Since the rise of industrialization, or perhaps even earlier, machines have been regarded as potential threats to our humanity, something oppressive, worthy of suspicion, certainly external. Machines were not our friends. If they are not exactly our friends today, our relationship with them, what practitioners call the user interface, has become a matter of understanding, communication, even empathy. We and our ubiquitous machines must interact in ways that make sense, both in terms of our sensibility and in terms of results.

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Interacting with our computers

Minimizing the barrier between software and hardware, human cognition and experience

Since the rise of industrialization, or perhaps even earlier, machines have been regarded as potential threats to our humanity, something oppressive, worthy of suspicion, certainly external. Machines were not our friends. If they are not exactly our friends today, our relationship with them, what practitioners call the user interface, has become a matter of understanding, communication, even empathy. We and our ubiquitous machines must interact in ways that make sense, both in terms of our sensibility and in terms of results.

The field of Human Computer Interaction (HCI), which at Stanford is a group within the Computer Science Department, is dedicated to minimizing the barrier between human cognition and experience, on the one hand, and software and hardware, on the other. Researchers work at both ends of this relationship—the social and the mechanical—and in between. They come from the social and behavioral sciences, engineering, computer science and education.

Like “environment,” which implicitly suggests a sphere in which nature and humans interact—that is, a terrain both external and internal to us—HCI embodies a relationship and, implicitly, responsibility.

HCI means different things to different people, depending where they are on the scientific spectrum and on whether they are interested in the relationship between a particular user and his technology or among many users who communicate via technology. Though we have a one-on-one relationship with our machines, our relationships with each other and, in fact, with ourselves, are also mediated by them.

Scott Klemmer, an assistant professor of computer science and co-director of the HCI group, said HCI “studies people acting through technology. The difference between HCI and other areas of computer science is that for much of computer science, the metric of success is the system (speed, capacity, etc.), while for us what matters is the user experience.”

With a background in design and computer graphics, Klemmer felt that an element was missing from many of his computer science classes when he was an undergraduate. “It was all about how we implement technology, and I wanted to know why we implement it. I wanted to create tools to enable designers and users to be more creative and to think about how computing can be better integrated into the practical logic of everyday life.”

Conceptually, his work lies at the intersection of computer users, computer scientists and designers. It is a big intersection, with lots of interaction, for there is virtually no part of our lives that is not linked to computer technology and that couldn’t be linked better. With the goal of enabling a prototyping culture, an expression heard often at the Design Institute (see story below), Klemmer has worked on such projects as a pen-and-notebook system that combines the best of paper and computer record-keeping; field research tools that technological mash-ups (composites of online or hardware sources) for “opportunistic design”; and a system that balances physical and virtual design with the simultaneous development of hardware and software. At the heart of his work always is a preoccupation with human needs.

Getting there from here

Two components of everyday life studied by a psychologist who works on HCI projects are route maps and as...
assembly instructions, that bane of every casual furniture shopper. Clearly, this is an area where the technology (in this case, visualization) does not correspond to ordinary human cognition.

Psychology Professor Emerita Barbara Tversky and her collaborators in computer science started off by working on maps. They wanted to use computers to represent cognitive design principles in algorithms that could then automate the generation of effective visualization. In other words, computers could be made to understand and illuminate how people actually visualize directions.

With undergraduates as her guide—they were asked to draw a map to a nearby Taco Bell—Tversky figured out how people think in sequences and hierarchies and how much information they actually need in order to get where they need to go. Then, graduate students Manosh Agrawala and Chris Stolte produced the algorithms that could generate maps. (Both have since earned their doctoral degrees.)

From there the team bravely moved on to assembly instructions, specifically for a television cart. The process was much the same; once again, undergraduates were observed, and “computer-generated instructions won that came in the box or to the best hand-drawn ones,” Tversky said. (The resulting software, developed by the graduate students, is called LineDrive.)

Tversky’s fellow traveler in much of her work has been Pat Hanrahan (adviser to Agrawala and Stolte), described by one of his colleagues as the world’s best when it comes to visualization. Hanrahan, the Canon USA Professor in the School of Engineering, has twice been honored by the Academy of Motion Picture Arts and Sciences (the Oscar people) for scientific and technical achievements in digital imaging. He says he “builds tools,” which include rendering software and graphics hardware that transform vast amounts of data into visualizations. Both Simbios and the Institute for Computational and Mathematical Engineering (see articles, page 5) consult with Hanrahan, who was trained as a biophysicist.

“I was always interested in scientific visualization,

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researchers from beyond. Kembel is an expert in idea generation and prototyping and—no surprise—has a bit of entrepreneurship in his background as well.

"Stanford was unique in balancing mechanical engineering and art," he said. "Most places emphasized one or the other. People here learned to reconcile the differences and create a more human experience. The products were essentially tools to teach students to be more human-centered."

Essentially, there was a shift from design to design thinking, from products to experience. The idea is that any problem can be approached from an experiential, observational, hands-on manner. Watch and listen, figure out the problem, then solve it.

The design people have had plenty of opportunities to put this into practice close to home, as they have moved three times already and are looking forward to two more moves before finally landing in the Peterson Building (next to Mitchell Earth Sciences) in 2009. Each time is an opportunity to prototype themselves, Kembel said.

The Birch module, the d.school’s previous home, was windowless, cramped and messy, though with a certain charm. They turned the space around four times, Kembel said. In December they decamped to Sweet Hall, where they have far more room, and the process continues, defining space with movable furniture, whiteboards on wheels and what appear to be transparent shower curtains marking off study and meeting areas. Treating space as if it was a product or device to satisfy human needs, they’re “prototyping [their] way to the new building,” in Kembel’s words.

In charge of the latest move (and glad it’s over) was Scott Doorley, one of three design fellows this year. The one-year fellowship program follows a master’s degree, which in Doorley’s case was in the School of Education’s Learning, Design and Technology program.

Doorley was on his way to a life in human-computer interaction (see article above) when he veered a bit, somewhat by chance. He was thinking about how people interact with the software designed by his classmates and he was curious about how they would use it.

“IT was always interested in human-computer interaction, looking at the prototyping process, and how people think about and use the technology they’re given,” he said. "I wanted to be able to influence that with design."

While earning his Stanford MBA and preparing to wear a business hat in the world of social advocacy (she had previously worked at Planned Parenthood), Greenberg came across Jim Patel’s course Entrepreneurial Design for Extreme Affordability. That led her to the d.school and, eventually, to small rural farms in Southeast Asia.

“I saw immediately they were using the vocabulary I had been seeking all this time,” she said. "It’s very user-centered; you get your words and ideas from the people who are affected. I always thought projects had to be complete, finished; prototyping was new to me."

Following Patel’s class, Greenberg spent six weeks working with farmers in Southeast Asia to figure out

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Scott Klemmer, co-director of the Human-Computer Interaction group, works with a class on writing a profile of a make-believe student who is interacting with the software designed by the group.
Biomechanics researchers are using simulations of gait to quantify how individual muscles contribute to an observed movement.
You may not know it, but it is likely you need the services of a computational mathematician. Lucky for you, you’re at Stanford.

The Institute for Computational and Mathematical Engineering (ICME) was launched in 2005 after several previous incarnations. Said its director, Peter Glyn. “It’s almost had to think of a part of the university that is not impacted by computational maths.”

Engineering has always had two pillars: theory and experimentation. Computational mathematics—the result of the dizzying increase in computers’ ability to compute—has now created a third pillar, unifying the other two. Modeling and simulation are now possible to such a degree that they play a role equal to that of theoretical math and hands-on experimentation.

“We’re interdisciplinary; we do research that’s usable and that creates links between engineering and math,” said Margot Gerritsen, a faculty member in the School of Earth Sciences who is on ICME’s steering committee. “So it’s not that we’re spreading out; we reach out. We’re almost like a service department.”

It was in that spirit that Gerritsen worked with students to set up a Computational Consulting website (http://icme.stanford.edu/consulting/squared/). Questions come from all over: graduate students, professors, industry professionals, even the Library of Congress. Consultations also can be face-to-face, said third-year students Jeremy Kozdon and David Gleich, who pointed out that they don’t always solve people’s problems, they mostly just put them on the right track.

ICME’s origins lie in the Scientific Computing and Computational Mathematics (SCCM) program, which began in 1988. The story is not a simple one. The Department of Computer Science (CS) at Stanford was founded in 1965 by people who were primarily mathematicians. At that time, there were few CS departments in the country, and graduate students came from a variety of disciplines. Over time, CS as a discipline grew closer to electrical engineering than to mathematicians, as a result of which the department moved into the School of Engineering in 1986. "Originally," said Walter Murray, professor of management science and engineering, "computers were designed and used by mathematicians to compute. But at some point, computer science became a subject in and of itself, devoted to the essence of the computer, and math was no longer a big part of its core. So, non-CS people were coming to Stanford to study computational math in the Computer Science Department, where they faced comprehensive exams in subjects such as hardware and artificial intelligence in which they had little interest and no knowledge."

In other words, he said, Stanford was losing graduate students who wanted to focus on computational mathematics. So SCCM was established in large part as a place where graduates from a variety of disciplines could study. For over a decade, the program produced stellar master’s and doctoral students.

But according to Murray, it was always a struggle. The program relied mainly on faculty volunteers and it was under-funded, a challenge to even a mathematician.

So John Hennessy, who at the time was dean of the School of Engineering, formed a committee to figure out a long-term solution. Several were proposed, including folding the program back into CS. An appendix to the committee’s report, written by Murray, proposed that computational mathematics form a department of its own in which the teaching of mathematics to engineers at both the graduate and undergraduate levels would be added to the research agenda of SCCM. The idea found support among a broad range of faculty members, and, after conversations with Hennessy’s successor as dean, Jim Plummer, SCCM was disbanded in 2004-05 and morphed into ICME.

**Engineering’s backbone**

Everyone involved in the process agreed that the in-
When Engineering Dean Jim Plummer was asked recently to predict the hottest new field, the uncharted territory just ahead, he didn’t take but a second to reply. “Nano,” he said. “It’s a sea change.”

Nanotechnology, by which certain physical and chemical operations enable mastery over unbelievably tiny structures, which in turn can benefit everything from medicine to sportswear, is occupying the time of a growing number of Stanford researchers. The university has two principal facilities. The Stanford Nanofabrication Facility (SNF), whose lab members work in a 10,500-square-foot clean room surrounded by observation windows, is in the Paul Allen CIS Building. “These places are very expensive to run, so people from various fields converge on them,” Plummer said. “Physics, chemistry, engineering all use them. The labs are like cafes; people go there to accomplish something. They have the same magic.”

But while nanotechnology is a technically exciting domain of inquiry with enormous potential, its possible effects on society are a focus of persistent controversy. In 2003 the National Science Foundation announced a competition to establish a network of nanotechnology facilities that would be open to academic, industrial and government researchers. SNF, together with labs at 12 other universities, submitted an application. The agency required that each proposal indicate how the group would address the “social and ethical implications of nanotechnology.” To help formulate that part of the proposal, SNF invited Professor (Teaching) Robert McGinn, of the Management Science and Engineering Department, to get involved, and he proposed carrying out a detailed empirical study of what researchers at the 13 labs thought about ethics and research. Ultimately, that proposal won the competition, and in 2004, SNF became part of the 13-node National Nanotechnology Infrastructure Network (NNIN).

After working for about a year with other researchers at SNF, McGinn finalized a questionnaire for an online survey titled “Ethics and Nanotechnology: Mapping the Views of the NNIN Community.” It was accessible to researchers from September 2005 to July 2006. The most important of McGinn’s results, in his view, is that it appears that most researchers (professors, engineers, scientists, postdoctoral scholars and graduate students) believe they have an ethical responsibility to anticipate the impact of their scientific work. In other words, they have a responsibility not only to ensure that they themselves cause no harm, but also to alert authorities if they think applications of their work might pose risks down the line. This, McGinn said, could well indicate a paradigm shift.

His other principal takeaway point is that it is up to managers to take responsibility for the safety and ethical culture of their labs. In somewhat contradictory fashion, a majority of researchers said their colleagues probably would not intervene if someone were taking shortcuts, though a large majority (77 percent) also disagreed with the proposition that their only responsibility is to follow lab safety rules. These matters are of such concern in the field of nanotechnology, as opposed to other technologies, because the enormous projected benefits conceivably conceal substantial ills. The fact that a new nanomaterial exhibits a particular property that is safe on the macro or micro scale in no way guarantees that the same material will exhibit the same property at the nanoscale.

That understanding led the National Science Foundation to issue its request for proposals; it also led the United Kingdom’s Royal Society and the Royal Academy of Engineering to recommend in 2004 that consider-
they would do but rather what everyone else would do. lab. In other words, respondents were asked not what asked what the most likely response would be in their
nature beforehand (72 percent thought the omission was unethical) or to inform administrators (37 percent).

If a researcher never before involved in an ethical dimension of the nanotech field with its scientific dimension, 43 percent of respondents believe that researchers must anticipate the ethical consequences of their work.

Among McGinn’s principal conclusions are that respondents believe quite strongly that it is important for ethical issues to be considered but are themselves only moderately interested; they believe themselves inadequately informed about ethical issues and want them incorporated into curricula; they need a better grasp of what constitutes ethical judgment, negligence and action; and they believe researchers have ethical responsibilities to society. Their notion of what constitutes “harm” is amorphous, he said, yet he took heart in the number who amorphous, he said, yet he took heart in the number who

McGinn’s survey garnered 1,037 responses (90 of them from Stanford), or about one-quarter of the total number of researchers—a sample he calls “robust but not random.” Eighty percent of respondents were men and about two-thirds were U.S. citizens. He divided the questionnaire into three categories: general beliefs about ethics and nanotechnology; specific ethical issues in the lab; and experiences and beliefs about the study of ethics in general.

Half the respondents either somewhat or strongly agreed with the statement “there are significant ethical issues related to nanotechnology,” and 27 percent somewhat or strongly disagreed. When asked to compare the importance of the ethical dimension of the nanotech field with its scientific dimension, 43 percent said they were equally important. However, far fewer ranked ethics more important than science (8 percent) than the reverse (49 percent). When asked how interested they are in ethical issues related to nanotech, 39 percent said they are quite or very interested; just 6 percent said they were somewhat, quite or very willing to spend time learning about the ethical issues related to nanotechnology, and two-thirds said they should become a standard part of the education of future engineers and scientists.

In general, the numbers for Stanford mirror the national numbers, with some exceptions.

Most researchers appear to believe they have an ethical responsibility to anticipate the impact of their work.

McGinn, a professor in the Management Science and Engineering Department, coordinated an empirical study of what researchers at 13 labs thought about ethics and nanotech research.
Gerritsen’s previous projects involved developing a computer code capable of tracking massive internal waves that begin on the ocean floor.

**ICME** continued from page 5


To keep the computation honest,” Schmidt said, they also must focus on specific biological problems that can be addressed by computation. In the case of Simbios, the four problems are neuromuscular dynamics, cardiovascular dynamics, myosin dynamics and RNA folding.

One of the bioengineering graduate students working on RNA structure prediction in Altman’s lab is Magda Jonikas, and she got there precisely because she saw it as a way of bringing it all together. She started off in protein and tissue engineering but missed the math. In Altman’s lab, using physics-based methods and informatics, she gets not only the math but the Simbios community as well.

“Working in Simbios has been a great experience so far, not just because I find the goals of the program interesting, but also because of the community of people,” she said.

Simbios’ home is the Department of Bioengineering, a pioneer in its own right, belonging to both the School of Engineering and the School of Medicine. Simbios depends on the department mostly for lodging and administrative support (its funding comes entirely from the NIH), but the proximity has certainly created good synergy, Altman said.

Thinking back to the birth of the Bioengineering Department, Engineering Dean Jim Plummer shook his head.

“Three years ago, if you had asked, how can we make this work, we’d have put together a list of problems so long you couldn’t imagine it,” Plummer said.
“Stanford is transitioning toward an interdiscipli-
nary model of teaching and research, and at some point we’ll have the mechanisms for making these appoint-
ments,” Glynn said. “In the meantime, we are focusing on building a world-class program that fully leverages all the opportunities that already exist here.”

For Gerritsen, “the most important thing is to show we can create a research vision. At the moment, we’re going for very big research grants that will allow us to attract more researchers. Later on, we can return to the billing discussion.”

The institute has around 35 affiliated faculty mem-
bers. They hail from computer science, mechanical engineering, energy resources, mathematics, statistics, aeronautics and astronautics, electrical engineering, civil engineering and management science. As Glynn said, there are few areas that couldn’t benefit from the assistance of an computational mathematician, and the 
field embraces such disparate areas as national security and ports, fluid dynamics and public policy.

“Every discipline has what physicists call the ‘grand challenge problems,’ and our faculty work on those,” Glynn said. “Since the advent of the computer, the human imagination has been highly creative in develop-

ing new problem structures that require ever more computational ability. To address those problems, we need high-end expertise.”

The students who choose to enter such a dynamic, challenging and extensive field are, to quote Murray, “tough sledding.” ICME has around 100 graduate students in the master’s and doctoral programs. This year’s crop of around 25 master’s students come from eight countries and have backgrounds in bioengineering, computer science, physics, applied math and aerospace.

Because ICME addresses a much wider range of is-

sues than engineering departments, students must be protected in the first and second year,” Murray said. “They need more time to figure out what they’re do-
ing. We don’t want them to arrive here knowing what they want to do.”

Kozdon, one of the students who operates Compu-
tational Consulting and computer science as an undergraduate. He said that when he got his bachelor’s degree he did not know of a graduate pro-
gram that would allow him to continue in both fields. By chance, he saw a journal article that mentioned Stanford’s new program.

“It’s tailored for the non-mathematicians, aimed

more at engineers, scientists, economists,” he said. “And because we’re an institute, not a department, I have the possibility. Thinking back on his own serendipitous 

Encountering of the interface between the disciplines, and con-
attract more researchers. Later on, we can return to

Making connections

Mathematician Gunnar Carlsson, who is affiliated with ICME, said he, for one, would embrace such a path to工程ing, he said he was lucky in knowing people who knew people.

“TheSE things happen at Stanford because the atmos-
phere is good, but they happen at random. The ques-
tion is, can we do more in a formal way? I think the [graduate commission’s] recommendations for faculty

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how people envision math and how mathematicians can share their information," he said. "If you think historically, you see techniques that we think are obvious, but they weren't; they took forever. Bar charts, for example, started being used only 150 years ago." Tversky too points out that “metaphorically visible” visualizations such as pie charts were late arrivals.

Hanrahan says he uses graphical techniques to convey information or support reasoning. His collaborators include psychologists, engineers, physicians, mathematicians and physicists. All those people need to visualize their data and their concepts; computers can make that happen, but someone has to ensure that the results make sense to humans and respond to the questions they’re asking.

Of course, different people ask different questions. As Tversky might say, they have different mental representations of space.

“The way you picture things depends on the questions you ask," Hanrahan said. "So that's an HCI point of view, trying to help people solve specific problems, not just make cool pictures. We build tools."

The flexible definition of HCI means that different universities house it in different ways. HCI is a degree-granting institute within Carnegie Mellon’s computer science school; a subgroup within Berkeley’s department of electrical engineering and computer sciences; a nucleus of courses within MIT’s Media Lab; and a degree-granting program sitting between the School of Psychology, the School of Literature, Communication and Culture and the College of Computing at Georgia Tech. Simbios, John provides a geometric correction. Barbara Tversky

‘You can’t just browse ideas; you need focused browsing, you need people who can tell you what the important problems are,’ Carlson said. 'I had been dreaming of this project for 15 years," Gerritsen said. "At other universities, students sort of understand; they sort of apply. But we guarantee that Stanford will always have a good selection of fundamental courses at a very advanced level and that our students will be able to develop their own computational algorithms."

Carlsson’s research direction took a decisive turn as a result of ICME. For a decade or so, he had been working on a pure problem regarding topology. He sensed there must be some application for the work, but he was unable to figure it out. Speaking about the problem one day to a friend in statistics, the friend recommended someone in psychology, who in turn suggested someone in computer science, and Carlson was introduced to the field of computational math.

“I had been dreaming of this project for 15 years,” he said, “but it wasn’t until I spoke to people from engineering that I realized what it was about, what it could mean.”

‘It’s much more than a spectrum,” he said. “I think of it as a tetrahedron, a pyramid with a triangle as its base. The three vertices of the base triangle represent life sciences, mathematics and computation. The fourth vertex, which lies above the triangle, represents generally.'

As for the disciplinary spectrum at places such as Simbios, John provides a geometric correction.

ICME

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sabbaticals for cross-training is a fantastic idea. But we need to identify people and put them together with the right people. You can’t just browse ideas; you need focused browsing, you need people who can tell you what the important problems are,’ Carlson said.

But with design, experience is what’s important. You can’t be precise about that, you can’t measure it. You have to meet needs that are not well specified. An old person will just say, ‘I want this computer to help me.’ So you learn by talking, observing, watching. Computers may have been getting smarter a few decades ago, Winograd said, but they weren’t getting any easier to use. They were not meeting those ill-specified but nonetheless crucial human needs.

He was not alone in his observation. The Department of Mechanical Engineering began making institutional moves decades ago in recognition of design deficits; down the road, those changes would lead to the establishment of the Design Institute. At the same time, the Computer Science Department, which moved out of the School of Humanities and Sciences and into the School of Engineering in 1986, began looking at the “why” instead of just the “how” of computing.

Two new concepts began attaining prominence: ubiquity and empathy. By 1990, when the HCI group was formed, computers were no longer bulky things sitting on desks. They were small and mobile, and their technology was not even confined to artifacts called

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ICME

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Artificial intelligence

One of Klemmer’s closest faculty associates in the HCI group is Terry Winograd, artificial intelligence pioneer, founder of Computer Professionals for Social Responsibility and adviser to untold numbers of students who have gone off and changed the world. His shift from artificial intelligence to HCI and design was as much a philosophical one as a mechanical one, he said. Design and research are two ways of thinking," he said. “With research you ask, which is the faster mouse? And you can test it. But with design, experience is what’s important. You can’t be precise about that, you can’t measure it. You have to meet needs that are not well specified. An old person will just say, ‘I want this computer to help me.’ So you learn by talking, observing, watching.”

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“Artificial intelligence has thus far has concentrated on breadth. As new courses are developed (a process that entails a good deal of hard work and modesty, Delp said, as noted by every field can be deemed essential core material), the vertical will gain in importance.”

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Design

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Design

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“computers.” Chips and handhelds and GPS devices began showing up in the most unexpected locations. It was the start of the era of ubiquitous computing, or ubiquitous computing as engineer as “technology that sup-
ports embodied cognition and that is integrated into everyday life.”

And with ubiquity comes the recognition that all people in all places at all times might require or benefit from technology and therefore have to be able to use it in a productive and enjoyable way. Enter the social scientists.

As Pamela Hinds, associate professor of manage-
ment science and engineering (MSE) says, “It’s very easy for people to design things for people similar to themselves.” Most people, however, are not like computer engineers.

Hinds, who has a PhD in organizational science and management, is co-director of the Center for Work, Technology and Organization, for example, which is interested in understanding how people in organizations work on the effects of technology on groups and teams.

Here the question is not just how a technology af-
fects a user, but how it affects workers’ ability to com-
municate with and understand each other, often at a distance. The disciplinary underpinnings of such work can be found in the behavioral sciences: anthropology, sociology, cognitive psychology and communication.

As an example, Hinds is working with colleagues at Carnegie Mellon on a human–robot project that links farmers in the Atacama Desert, in northern Chile, a four-wheeled, solar-powered ro-
botic astrolabe named Zoë goes about picking up solar-powered signals and misuderstandings, which are as much behavioral or cognitive issues as technical ones.

Essentially, robots have to be trained to be more perceptive about humans and to provide enough con-
textual information to the scientists so that the latter are able to form sound conclusions. In Hinds’ words, the robots have to be “creative communicators.” They have to know what to say and when to say it.

In this study, Hinds relies on common ground the-
ory, the idea that the scientists use to assess the chances of successful collaboration. In this case, Hinds’ team reported, “The interactive process ... was problematic.” Just as a human being needs to know what another person’s knowledge, attitudes and expectations are in order to have a fruitful conversation, so too with ro-
bots.

Sharing knowledge

In a similar fashion, certain technologies may enable humans to share knowledge, not just in the technical sense of moving a file from one place to another but in the sense of generosity or inspiration. These matters are addressed by the subfield of HCI called computer-supported cooperative work (CSCW), which is Hinds’ specialty. Groupware, social bookmarking, blogging and wikis are all examples.

For example, one of the students in the Center for Work, Technology and Organization, for example, is examining two software development teams; the mem-
bers of one are all in the same place, while the mem-
bers of the other are dispersed in the degree to which technology helps them share knowl-
edge. Beyond the technical aspects, she is interested in the ways in which people conceive of knowledge-seeking.

The biggest challenge is learning to speak everyone else’s language,” she said. “My work crosses so many disciplines, but translating that is really difficult. Some people say it’s too technical, other people say too orga-
nizational.”

“Do you have to learn to say it’s A or it’s B or it’s C.”

“So you just have to highlight certain things, and

Hinds considers herself fortunate to be in an engi-
neering school. Most people who do similar work are in business schools and, for the purposes of evaluation, they publish mostly in business journals. Likewise, if you were in a sociology department (which she could be), she probably would publish in sociology journals. “The real challenge,” observed Lee, “is when people say, ‘What is your work on?’ So you say, ‘It’s on this and on that.’”

“There’s tension inherent in any interdisciplinary field,” Chong agreed. “There are many perspectives about the end result. You wonder, where am I putting my eggs? There are tensions about the direction of the field, but it’s a good conversation.”

Bridging the worlds of the physical and the digital seems only natural to someone like Klemmer, who has worked in multiple disciplines since the beginning of his schooling.

“Perhaps civilization’s biggest screw-up came when Rene Descartes said, ‘I think, therefore I am,’” said Scott Klemmer, left, with Matt James and Ryan Park, in Klemmer’s project-
based class, Human-Computer Interaction Design Studio.

L.A. OHIO

Pat Hanrada, a professor in the Com-
puter Science Department, works with

Designers to help them use visualizations to improve their work, convey information and sup-
port reasoning.

L.A. OHIO

Scott Klemmer, left, with Matt James and Ryan Park, in Klemmer’s project-
based class, Human-Computer Interaction Design Studio.

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11
Science, Technology and Society

This success aside, the troubles in the 1990s point to the chief vulnerability of STS, a program whose success is not assured. STS has long been a favorite target of those who believe that it is too theoretical, unpractical, and not worth the money. This is a constant battle for STS. The program has been criticized for its interdisciplinary approach, which is seen as too broad and too difficult to assess. Some critics argue that STS is simply a collection of courses that are not directly related to any one discipline. Others argue that STS is too narrow and does not provide a comprehensive understanding of the relationship between science and society.

But despite these challenges, STS has continued to grow and thrive. The program has received generous funding from a variety of sources, including from the National Science Foundation, the National Institutes of Health, and the Ford Foundation. These funds have allowed the program to expand its offerings and to support research and other activities.

One of the keys to the program's success has been its ability to attract talented and motivated students. Many students are drawn to STS because of its interdisciplinary approach and its focus on the intersection of science and society. The program has a strong commitment to small classes and to providing opportunities for students to explore their interests in depth.

The program also benefits from a strong faculty and a supportive administration. The faculty is composed of a wide range of experts, including those from the natural sciences, the humanities, and social sciences. The faculty is also committed to engaging with students and providing them with opportunities for professional development.

In conclusion, STS is a important and dynamic program that continues to evolve and to meet the challenges it faces. The future of the program is bright, and it has a strong track record of success.

Ruth MacKay

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