**TESTIMONY OF THE
COMPUTING RESEARCH ASSOCIATION**

**FOR THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
HEARING ON**

"The Globalization of R&D and Innovation"

June 12, 2007

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Thank you, Chairman Gordon and Ranking Member Hall, for convening this hearing and for your committee's continued support of the U.S. science and engineering enterprise. In organizing this hearing the committee has identified a number of important issues and concerns surrounding the globalization of research and development work, including the implications for the U.S. science and engineering pipeline and its impact on the nation's future competitiveness. As an organization representing more than 200 PhD-granting university computer science and computer engineering departments, 26 industrial research labs, and six affiliated computing societies, the Computing Research Association (CRA) shares your concerns and hopes that, through this testimony and future interactions, we can help provide valuable input to the committee as it seeks to understand these issues.

CRA is primarily focused on the health of the computing research community in North America. As a result, we are an organization with a deep interest in the U.S. educational system, because that is the pipeline by which U.S. research strength is maintained. We are therefore concerned not only with the effects of globalization on first-order effects of investment in R&D, but on the larger system of knowledge discovery and application, including the educational pipeline. Our testimony will be focused on three relevant "Issues and Questions" raised by the committee in its comprehensive Hearing Charter.

Issue One

Does offshoring of science and engineering lead to lesser spillover benefits from R&D?
The primary rationale for government subsidies of R&D is the capture of downstream benefits by companies operating in the U.S. Does offshoring of science and engineering work mean that those benefits are more likely to quickly leak outside the country?

It is the nature of fundamental research to "leak" across borders – science does not move forward without this free flow of ideas. However, capitalizing on the fruits of this research requires creating an environment for innovation to flourish. Innovation requires a home where there is intellectual curiosity, respect for creativity, an environment that fosters experimentation and rewards for discovery. An obvious metaphor is of tossing seeds in a field. If the field is fertilized, plowed and kept well-irrigated, you get a crop; if not, the only sprouts are accidental, or in another field where the wind carries them.

Indeed, as the amount of research performed elsewhere increases, it is even more important that we nurture our own innovation ecosystem at home. The only way that we can take similar advantage of work done in other places in the world is if we have a vibrant, robust, and inspired national research enterprise here at home that is current in the same fields and able to understand

and follow-up what is being done elsewhere. Fortunately, the United States has an innovation ecosystem that remains the envy of the world – and a key piece of that ecosystem is the federal government's continued support for fundamental research, particularly at our universities and national labs.

There are many reasons that support for fundamental research is an appropriate role for the federal government and enormously beneficial to the nation. As representatives of the computing research community, the most obvious way for us to demonstrate this is to look at a case-study of our own field: information technology.

In IT, there is certainly a strong economic case to be made. The importance of computing research in enabling the new economy is well documented. The resulting advances in information technology have led to significant improvements in product design, development and distribution for American industry, provided instant communications for people worldwide, and enabled new scientific disciplines like bioinformatics and nanotechnology that show great promise in improving a whole range of health, security, and communications technologies. Federal Reserve Board Chairman Alan Greenspan has said that the growing use of information technology has been the distinguishing feature of this "pivotal period in American economic history." Recent analysis suggests that the remarkable growth the U.S. experienced between 1995 and 2002 was spurred by an increase in productivity enabled almost completely by factors related to IT. A report by the Information Technology and Innovation Foundation released in March 2007 noted: "In the new global economy information and communications technology (IT) is the major driver, not just of improved quality of life, but also of economic growth…In fact, in the United States IT was responsible for two-thirds of total factor growth in productivity between 1995 and 2002 and virtually all of the growth in labor productivity."

Information technology has also changed the conduct of research, becoming an essential third leg of scientific research – complementing theory and experiment with computational approaches. Innovations in computing and networking technologies are enabling scientific discovery across every scientific discipline – from mapping the human brain to modeling climatic change. Researchers, faced with research problems that are ever more complex and interdisciplinary in nature, are using IT to collaborate across the globe, simulate experiments, visualize large and complex datasets, and collect and manage massive amounts of data.

There is also a compelling national security case for federal support of fundamental research in IT R&D. Information technology is at the heart of our military's strategic advantage over our adversaries. "Network-centric warfare" – the ability of our military to collect, process and distribute information to all pieces on, above and around the modern battlefield – forms the core of our military's ability to maintain its dominant position, even over numerically superior enemies. The U.S. needs to continue to be at the leading edge of the IT sector if we are to preserve that technological advantage. Staying at that leading edge will require a continued supply of new ideas and, just as importantly, people – especially those who can be cleared to work on classified material. Both are products of U.S. universities.

The National Research Council noted this in a 1995 report when they found that a significant reason for the dramatic advance in IT and the subsequent increase in innovation and productivity is the "extraordinarily productive interplay of federally funded university research, federally and privately funded industrial research, and entrepreneurial companies founded and staffed by people who moved back and forth between universities and industry." That report, and a subsequent 1999 report by the President's Information Technology Advisory Committee (PITAC), emphasized the "spectacular" return on the federal investment in long-term IT research and development.

The 1995 NRC report, *Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure*, included a compelling graphic illustrating this spectacular return. The graphic was updated in 2002 and is included with this testimony. (See figure 1.)

It is worth a moment to consider the graphic. The graphic charts the development of technologies from their origins in industrial and federally-supported university R&D, to the introduction of the first commercial products, through the creation of billion-dollar industries and markets. The original 1995 report identified 9 of these multibillion-dollar IT industries (the categories on the left side of the graphic). Seven years later, the number of examples had grown to 19 – multibillion-dollar industries that are transforming our lives and driving our economy. If the chart were to be redone today, at least three new billion-dollar sectors would need to be added: search technologies, social networking, and internet video. Every one of these multibillion-dollar sectors bears the stamp of federally supported research.

But one important aspect of federally-supported university research that is only hinted at in the flow of arrows on this complex graphic is that it produces people – researchers and practitioners

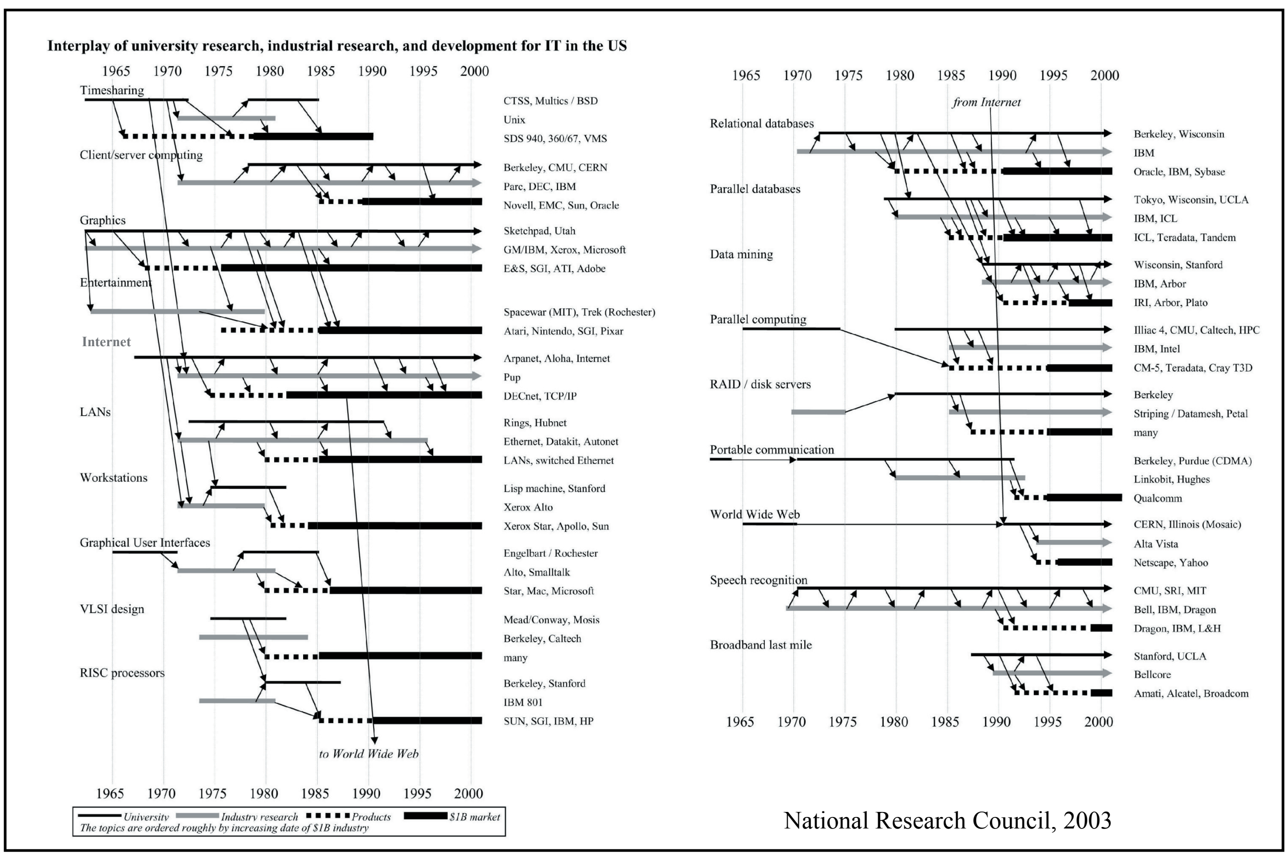

Figure 1.

– as well as ideas. This is especially important given the current outlook for IT jobs in the coming decade. Despite current concerns about offshoring and the end of the IT boom times, the U.S. Bureau of Labor Statistics in 2005 released projections that continue to show a huge projected shortfall in IT workers over the next 10 years. As figure 2 illustrates, the vast majority of the entire projected workforce shortfall in all of science and engineering is in information technology. These are jobs that require a Bachelors-level education or greater. In addition to people, university research also produces tangible products, such as free software and programming tools, which are heavily relied upon in the commercial and defense sectors. Continued support of university research is therefore crucially important in keeping the fires of innovation lit here in the U.S.

Also required is for the U.S. to continue to be well positioned to attract the best minds and talent in the world. Failing to do so will put us at a serious competitive disadvantage. Right now, our university system ranks as the finest in the world, continuing to be a magnet drawing the best talent to our shores. A recent report by the Ewing Marion Kauffman Foundation emphasizes this, finding that a quarter of technology and engineering companies launched in the U.S. between 1995 and 2005 had at least one foreign-born founder, and the majority of those foreign-born entrepreneurs came to the U.S. to attend a U.S. university.[1] These enterprises generated $52 billion in 2005 and provided jobs to more than 450,000 workers.

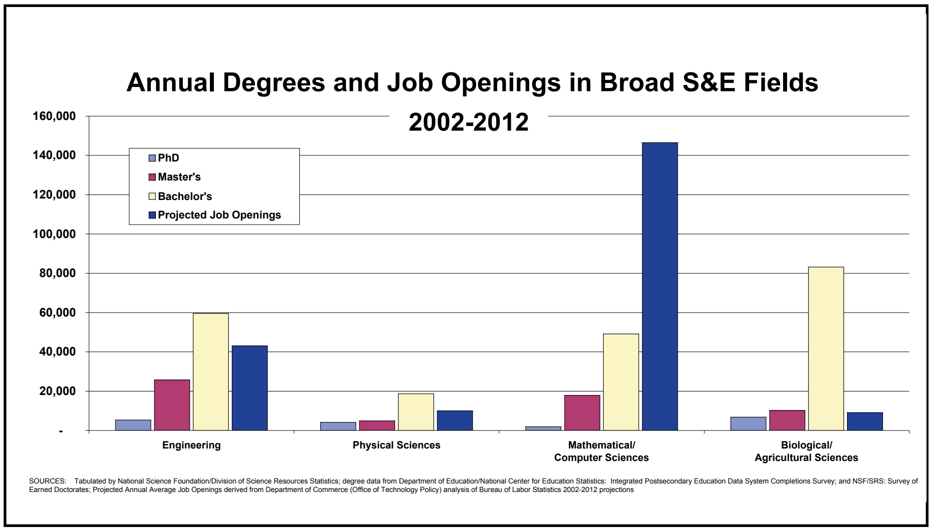

Figure 2.

Issue Two

What STEM fields are most vulnerable?

Computer science undergraduate enrollments are down 40 percent in the past four years, but not because our K-12 education system has not adequately prepared students. Instead, the culprit has been fear by students that their future jobs might be offshored. Is this fear well-founded? Students, educators and workers need better data and estimates to make informed career and educational choices. How do we ensure that STEM fields are still attractive?

In the case of computer science, the prevailing perception of the problem appears to be far more serious than the problem itself. In 2004, the Association for Computing Machinery (ACM) sponsored a Job Migration Task Force to examine the issue of the globalization and offshoring of software. After an extensive review of all the available studies and data, the task force released a re-

[1] http://www.kauffman.org/items.cfm?itemID=869

port[2] in 2006 that found that the impact of offshoring on the U.S. IT jobs had been overstated – it then affected only 2 to 3 percent of the overall IT workforce – and that, in truth, the job market in IT in the U.S. was really quite strong. In fact, the Task Force found that, despite perceptions to the contrary, more people in the U.S. were working in IT fields in 2005 than at the height of the "dot com" boom (Nov 2000). The most recent projections from the U.S. Department of Labor, Bureau of Labor Statistics, also suggest that, despite an assumed rise in the use of offshore outsourcing, job growth in the IT sector will dwarf growth in all other science and engineering disciplines. (See figure 2)

Yet perceptions of the IT job market are far more pessimistic than these figures would suggest they should be – and it appears that those perceptions have had an impact on the number of students enrolling in computer science programs. While this is cause for concern within the computing community – and indeed, has triggered much discussion and activity, including efforts to work with schools and policymakers to help improve the "pipeline" of students from grades K-12 into science and engineering disciplines, to revamping undergraduate curriculum to attract more good students into CS – it is also necessary to keep some perspective. Student demand in the field has historically been cyclic (see figure 3) and the latest data appears to show enrollments beginning to rebound. Also, the number of computer science bachelors degrees granted in 2005 were more than all the other physical and mathematical sciences degrees combined.

And while it is clear that perceptions about the current and future state of the job market are likely impacting interest in computer science (or science and engineering, generally) among incoming college freshman, it is not clear that those perceptions are the sole factors, or even the primary ones in influencing student interest. The computing community is also looking at other aspects of the issue, including a poor "image" of what a career in computing is really like, and the need to do a better job evangelizing the richness of the field's intellectual footing and the grand challenges yet left to be solved. In this effort the computing community is not alone. Across the science and engineering disciplines, task forces, committee, panels, workshops are being convened and pushed forward in an effort to increase the participation of American students in science and engineering. Congress can be helpful in this effort by supporting efforts to reach populations that are currently underrepresented in science and engineering and by demonstrating a continued commitment to the federal fundamental research enterprise.

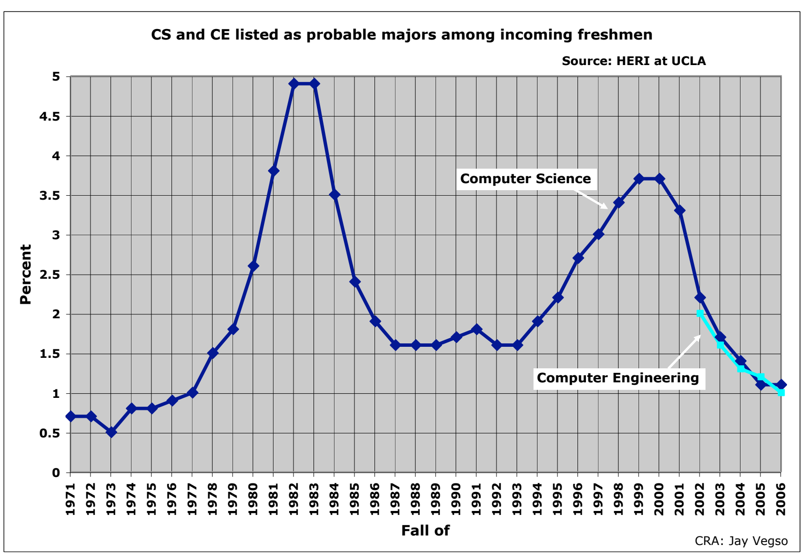

Figure 3.

Issue Three

Should we be investing in all STEM fields or only those where we expect will be rooted in America?

Should a reallocation of resources be made to concentrate efforts on the fields that are most likely to stay in the U.S. Should educators

[2] Available at http://www.acm.org/globalizationreport/

adjust their curricula to teach skills that buffer workers from offshoring? If so, what content should it have?

The United States has the world's largest economy and the world's best system of higher education and research training. We are unique in the world in our ability to lead the world in a wide array of science and technology areas. This is not merely a special opportunity for the US to show global leadership – though it is that and we have been leaders for many decades. It is in our own self-interest. We prevailed during the perilous risks of the second half of the 20th century in large part because of our technological superiority. The challenges we face now are no less grave, and we will depend on technological superiority even more than in the past to see our way through. This does not mean we can or should go it alone – science and technology are increasingly global, and so are the problems we must confront. We are already partnering with others, and this partnering will grow. But we still have a leadership role to play in helping to show the way, finding the right mix of technological strength and moral purpose so that our technological solutions to global problems also reinforce our democratic values. To lead in this way, we must be superior in our knowledge of where the science and technology is going – and this comes only through maintaining research and development strengths in all the fields of importance to our welfare.

Thank you for the opportunity to provide input to the committee on this important issue. Globalization is already bringing considerable change to the U.S. innovation ecosystem. If we are to ensure the nation’s continued global leadership and the continued high standard of living of Americans, we must ensure that all elements of that ecosystem are poised to take advantage of the opportunities created by those changes. We would counsel you to recommit to support for all STEM disciplines. The US is in an ideal position to capitalize on new discoveries wherever they are made in the world, but this requires that we continue to have a robust, innovative and broadly-based R&D infrastructure of our own. The best way to cope with globalization is not to retreat from some fields, but to increase our efforts and thus maintain leadership.