Assisting Universities in Developing Cyberinfrastructure Strategies

for Research and Education

The Opportunity and the Challenge

It is becoming increasingly clear that we are approaching an inflection point in the potential of rapidly evolving information and communications technology to transform how the scientific and engineering enterprise does knowledge work, the nature of the problems it undertakes, and the broadening of those able to participate in research activities. To quote the conclusion of the recent NSF Blue Ribbon Advisory Panel on Cyberinfrastructure,

"A new age has dawned in scientific and engineering research, pushed by continuing progress in computing, information, and communication technology, and pulled by the expanding complexity, scope, and scale of today's challenges. The capacity of this technology has crossed thresholds that now make possible a comprehensive 'cyberinfrastructure' on which to build new types of scientific and engineering knowledge environments and organizations and to pursue research in new ways and with increased efficacy. Such environments and organizations, enabled by cyberinfrastructture, are increasing required to address national and global priorities. The emerging vision is to use cyberinfrastructure to build more ubiquitous, comprehensive digital environments that become interactive and functionally complete for research communities in terms of people, data, information, tools, and instruments and that operate at unprecedented levels of computational, storage, and data transfer capacity. Increasingly, new types of scientific organizations and support environments for science are essential, not optional, to the aspirations of research communities and to broadening participation in those communities. They can serve individuals, teams, and organizations in ways that revolutionize what they can do, how they do it, and who participations. This vision has profound broader implications for education,

commerce, and social good."[1]

While promising significant new opportunities for scientific and engineering research and education, the emergence of such cyberinfrastructures will also pose considerable challenges as they drive profound transformations in existing organizations such as universities, national and corporate research laboratories, and funding agencies such as NSF. Here it is important to recognize that the implementation of such new technologies involve social and organizational issues as much as they do technology itself. Although the domain-specific science and engineering directorates of NSF, operating through the traditional bottom-up process of investor-proposed projects, should play the lead role in responding to the opportunities and challenges of cyberinfrastructure, there is a clear need to involve and stimulate as well those organizations that span disciplinary lines and integrate scholarship and learning. Perhaps the most important such organization is the research university, which despite the potential of new CI-based structures, will continue to be the primary institution for educating, developing, and sustaining the American scientific and engineering enterprise. Furthermore, because the contemporary research university not only spans the full range of academic disciplines but as well as the multiple missions of education, scholarship, and service to society, it can–indeed, it must–serve as the primary source of the threads that stitch together the various domain-focused efforts of the NSF CI program.

Hence, beyond the opportunity and challenge facing NSF in developing new CI programs for the scientific and engineering communities through the traditional research programs conducted by directorates, it is our belief that NSF also has a major responsibility to assist research universities in developing CI strategies that enable them to take advantage of these rapidly evolving technologies that both align with and sustain NSF programs. That is, beyond focusing its efforts on the research projects of investigators through conventional directorate programs, the success of the advanced CI effort will require as well a parallel investment in the capacity of the host universities to explore and develop new CI-based activities across the full spectrum of institutional programs and activities. Indeed, without such a parallel effort, the NSF CI effort is unlikely to succeed, since the existing culture, structure, and function of the research university will likely resist and possibly reject emerging cyberinfrastructure efforts that

challenge the status quo.

The IT Forum of the National Academies

For the past three years the National Academies have worked closely with university leaders and national university organizations such as the AAU, ACE, and NASULCG to study the implications of rapidly evolving digital technology for the future of higher education. The early effort, sponsored directly by the National Academies, took the form of a SWAT analysis to understand more clearly the likely development of information technologies in the near term (a decade or less), the potential impact of such technologies for the activities and organization research university, and the implications for public policy.[2] More recently, a grant from the Atlantic Philanthropies has allowed the National Academies to extend this effort to involve directly a large number of research universities by 1) creating a National Academy Forum on Information Technology and Research University to track both the technology and identify the key issues, 2) conducting a series of workshops for university presidents and chief academic officers in an effort to help them understand better the transformational nature of these technologies and the importance of developing strategic visions for the future of their institutions, and 3) raise the awareness of research sponsors such as nonprofit foundation and government agencies as to potential of these technologies for harnessing research universities to better address national and global priorities. These events revealed not only a broad interest in and awareness of the importance of these issues, but a willingness to explore new paradigms such as national consortia, open-source projects, and knowledge commons. It was our sense that the leadership of the research universities is prepared to undertake major efforts and consider very substantial changes (in organization, function, and culture) to respond to the opportunities and challenges posed by information technology. But first they need help in identifying suitable visions for their future.

A Proposed Role for the National Academies

The National Academies are unique in their abilities to convene key members of the scientific and engineering community (both people and institutions), facilitate their interaction, deepen their understanding of complex issues, capture their ideas, and provide feedback to national agencies such as the NSF. To this end, the National Academies seek support for a major effort to build the capacity of universities to develop innovative visions for institutional (or multi-institutional) cyberinfrastructures, to provide feedback to the NSF that will prove useful to their advanced cyberinfrastructure program, and to build understanding and support among the university community for these important NSF ACI efforts.

More specifically, using the IT Forum as a convening device, the National Academies would host a series of workshops during 2004-2005 for roughly two dozen leading research universities, in which their executive leadership cores (president, provost, VPCFO, CIO, and other executive leaders) would be brought together in groups of 5-6 institutions to discuss and compare IT strategies. Here it should be noted that the workshops for university presidents and provosts held in 2003 suggested that this procedss could be of immense value to institutions not only in sharing best practices but also in building communication channels now missing within most universities.

Next, the IT Forum would conduct a series of campus-based, grass-roots conversations among faculty, students, and administrators concerning IT strategies in 2005 and 2006, using the townhall meeting format developed in the mid-1990s by the National Science Board and the National Academies for a consideration of the concerns of primary investigators. Here the primary intent would be to encourage deep conversations and stimulate experimentation concerning cyberinfrastructure on the campuses and to capture ideas and perspectives that could be of use to NSF in their advanced CI programs. A number of research universities have already expressed strong interest to the IT Forum in such activities and volunteered to participate in such events.

In 2006, the National Academies would sponsor a major convocation bringing together representatives from the institutions participating in the executive core leadership retreats and campus dialogues, along with representatives from federal agencies, congressional staff, foundations, industry, and other higher education constituents. The convocation would both facilitate and frame discussion of next steps as well as provide feedback to the NSF and other sponsors and participants in advanced

CI efforts.

To coordinate these efforts, while continuing to track the evolution of information and communications technologies of particular relevance to the research, education, and service missions of the university, the National Academies also seeks support for the IT Forum itself for a three year period (2005-2007).

Concluding Remarks

The Blue Ribbon Advisory Panel on Cyberinfrastructure noted its belief that "the National Science Foundation has a once-in-a-generation opportunity to lead the revolution in science and engineering through coordinated development and expansive use of cyberinfracture". Yet for the advanced cyberinfrastructure program to be successful, it must extend beyond the support of investigators and projects in domain-specific science and engineering research to include parallel efforts in stimulating institutional capacity.

During the past three years the National Academies have worked closely with the research university community to stimulate conversations on these issues and raise awareness of the opportunities and challenges posed by rapidly evolving information and communications technologies through its projects concerning "The Impact of Information Technology on the Future of the Research University" and the "IT Forum". NSF support of both the IT Forum and a series of university leadership core and campus based workshops could be an important step in moving to the next level to help universities develop CI strategies, provide important feedback to NSF as the advanced CI program evolves, and build support among the research university community for these NSF efforts. As in the past, the ideas generated in these campus-based workshops and conversations will likely stretch the vision for advanced CI development, stimulating the NSF to think and act outside of the box.

Finally, it should also be noted that since universities have broad missions impacting many of the responsibilities of the National Science Foundation, such as education and future scientific and engineering workforce development, extending educational and research opportunities to underserved communities, and transferring the results of campus-based activities to serve society, such an NSF-sponsored effort

would have considerable leverage.

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[1] Atkins, D. (chair), (2003). *Revolutionizing Science and Engineering Through Cyberinfrastructure*, Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure. National Science Foundation, Washington, DC.

[2] *Preparing for the Revolution: Information Technology and the Future of the Research University*, National Research Council (National Academy Press, Washington, 2002) 80 pp.