

# Human-Centered Computing

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Computers today are ubiquitous in the workplace and are reaching into recreation and social environments. Information technology is widely credited as one cause of the recent and remarkable growth in productivity nationwide, and it is the “everyday use” of computing that has fed this growth. Many difficult technical challenges have been addressed and solved, feeding an extraordinary growth period for the computer industry. Yet, there are critical frontiers of information technology that require more than just technical expertise: (1) classroom and distance learning; (2) e-commerce; (3) bridging the “digital divide”; and (4) ubiquitous and post-PC computing. To better understand and address issues such as these, technical know-how must be accompanied by expertise in education, economics, and understanding of human behavior and social practices. At Berkeley, a group of faculty has formed an interdisciplinary consortium for research on “Human-Centered Computing” (HCC). HCC is the study and design of information systems in human contexts. The representative research frontiers in more detail are:

**Classroom and Distance Learning.** Research at Berkeley on education and distance learning is proceeding on two fronts. On one front, Berkeley education faculty are developing simulations to make the invisible world of science and mathematics visible. They are creating web interfaces to promote collaborative learning among students, teachers and citizens. They are designing learner supports so individuals can take charge of their education and become lifelong, autonomous learners. On the other front, Berkeley engineers are creating devices that enable learners to gather and share data in new learning contexts. They are building novel interfaces, smart classrooms, and broadband delivery services that expand the classroom and learning labs. In spite of the great possibility for synergies between education faculty and engineers, most of these in-class and distance learning projects occur separately. The Human-Centered Computing initiative seeks to bridge this gap, promoting collaborative efforts amongst educators and engineers. Such an interdisciplinary meeting of minds is a fermenter of revolutionary ideas. Education at the beginning of the 21st century is ripe for transformation, and revolutionary ideas will be needed to make this happen.

**Internet Commerce and Security.** E-commerce has been hyped endlessly in the popular press, but it is remarkable how little is really known about how to make it work. The following are key examples: Basic processes such as strategy, marketing, accounting, and finance are only slowly evolving to take account of the possibilities offered by the Internet. Government faces many of the same challenges in evolving its processes and policies. Questions about competition policy, privacy, taxation, and other economic and social issues are becoming critical issues; The huge potential for e-trade in intellectual property is limited not by physical aspects (nothing needs be shipped), but by today’s systems for protecting IP (copyright and patents) which are sluggish and byzantine for microsecond e-commerce. A promising answer is for computer agents to negotiate IP rights under the applicable laws, negotiate price, and complete a transaction in micro-seconds, all based on the user’s prespecified choices; E-commerce systems today make use of extensive user profiling data, but their models are simplistic and uninformed by knowledge of social and demographic forces, personality and other preference traits; Especially for E-commerce, but also for many other computer applications, security is essential to protect the individual. But it is increasingly clear that security requires more than effective systems design: no matter how secure the system in theory, it will not work unless it matches well with typical human behavior. Addressing any of these issues requires close collaboration between engineers economists, psychologists and experts in business, public policy and law. The Berkeley faculty include former chief economists for the Department of Justice, 2 former chief economists for the FCC,

2 former chairs of the Council of Economic Advisors, and a former Federal Reserve Governor, and many of the worlds foremost experts on technical aspects of security and e-commerce system design.

**The Digital Divide.** Although the internet is an important medium for access to information, education, shopping and job-hunting, there exists a disparity between information haves and have-nots. As a result of this digital divide, those with little or no access to the internet are disadvantaged compared to others. Unfortunately, those without internet access also happen to be, by and large, groups that are already socially disadvantaged. While new technologies like the internet compound this situation, they can also provide new insights for alleviating it. For example, whereas companies use “cookies” and customer profiling in websites for better understanding of customer behavior, social scientists can use similar techniques on public gateways, like AOL and Yahoo, or usenet newsgroups, to attain rich information about communities. To do this, social scientists must collaborate with engineers, who have the expertise to build data access and analysis tools. Through these studies, social scientists can alert and inform engineers and policy makers about such important issues as the psychological effects of prolonged interaction online, new types of community, and demographic transformation. It is already recognized that social, cultural and personality differences play a major role in the effectiveness of peoples’ interaction with computers. It is critical that social scientists who study these factors participate in the design of tomorrow’s computing environments.

**Ubiquitous and Post-PC Computing** We are moving from the age of the PC and digital desktop to the age of “ubiquitous computing”, where information devices are everywhere, and fit seamlessly into daily life. The next generation of human-computer interfaces will be multi-modal (including modes such as speech, text, video), and reside in mobile devices and built into office environments. The computer will no longer be in the foreground and in fact, will often be invisible. Rather than people expressing their intentions through computer-understandable actions, computers will need to model the contexts in which they are used and learn what actions are appropriate in those contexts. As we move to an era where machines relate to humans on human terms, understanding the social contexts, constructing theories of mind and dealing with the complexity of human communication will be essential. To make this happen, much interdisciplinary work is needed between engineers who work on the physical aspects of interfaces – design of new input devices, displays and actuators – and social psychologists, anthropologists and sociologists, who work on the social plane. There are great opportunities here for truly innovative computer interfaces through closer collaboration.

The four frontiers listed above are representative of Human-Centered Computing (HCC). There are strong synergies between the frontiers which, in turn, make HCC greater than its parts. Breakthroughs in one area have implications for the others. Common to all are: integration of technical artifacts and real work practices, collaboration, improved computer interfaces, and understanding of the role of social context. The Human-Centered Computing consortium incubates new research partnerships through conferences, workshops, and seminars. Information Technology has fed a national economic boom that is unprecedented, and this benefit has been due to the pervasive and everyday use of computing. We believe that this benefit has only partly been felt. Whereas technical boundaries have fallen, many deep challenges remain to the everyday use of computing, and these lie between the disciplines (education, e-commerce, the digital divide and post-PC computing). Addressing these and bridging traditional disciplinary boundaries will extend to everyone the full promise of information technology for education, economic advancement, and personal growth.