed the role of technology, however. In our review, this is the second milestone. The ascent of human-computer interaction as a design discipline required a fundamental shift in expectations. What made the personal computer so radical was the notion that someone might look forward to using it.

More specifically, computers became the first technology to provide two-way engagement. Despite common misuse of the word, not everything that is operable is interactive. A film may stir deep reactions; a chisel might let a sculptor feel that work is flowing; a lathe may have several buttons and controls; and a telephone lets people interact remotely; yet none of these technologies is itself interactive. Only when technology makes deliberative and variable response to each in a series of exchanges is it at all interactive. Such exchange is like a conversation in how participants coordinate process as well as content by means of acknowledgments, corrective interruptions, and cues. Although some people too readily attribute thought to symbolic processing technology, nevertheless we rightly experience interaction.[31] A computer might even beat you at chess.

Computer-human interface (CHI) became the subject matter of design only when processing and memory become inexpensive enough that they could be used not only to accomplish storage and calculations, but also to make those processes more convenient to people. The familiar graphical user interface (GUI) represents the latter stage of development. It is of course what first made computing accessible to nonspecialists. The admission of psychological principles into the previously all hard-numbers field of computer science brought it to the mainstream. Twenty years later, and still measured in mechanical first-time usability, building better interfaces remains the goal of much of the CHI community. (Not surprisingly, this community sometimes approaches ubiquity as if that means putting those window-and-menu screens everywhere.)

As interactivity become more widespread, expectations for automation gave way. For example, up until the network computing boom of the 1990s, efforts at artificial intelligence sought to capture knowledge, build inference engines, and, ever in industrialist mindset, proceduralize competent work. Then the spread of networks made information technology into a catalyst of organizational change. Designers and managers then recognized how the kinds of expertise resident in communities were unlikely to be automated, but could be served by better information "environments."

The idea of context has been growing all along. The graphical user interface was a conceived as a context for processing symbols, for instance. Later, the information flow through an enterprise was a context in which new software had to be introduced appropriately. Next that flow moved out onto mobile devices. Those devices meet up in arbitrary locations; others are embedded into relatively permanent local configurations; and sensors and effectors are added to the built environments that house them.

What is at issue is participation. The pushbutton industrial machinery of 1939 and the virtual realities of 1989 both left the human subject just sitting. Well-being requires a better state of human activity. Much of the human sense of environment emerges from our activity in habitual contexts. All this becomes the subject matter of design.

In the words of designer Clement Mok, "The most basic function of an interactivity art is providing a cue for a specific action."[32] Today the context of the digital task has extended beyond the desktop to world of work, play, travel, and dwelling. To anyone with too much gear and too little time, the mere availability of technical capabilities hardly guarantees utilization.[33] Whether features are understood and applied depends on context in which they are encountered. At this point, "contextual design" of information technology has to address such practices in situ.

This is the latest milestone. The role of computing has changed. Information technology has become ambient social infrastructure. This allies it with architecture. No longer just made of objects, computing now consists of situations.

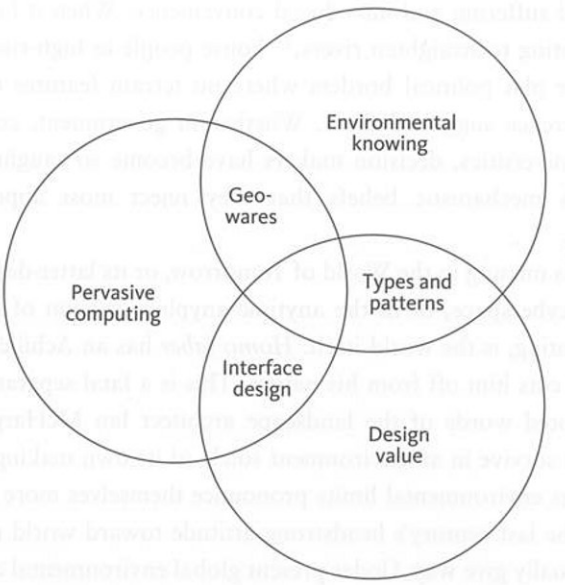
A Cultural Challenge

Rather than turning our backs on pervasive computing because surveillance is objectionable or the Internet boom is over, we should explore its cultural aspects. We should no more ignore this movement than the Internet or personal computing before it. Given our fears about privacy, autonomous annoyances, and rigidly preprogrammed activities, we should pay more, not less attention to this stage of technological development.

As you fuss to assimilate yet another bit of hardware or software into your daily routine, such grand ideas may seem awfully distant. Like the videocassette recorder flashing 12:00 in living rooms all over the world, just about every addition of gear to our lives comes with more technical detail than we are ready to absorb. Some of it is just unnecessary. What if your latest car came with additional pedals on the floor?

Today we can no longer assume that mechanical efficiency is the root of usability, that more features mean better technology, or that separately engineered devices will aggregate into anything like optimal wholes. The kinds of judgment necessary for establishing appropriateness in interaction design are at least as professional as artistic or scientific in character. We need to advance the science of the computer-human-interface into a culture of situated interaction design (figure 1.7). "We" is a lot of us: psychologists, architects, ethnographers, product designers, entertainers, management consultants, policy makers.

This challenge seems inseparable from establishing more general legitimacy for design. When the most conservative accountancies are declaring the value of design, and more creative strategists are understanding design in terms of the propositional thinking that occurs beyond the limits of predictive analysis, then design, writ large, is becoming more important. Under this broader conception of design, better technology is not just faster, prettier, or more usable, although those attributes are usually welcome. It must also be useful, and it should also be more appropriate. Thus it must be the product of cultural deliberation. If it is not, then it is likely to be objectionable, and perhaps costly.



1.7 Intersecting domains

Fortunately, so far in the history of computing, the law of unintended consequences has tended more toward chaos, creativity, and occasional delight, and less toward the sorts of command-and-control anticipated in the industrial era. As in the first fun software of the 1980s, or the first online social lives of the 1990s, our present decade's early delights in smart things and responsive spaces may come from people not burdened by existing expectations about the role of technology.

Expectations are critical. Expectation management dominates technology implementations. What technology can do may not be so important as what we want to do with it, and whether that is reasonable.

To modernity, technology was for world making: to overcome the limits presented to us by our place in the physical world. Its goal has been pure artifice.[34] With an unprecedented confidence in the accuracy of its methods, modernity has imposed its formulas on the world until they have become the world. When it has worked, this approach

has relieved suffering and introduced convenience. When it failed, it was attempting to straighten rivers,[35] house people in high-rise filing cabinets, or plat political borders where no terrain features or language difference suggested them. Whether in government, corporations, or universities, decision makers have become so caught up in modernity's mechanistic beliefs that they reject most appeals to nature.[36]

What is missing in the World of Tomorrow, or its latter-day counterpart in cyberspace, or in the anytime-anyplace version of ubiquitous computing, is the world itself. *Homo faber* has an Achilles' heel; his artifice cuts him off from his nature. This is a fatal separation. In the oft-quoted words of the landscape architect Ian McHarg: "No species can survive in an environment solely of its own making."[37]

Now as environmental limits pronounce themselves more loudly, however, the last century's headstrong attitude toward world making must eventually give way. Under present global environmental circumstances, appeals to place can no longer be dismissed as romanticism.

As the discipline of interaction design continues to mature, it must be measured by increases in human, cultural, and natural capital. It must involve more kinds of observation and critique. As graduate programs sprout in universities, let their proponents find a way beyond business automation. If communication technologies affect imaginations, let there be an awakening of mental environmentalism. Since cultural productions are measured in appreciation, let interactivity inspire staff critics to write weekly columns in the local newspaper.

But let us avoid the future tense. Let us focus on habits rather than novelties, on people rather than machines, and on the richness of existing places rather than invention from thin air. What purpose do we expect pervasive information technology to serve? When, if ever, does it seem natural to use?