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How Computers Change the Way We Think

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The tools we use to think change the ways in which we think. The invention of written language brought about a radical shift in how we process, organize, store, and transmit representations of the world. Although writing remains our primary information technology, today when we think about the impact of technology on our habits of mind, we think primarily of the computer.

My first encounters with how computers change the way we think came soon after I joined the faculty at the Massachusetts Institute of Technology in the late 1970s, at the end of the era of the slide rule and the beginning of the era of the personal computer. At a lunch for new faculty members, several senior professors in engineering complained that the transition from slide rules to calculators had affected their students' ability to deal with issues of scale. When students used slide rules, they had to insert decimal points themselves. The professors insisted that that required students to maintain a mental sense of scale, whereas those who relied on calculators made frequent errors in orders of magnitude. Additionally, the students with calculators had lost their ability to do "back of the envelope" calculations, and with that, an intuitive feel for the material.

That same semester, I taught a course in the history of psychology. There, I experienced the impact of computational objects on students' ideas about their emotional lives. My class had read Freud's essay on slips of the tongue, with its famous first example: The chairman of a parliamentary session opens a meeting by declaring it closed. The students discussed how Freud interpreted such errors as revealing a person's mixed emotions. A computer-science major disagreed with Freud's approach. The mind, she argued, is a computer. And in a computational dictionary -- like we have in the human mind -- "closed" and "open" are designated by the same symbol, separated by a sign for opposition. "Closed" equals "minus open." To substitute "closed" for "open" does not require the notion of ambivalence or conflict.

"When the chairman made that substitution," she declared, "a bit was dropped; a minus sign was lost. There was a power surge. No problem."

The young woman turned a Freudian slip into an information-processing error. An explanation in terms of meaning had become an explanation in terms of mechanism.

Such encounters turned me to the study of both the instrumental and the subjective sides of the nascent computer culture. As an ethnographer and psychologist, I began to study not only what the computer was doing *for* us, but what it was doing *to* us, including how it was changing the way we see ourselves, our sense of human identity.

In the 1980s, I surveyed the psychological effects of computational objects in everyday life -- largely the unintended side effects of people's tendency to project thoughts and feelings onto their machines. In the 20 years since, computational objects have become more explicitly designed to have emotional and cognitive effects. And those "effects by design" will become even stronger in the decade to come. Machines are being designed to serve explicitly as companions, pets, and tutors. And they are introduced in school settings for the youngest children.

Today, starting in elementary school, students use e-mail, word processing, computer simulations, virtual communities, and PowerPoint software. In the process, they are absorbing more than the content of what appears on their screens. They are learning new ways to think about what it means to know and understand.

What follows is a short and certainly not comprehensive list of areas where I see information technology encouraging changes in thinking. There can be no simple way of cataloging whether any particular change is good or bad. That is contested terrain. At every step we have to ask, as educators and citizens, whether current technology is leading us in directions that serve our human purposes. Such questions are not technical; they are social, moral, and political. For me, addressing that subjective side of computation is one of the more significant challenges for the next decade of information technology in higher education. Technology does not determine change, but it encourages us to take certain directions. If we make those directions clear, we can more easily exert human choice.

Thinking about privacy. Today's college students are habituated to a world of online blogging, instant messaging, and Web browsing that leaves electronic traces. Yet they have had little experience with the right to privacy. Unlike past generations of Americans, who grew up with the notion that the privacy of their mail was sacrosanct, our children are accustomed to electronic surveillance as part of their daily lives.

I have colleagues who feel that the increased incursions on privacy have put the topic more in the news, and that this is a positive change. But middle-school and high-school students tend to be willing to provide personal information online with no safeguards, and college students seem uninterested in violations of privacy and in increased governmental and commercial surveillance. Professors find that students do not understand that in a democracy, privacy is a right, not merely a privilege. In 10 years, ideas about the relationship of privacy and government will require even more active pedagogy. (One might also hope that increased education about the kinds of silent surveillance that technology makes possible may inspire more active political engagement with the issue.)

Avatars or a self? Chat rooms, role-playing games, and other technological venues offer us many different contexts for presenting ourselves online. Those possibilities are particularly important for adolescents because they offer what Erik Erikson described as a moratorium, a time out or safe space for the personal experimentation that is so crucial for adolescent development. Our dangerous world -- with crime, terrorism, drugs, and AIDS -- offers little in the way of safe spaces. Online worlds can provide valuable spaces for identity play.

But some people who gain fluency in expressing multiple aspects of self may find it harder to develop authentic selves. Some children who write narratives for their screen avatars may grow up with too little experience of how to share their real feelings with other people. For those who are lonely yet afraid of intimacy, information technology has made it possible to have the illusion of companionship without the demands of friendship.

From powerful ideas to PowerPoint. In the 1970s and early 1980s, some educators wanted to make programming part of the regular curriculum for K-12 education. They argued that because information technology carries ideas, it might as well carry the most powerful ideas that computer science has to offer. It is ironic that in most elementary schools today, the ideas being carried by information technology are not ideas from computer science like procedural thinking, but more likely to be those embedded in productivity tools like PowerPoint presentation software.

PowerPoint does more than provide a way of transmitting content. It carries its own way of thinking, its own aesthetic -- which not surprisingly shows up in the aesthetic of college freshmen. In that aesthetic, presentation becomes its own powerful idea.

To be sure, the software cannot be blamed for lower intellectual standards. Misuse of the former is as much a symptom as a cause of the latter. Indeed, the culture in which our children are raised is increasingly a culture of presentation, a corporate culture in which appearance is often more important than reality. In contemporary political discourse, the bar has also been lowered. Use of rhetorical devices at the expense of cogent argument regularly goes without notice. But it is precisely because standards of intellectual rigor outside the educational sphere have fallen that educators must attend to how we use, and when we introduce, software that has been designed to simplify the organization and processing of information.

In "The Cognitive Style of PowerPoint" (Graphics Press, 2003), Edward R. Tufte suggests that PowerPoint equates bulleting with clear thinking. It does not teach students to begin a discussion or construct a narrative. It encourages presentation, not conversation. Of course, in the hands of a master teacher, a PowerPoint presentation with few words and powerful images can serve as the jumping-off point for a brilliant lecture. But in the hands of elementary-school students, often introduced to PowerPoint in the third grade, and often infatuated with its swooshing sounds, animated icons, and flashing text, a slide show is more likely to close down debate than open it up.

Developed to serve the needs of the corporate boardroom, the software is designed to convey absolute authority. Teachers used to tell students that clear exposition depended on clear outlining, but presentation software has fetishized the outline at the expense of the content.

Narrative, the exposition of content, takes time. PowerPoint, like so much in the computer culture, speeds up the pace.

Word processing vs. thinking. The catalog for the Vermont Country Store advertises a manual typewriter, which the advertising copy says "moves at a pace that allows time to compose your thoughts." As many of us know, it is possible to manipulate text on a computer screen and see how it looks faster than we can think about what the words mean.

Word processing has its own complex psychology. From a pedagogical point of view, it can make dedicated students into better writers because it allows them to revise text, rearrange paragraphs, and experiment with the tone and shape of an essay. Few professional writers would part with their computers; some claim that they simply cannot think without their hands on the keyboard. Yet the ability to quickly fill the page, to see it before you can think it, can make bad writers even worse.

A seventh grader once told me that the typewriter she found in her mother's attic is "cool because you have to type each letter by itself. You have to know what you are doing in advance or it comes out a mess." The idea of thinking ahead has become exotic.

Taking things at interface value. We expect software to be easy to use, and we assume that we don't have to know how a computer works. In the early 1980s, most computer users who spoke of transparency meant that, as with any other machine, you could "open the hood" and poke around. But only a few years later, Macintosh users began to use the term when they talked about seeing their documents and programs represented by attractive and easy-to-interpret icons. They were referring to an ability to make things work without needing to go below the screen surface. Paradoxically, it was the screen's opacity that permitted that kind of transparency. Today, when people say that something is transparent, they mean that they can see how to make it work, not that they know how it works. In other words, transparency means epistemic opacity.

The people who built or bought the first generation of personal computers understood them down to the bits and bytes. The next generation of operating systems were more complex, but they still invited that old-time reductive understanding. Contemporary information technology encourages different habits of mind. Today's college students are already used to taking things at (inter) face value; their successors in 2014 will be even less accustomed to probing below the surface.

Simulation and its discontents. Some thinkers argue that the new opacity is empowering, enabling anyone to use the most sophisticated technological tools and to experiment with simulation in complex and creative ways. But it is also true that our tools carry the message that they are beyond our understanding. It is possible that in daily life, epistemic opacity can lead to passivity.

I first became aware of that possibility in the early 1990s, when the first generation of complex simulation games were introduced and immediately became popular for home as well as school use. SimLife teaches the principles of evolution by getting children involved in the development of complex ecosystems; in that sense it is an extraordinary learning tool. During one session in which I played SimLife with Tim, a 13-year-old, the screen before us flashed a message: "Your

orgot is being eaten up." "What's an orgot?" I asked. Tim didn't know. "I just ignore that," he said confidently. "You don't need to know that kind of stuff to play."

For me, that story serves as a cautionary tale. Computer simulations enable their users to think about complex phenomena as dynamic, evolving systems. But they also accustom us to manipulating systems whose core assumptions we may not understand and that may not be true.

We live in a culture of simulation. Our games, our economic and political systems, and the ways architects design buildings, chemists envisage molecules, and surgeons perform operations all use simulation technology. In 10 years the degree to which simulations are embedded in every area of life will have increased exponentially. We need to develop a new form of media literacy: readership skills for the culture of simulation.

We come to written text with habits of readership based on centuries of civilization. At the very least, we have learned to begin with the journalist's traditional questions: who, what, when, where, why, and how. Who wrote these words, what is their message, why were they written, and how are they situated in time and place, politically and socially? A central project for higher education during the next 10 years should be creating programs in information-technology literacy, with the goal of teaching students to interrogate simulations in much the same spirit, challenging their built-in assumptions.

Despite the ever-increasing complexity of software, most computer environments put users in worlds based on constrained choices. In other words, immersion in programmed worlds puts us in reassuring environments where the rules are clear. For example, when you play a video game, you often go through a series of frightening situations that you escape by mastering the rules -- you experience life as a reassuring dichotomy of scary and safe. Children grow up in a culture of video games, action films, fantasy epics, and computer programs that all rely on that familiar scenario of almost losing but then regaining total mastery: There is danger. It is mastered. A still-more-powerful monster appears. It is subdued. Scary. Safe.

Yet in the real world, we have never had a greater need to work our way out of binary assumptions. In the decade ahead, we need to rebuild the culture around information technology. In that new sociotechnical culture, assumptions about the nature of mastery would be less absolute. The new culture would make it easier, not more difficult, to consider life in shades of gray, to see moral dilemmas in terms other than a battle between Good and Evil. For never has our world been more complex, hybridized, and global. Never have we so needed to have many contradictory thoughts and feelings at the same time. Our tools must help us accomplish that, not fight against us.

Information technology is identity technology. Embedding it in a culture that supports democracy, freedom of expression, tolerance, diversity, and complexity of opinion is one of the next decade's greatest challenges. We cannot afford to fail.

When I first began studying the computer culture, a small breed of highly trained technologists thought of themselves as "computer people." That is no longer the case. If we take the computer as a carrier of a way of knowing, a way of seeing the world and our place in it, we are all computer people now.

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