ABOUT H-STAR

H-STAR is a Stanford interdisciplinary research center focusing on people and technology—how people use technology, how to better design technology to make it more usable (and more competitive in the marketplace), how technology affects people's lives, and the innovative use of technologies in research, education, art, business, commerce, entertainment, communication, national security, and other walks of life.

Among the large, complex, global problems that are at the heart of the H-STAR research agendas are:

- **Reducing complexity of technology** to enable its universal uses for work, learning and other vital sectors of life
- **Closing digital divides** across class, race, gender, age and nations, so that access to and fluencies with technologies can provide equal opportunities to learn and work productively for personal and societal well-being
- **Accelerating innovation** in the creation and diffusion of products and services that better meet human needs
- **Solving security and trust problems** of computing, communications, and information systems at home, work and in governmental affairs
- **Ensuring pervasive safety and health** of people over the lifespan with human-centered technology innovations

An innovative structure

Interdisciplinary research institutes are fairly common in leading universities. As the complexity of modern life and new technologies has increased, so too has the need to combine expertise in order to better study new ways of working and playing, to analyze how people use new technologies and gain insights leading to better design. Typically such interdisciplinary institutes are created by means of a collaborative initiative by individuals in two or three academic disciplines. H-STAR takes a significant step beyond that approach.

H-STAR cuts across the entire university, bringing together leading scholars from many disciplines, some of which have traditionally been far apart, such as engineering and theater studies, communications and art, or medical informatics and psychology. What defines H-STAR, and what unites the Stanford researchers that participate in the new institute, is a passionate interest in the disciplines that contribute to the interdisciplinary mix of the institute, and the ways in which people and technology interact— interests that are at the same time well defined yet so broad as to be campus wide.

The problems that H-STAR focuses on are in general too broad to determine in advance which researchers or which disciplines can best contribute. Accordingly, H-STAR is not based on a traditional membership model. All Stanford faculty are potentially H-STAR researchers. To date, a total of 64 Stanford researchers from all five schools have carried out H-STAR funded research, participated in an H-STAR research planning retreat, or hosted a visiting H-STAR researcher from another university. In addition, over

90 Stanford faculty have received over $3.5M in research support through H-STAR's mediaX Industry Partners Program.

The Stanford secret

The secret sauce that has made Stanford the leading university in the world for the launch of successful, innovative startup companies (many of which have become world leaders themselves) is not a secret at all. What makes Stanford so successful is a tradition of innovative research that cuts across traditional disciplines, breaking down the barriers that separate them. Other leading universities have also promoted interdisciplinary research, generally by creating multi-disciplinary research centers, which hire cross-disciplinary thinkers. That approach can be highly successful, but it is not how we do it.

At Stanford we have always recognized the power of the traditional disciplines. Everyone in H-STAR is a world expert in a traditional discipline. Indeed, many in the institute work in traditional ways almost entirely within their discipline, and it is only by taking a step back that the synoptic campus-wide interdisciplinary picture emerges. Regardless of the degree to which H-STAR researchers are engaged in interdisciplinary projects, the metric by which their work is evaluated is that of their core discipline, within their home department.

How H-STAR works

H-STAR was created by the researchers themselves, in recognition of the fact that the design and use of new technologies and the radical changes those new developments have made and continue to make to the way we live our lives, present challenges that no single research discipline, or even a small collaborative group of disciplines, can properly address. The institute operates by fostering both disciplinary and interdisciplinary research and university partnerships that (directly or indirectly) advance ideas about the role of technology in such domains as learning, commerce and entertainment, with the promise to improve people's lives and solve social problems. The institute is driven by a steadfast belief in the inspiration and innovation that emerges at the intersection of practical problems and academic research, and in the boundary-crossing and conceptual collisions that occur between multiple disciplines addressing the same questions.

The H-STAR Institute supports research, through partnerships, grants and contracts, in areas at the intersection of the human sciences and technologies. H-STAR programs leverage common interests across the *different contexts* in which information technology is used (e.g., learning, commerce, entertainment, work), the *different motivations* for research (e.g., designing information environments and studying their consequences), and the *different technologies* employed in information system solutions (e.g., computing, new media, mobile devices, networks, sensors).

Through its affiliated mediaX Industry Partners Program, the H-STAR Institute extends its research activities to include collaborations and consultations with industry, enabling us to build bridges that connect the best faculty and student scholars at Stanford to thought leaders from influential companies, to address questions of real importance within both academia and industry about the future of people and technology.

Research areas supported by the Institute include learning technologies, human-machine interaction design, pervasive computing including mobile devices, speech recognition, automated dialogue systems, collaboration technologies, entertainment and serious games, immersive virtual worlds and virtual humans, technology and the developing world, information and social network visualization, security and privacy, participatory media including web video technologies, simulation, law and information policy, and novel input and display devices. We partner with other research centers on the Stanford campus that address related issues.

A crossroads for interdisciplinary research

H-STAR is a crossroads for people, expertise, projects and programs that connect Stanford resources in human sciences with research and innovation about information technology. The social problems found at this intersection are significant, challenging, and in flux, in part because there is no social equivalent to Moore's Law—technological capabilities are expanding far more rapidly than social and cultural adaptations to their properties and prospects. At the individual level, technology is difficult to use, limiting its potential benefits: it can join people—but also separate them; it can teach—but also distract and create new inequities; and it can accelerate work and life—but also interfere and overwhelm. At the social level, technology both threatens and enhances our security, whether in the home, community or workplace. The "digital divide" highlights how information technology is distributed unevenly on the basis of economics, knowledge, language, and culture. And technology is a primary business force that can make products and services better, cheaper, and faster, while also transforming their fundamental character in disruptive waves that create new marketplaces and communication revolutions.

H-STAR addresses these individual and societal challenges with research and innovation that preserves the details, literatures, and methods of traditional disciplines while benefiting from the emergent synergies and surprises that come from interdisciplinary ventures. The human science literatures represented in H-STAR include the cognitive sciences and neurosciences, linguistics, logic, symbolic systems, learning sciences and education, philosophy, sociological and anthropological studies of social interaction mediated by technologies, information processing, emotions, persuasion and rhetoric, visualization and vision sciences, and work about oral, written, visual and musical production. The information technologies that H-STAR influences include computing and media systems of all shapes and sizes that can understand and produce language, faces, gestures and emotions, and systems that can automate human-machine dialogue, display information in different formats and sizes, and create collaborative work and learning spaces, incorporating agents, avatars, gaming, and immersive environments.

A global need

For the first time in human history, we are in a position to largely eradicate famine and poverty, and create a world in which everyone has an opportunity for a long, enjoyable, and productive life. The key is not charity (though there may always be a need for the better off to help the less fortunate), but the wise development and application of science and technology, fueled by both public government and private foundation support and commercial profit.

Thanks largely to the rapid advances in science and technology over the second half of the twentieth century, we now have the basic scientific and technological know-how to ensure that every living person has access to clean water, adequate food supplies, global information, and worldwide communications. What we do not yet have is the knowledge to provide these key components in ways that everyone can use. Just because a twelve-year old middle class child in Palo Alto can surf the Web and find a description of the medication he or she has just been prescribed does not mean that a thirty-five-year-old father of four in rural India or sub-Saharan Africa would know how to do it even if given the access.

Today's technologies are powerful and remarkably pliant in the hands of those who are both literate and sufficiently savvy to use them. But much of their power is lost on over half the world's population. The people for whom these technologies would be most transformative are the ones who, even if they had physical access, would not be able to use them.

In theory, there are two ways out of this dilemma. One is to embark on a worldwide program of universal literacy and technological skill acquisition. The other is to design the technologies such that they can be used by any human being. The first option is a great dream, but likely to remain that for some decades to

come. The second option can be pursued now. Current technologies are designed largely for consumers who are literate and familiar with using similar devices. Designers, by and large, design things to be used by people not unlike themselves. They have to, since those are the only users they really know. For what is missing is deep, fundamental understanding of how people use technology and knowledge of how to design for use by people coming from different backgrounds.

For example, the user experience innovations of the Apple Macintosh interface (significantly influencing Microsoft Windows) made computers accessible and usable to people who knew nothing about programming or how computers worked. But they had to be familiar with a (regular, physical) desktop. There is no reason why we cannot make computers usable to individuals who are not even literate. We need to figure out how to do it.

But it's not just the developing world that can benefit from greater understanding of how people work with technology. Every one of us is regularly frustrated by technologies that are difficult to operate or that make us feel inept. We drive cars that sometimes collide, although the technology exists to make that a virtual impossibility. (The challenge is integrating it safely into the driving experience in a way that drivers are comfortable with.) We find ourselves frustrated by websites and automated phone systems that are cumbersome to negotiate. And a massive population bulge of aging people is already starting to highlight still more problems with technology.

There is no shortage of smart people with good ideas for how to improve things, but much of the activity today consists of isolated, scatter-shot projects. What is needed is a deep, solid science of how people use technologies, on which future developments can build. H-STAR sets its sights on this hugely important goal.

Building on a tradition of innovation

H-STAR was created in 2005-06 by faculty from two interdisciplinary university centers: CSLI (Center for the Study of Language and Information) and SCIL (Stanford Center for Innovations in Learning), with the intention of continuing and building on the long tradition of innovative research for which both centers are known, but with the much broader scope required to tackle the major people-technology problems of today.

CSLI

CSLI was founded in 1983, with initial funding from the System Development Foundation (a nonprofit spinoff from the RAND Corporation) to investigate fundamental issues of language from the different perspectives of linguistics, mathematical logic, philosophy, and computation. After merging with SCIL to create H-STAR, CSLI was re-established as a separate laboratory in fall 2008.

SCIL

The Stanford Center for Innovations in Learning (SCIL) was founded in late 2001 with a focus on research directed to inventing the future of learning and establishing a center of excellence to conduct scholarly research for advancing the sciences, technologies, and practices of learning to support K-12 and college level learning and teaching. It was launched in part with a Hewlett Foundation Institutional Development Grant, Presidential Funds, and a number of National Science Foundation grants. SCIL ceased to operate as a separate institute in 2011. Projects that would formerly have been conducted within SCIL are now carried out in the H-STAR Institute.

Wallenberg Hall

H-STAR occupies research space on the fourth floor of Wallenberg Hall, a state-of-the-art research laboratory and testing ground for technology applications in the classroom. In addition to its research

focus, H-STAR also seeks to foster innovations in higher education that serve as practical applications of the sciences of learning. This goal is achieved by engaging Stanford faculty within Wallenberg Hall and beyond, as well as globally distributed partners, in researching and testing new pedagogical applications of current and emerging technologies in the context of their regular teaching responsibilities.

mediaX

In 2002, we launched mediaX, a University–Industry Partners Program that focuses on the initiation and support of interdisciplinary research of direct relevance to industry. All mediaX research is directed to issues that emerge from collaborative deliberations between the program's industry partners and H-STAR faculty and mediaX leadership. Industry partners help select the actual projects funded and are invited to participate in the research.

Although H-STAR was founded by faculty from the two centers CSLI and SCIL, its research scope is much broader than either. As mediaX grew in membership (the program currently has around 25 industry partners), so too did its research profile. We established H-STAR as a university research institute that focuses on the same broad spectrum of issues that emerged within mediaX. We believe that this kind of close involvement with leading industries is the way a cutting edge university should establish new units, if they are to be responsive to the needs of society and lead the way into interdisciplinary inquiries to tackle the complex problems facing the world of tomorrow.

Research centers and programs within H-STAR

H-STAR has a subunit that functions as a research center in its own right: SCIL (Stanford Center for Innovations in Learning).

H-STAR is home to several ongoing, large-scale innovative collaborative projects, including:

(1) **mediaX** (http://mediax.stanford.edu/). mediaX seeks to build bridges among scholars and thought leaders from influential companies to address questions of real importance within both academia and industry. Fundamental to the mediaX vision is the belief that the program serves two customers: industry partners that affiliate with the program, and the research community within Stanford University. mediaX currently has 24 industry partners, and has funded over $2m of Stanford research.

(2) **LIFE Center** (http://life-slc.org). LIFE (Learning in Informal and Formal Environments), located within SCIL, is one of four national Science of Learning Centers funded by the National Science Foundation ($42.2M for ten years through October 2014). The mission of the LIFE Center, a distributed center jointly developed and operated by Stanford University, the University of Washington, and SRI International, is to develop and test principles about the social foundations of human learning in informal and formal environments with the goal of enhancing human learning from infancy to adulthood. The center involves faculty and students from Education, Communication, and Psychology.

(3) **Persuasive Technology Lab** (http://captology.stanford.edu/). The Stanford Persuasive Technology Lab, directed by Dr. BJ Fogg, creates insight into how computing products - from websites to mobile phone software - can be designed to change what people believe and what they do, to bring about positive changes in many domains, including health, business, safety, and education. With such ends in mind, we are creating a body of expertise in the design, theory, and analysis of persuasive technologies, an area called *captology*.

(4) **Triple Helix Research Group** (http://triplehelix.stanford.edu/3helix_about_us). Originating as a metaphor acknowledging the key actors in innovation systems, the Triple Helix has developed into an internationally recognized model of university-industry-government interaction that is at the heart of the emerging discipline of innovation studies, and a guide to policy and practice at the local, regional, national

and multi-national levels. The Stanford Triple Helix group, within H-STAR, is led by Prof. Henry Etzkowitz and Dr. Marina Ranga.

(5) **AAAlab** (http://aaalab.stanford.edu). The AAAlab studies understanding and the ways that technology can facilitate its development. The lab works at the intersection of cognitive science, education, and computer science by examining and enhancing learning in individual, cross-cultura;, and technological settings. A theme throughout the research is how people's facility for spatial thinking can inform and influence processes of learning, instruction, assessment, and problem solving.

(6) **ARPA-e Project** (http://peec.stanford.edu/behavior/research/). This Department of Energy (ARPA-e) funded $6.2M project, carried out in collaboration with Stanford's Precourt Energy Efficiency Center, focuses on the development of an interactive software system that encourages people to be more energy efficient at home. The goal is to develop a comprehensive human-centered solution that leverages the anticipated widespread diffusion of energy sensors to significantly reduce and shift energy use, using a transformative system that combines behavioral techniques with human-centered design, computation, and technology to affect energy behavior. Involves 15 faculty and over 20 students from Psychology, Communication, Engineering, and the Medical School.

Stanford Research Centers Affiliated with H-STAR

(1) **Center for Foresight and Innovation** (http://foresight.stanford.edu/). CFI is a strategic think tank focusing on strategic planning, innovation management, and foresight engineering. Through a collaborative, team-based approach, the center helps companies find innovative, long-term strategies to put into action today, while also helping them build internal competencies and more effective decision-making processes to meet R&D challenges in the future.

(2) **Center for Design Research** (http://me.stanford.edu/research/centers/cdr/). CDR focuses on understanding and augmenting engineering design innovation and design education. The center is dedicated to facilitating individual creativity, understanding the team design process, and developing advanced tools and methods that promote superior design and manufacturing of products.

H-STAR and undergraduate education

As an interdisciplinary research center, H-STAR is not directly involved in undergraduate education. Intellectually, however, the interests of H-STAR are totally reflected in Stanford's Symbolic Systems Program, an interdisciplinary degree program administered in the School of Humanities and Sciences.

The declared goal of the Symbolic Systems Program (SSP) is to provide students with the vocabulary, theoretical background, and technical skills needed to understand and participate in contemporary interdisciplinary research about language, information, and intelligence — both human and machine — and to follow rewarding careers in the technology and information sciences fields.

The SSP curriculum combines traditional humanistic investigative approaches with contemporary developments in the science and technology of computation.

The SSP has consistently attracted some of the brightest students at Stanford. Typically over 30 students graduate from the program each year, and many of them go on to pursue successful careers in technology.

H-STAR and graduate education

H-STAR faculty are regularly involved in teaching courses and mentoring graduate students in the learning sciences and technologies programs of the Stanford University School of Education, and their research

preparation is commonly advanced through apprenticeship learning in research and development projects of H-STAR programs and grants.

Learning Sciences and Technology Design (Ph.D.)

Students in the Learning Sciences and Technology Design Ph.D. program complete foundational research on learning, and they design innovative learning technologies. Graduates of the program will take leadership positions as faculty, research scientists in universities and companies, designers and evaluators of formal and informal learning environments, and in learning technology policy-making.

Learning Design and Technology (MA)

The LDT masters program, launched in 1997, was established in response to a need for more educationally valuable interactive learning materials and environments. Our vision has been to prepare entry-level designers who would bring powerful contemporary ideas about learning to the design of technology-based products, settings, and social arrangements for learning.

LDT graduates are prepared to work in teams with content specialists, artists, programmers, and managers to design effective technology- based products and environments for various learning settings, including schools, museums and other community education agencies, educational developers, and agencies that design continuing professional education.

The LDT program is intended for persons who aim to develop new and better ways to use information technology for learning. It is a one year program of graduate study at Stanford University leading to the degree of Master of Arts in Education. It consists of four consecutive academic quarters of study beginning in autumn, and totaling 45 units. It includes a project-oriented, year-long internship seminar, required and elective courses in education, computer science, and other departments, plus an internship, a major project and a portfolio.

Human-Computer Interaction (MS)

Stanford's world famous Computer Science Department offers masters degree programs in a number of areas of specialization. One of these, Human-Computer Interaction (HCI) is within the academic area spanned by H-STAR and is taught by faculty active in H-STAR. Typical issues addressed by HCI are: ‘How do you design for users?’ and ‘Is a keyboard and mouse the best we can do?’

HCI spans interfaces from large wall-size computing down to handheld devices and invisible “ubiquitous computers”. The HCI masters program teaches user-centered design thinking and methods for user studies. HCI research applies to areas like collaborative work, information visualization, and “tangible computing”.

For further information

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