Summary Document

The National Academies' Project on the
Impact of Information Technology
on the Future of the Research University

Today our society is being reshaped by the rapid advances in information technology: computers, telecommunications, networks, and other digital technologies. Modern digital technologies have increased vastly our capacity to know and to do things and to communicate and collaborate with others. They allow us to transmit information quickly and widely, linking distant places and diverse areas of endeavor in productive new ways. This technology allows us to form and sustain communities for work, play, and learning in ways unimaginable just a decade ago. Information technology changes the relationship between people and knowledge. It is likely to reshape in profound ways knowledge-based institutions such as our colleges and universities.

Of course higher education has already experienced significant change driven by digital technology. Our management and administrative processes are heavily dependent upon this technology. Research and scholarship are also highly dependent upon information technology, for example, the use of computers to simulate physical phenomena, networks to link investigators in virtual laboratories or "collaboratories," and digital libraries to provide scholars with access to knowledge resources. There is an increasing sense that new technology will also have a profound impact on teaching, freeing the classroom from the constraints of space and time and enriching learning of by providing our students with access to original source materials.

Yet, while information technology has the capacity to enhance and enrich teaching and scholarship, it also poses certain threats to our colleges and universities. We can now use powerful computers and networks to deliver educational services to anyone, anyplace, anytime, no longer confined to the campus or the academic schedule. Technology is creating an open learning environment in which the student has evolved into an active learner and consumer of educational services. Faculty loyalty is shifting from campus communities and universities to scholarly communities distributed in cyberspace. The increasing demand for advanced education and research from a knowledge driven society, the appearance of new for-profit competitors, and technological innovations are stimulating the growth of powerful market forces that could dramatically reshape the higher education enterprise.

In response to these concerns, last year the presidents of the National Academies (National Academy of Science, National Academy of Engineering, and Institute of Medicine) launched a project to understand better the implications of information technology for the future of the research university. The premise of the National Academies study is a simple one: The rapid evolution of digital technology will present many challenges and opportunities to higher education in general and the research university in particular. Yet there is an increasing sense that many of the most significant

issues are neither well recognized nor understood either by leaders of our universities or those who support and depend upon their activities.

The first phase of the project, funded from internal Academy funds and organized under the Government-University-Industry Research Roundtable (GUIRR), was aimed at addressing three sets of issues: 1) To identify those technologies likely to evolve in the near term (a decade or less) which could have major impact on the research university; 2) To examine the possible implications of these technology scenarios for the research university: its activities (teaching, research, service, outreach); the organization, structure, management, financing of the university; and the impact on the broader higher education enterprise and the environment in which it functions. 3) To determine what role, if any, there is for the federal government and other stakeholders in the development of policies, programs, and investments to protect the valuable role and contributions of the university during this period of change.

To this end, a Steering Committee to guide the project was formed last year consisting of leaders drawn from industry, higher education, and government with expertise in the areas of information technology, research universities, and public policy. Since first convening in February 2000, the Steering Committee has held several meetings (including site visits to major technology development centers such as Lucent (Bell) Laboratories and IBM Research Laboratories) and held numerous conference calls to identify and discuss trends, issues, and possible recommendations. The key themes addressed by these activities were:

- The pace of evolution of information technology (e.g., Moore's Law).
- The ubiquitous/pervasive character of the Internet (e.g., wireless, photonics).
- The relaxation (or obliteration) of the conventional constraints of space, time, and monopoly.
- The democratizing character of IT (access to information, education, research).
- The changing ways we handle digital data, information, and knowledge.
- The growing importance of intellectual capital relative to physical or financial capital.

In January 2001 a two-day workshop was held at the National Academies with invited participation of over 100 leaders from technology, higher education, and government. The purpose of the workshop was to stimulate a conversation, to launch a dialog, aimed at identifying key themes and issues, to suggest possible recommendations and strategies for research universities and their various stakeholders, and to provide guidance on the next phase of the project. The key presentations and discussion of the workshop were videotaped and broadcast on the Research Channel and video-streamed from its website during the spring to serve as an archive for further discussion.

Although the project is still in an early phase, there are already some important preliminary conclusions:

1. The extraordinary evolutionary pace of information technology is likely not only to continue for the next several decades, but it could well accelerate on a superexponential slope. Photonic technology is evolving at twice the rate of silicon chip technology (e.g., Moore's Law), with miniaturization and wireless technology moving even faster, implying that the rate of growth of network appliances will be incredible. For planning purposes, we can assume that within the decade we will have infinite bandwidth and infinite processing power (at least compared to current capabilities).

2. The event horizons are moving ever closer. Getting people to think about the implications of accelerating technology learning curves as well as technology cost-performance curves is very important. There are likely to be major technology surprises, comparable in significance to the PC in 1980 and the Internet browser in 1994, but at more frequent intervals. The future is becoming less certain.

3. The impact of information technology on the university will likely be profound, rapid, and discontinous–just as it has been and will continue to be for the economy, our society, and our social institutions (e.g., corporations, governments, and learning institutions). It will affect our activities (teaching, research, outreach), our organizations (academic structure, faculty culture, financing and management), and the broader higher education enterprise as it evolves into a global knowledge and learning industry.

4. For at least the near term, meaning a decade or less, the research university will continue to exist in much its present form, although meeting the challenge of emerging competitors in the marketplace will demand significant changes in how we teach, how we conduct scholarship, and how our institutions are financed. Universities must anticipate these forces, develop appropriate strategies, and make adequate investments if they are to prosper during this period.

5. Over the longer term, the basic character and structure of the research university may be challenged by the IT-driven forces of aggregation (e.g., new alliances, restructuring of the academic marketplace into a global learning and knowledge industry) and disaggregation (e.g., restructuring of the academic disciplines, detachment of faculty and students from particular universities, decoupling of research and education).

6. Procrastination and inaction are the most dangerous courses for colleges and universities during a time of rapid technological change. To be sure, there are certain ancient values and traditions of the university that should be maintained and protected, such as academic freedom, a rational spirit of inquiry, and liberal learning. But, just as in earlier times, the university will have to transform itself to serve a radically changing world if it is to sustain these important values and roles.

7. Although we feel confident that information technology will continue its rapid evolution for the foreseeable future, it is far more difficult to predict the impact of this technology on human behavior and upon social institutions such as the university. It is important that higher education develop mechanisms to sense the changes that are being driven by information technology and to understand where these forces may drive the university.

8. Because of the profound yet unpredictable impact of this technology, it is important that institutional strategies include : 1) the opportunity for experimentation, 2) the formation of alliances both with other academic institutions as well as with for-profit and government organizations, and 3) the development of sufficient in-house expertise among the faculty and staff to track technological trends and assess various courses of action.

9. In summary, for the near term (meaning a decade or less), we anticipate that information technology will drive comprehensible if rapid, profound, and discontinuous change in the university. For the longer term (two decades and beyond), all bets are off. The implications of a million-fold increase in the power of information technology are difficult to even imagine, much less predict.

Possible Issues and Questions Identified by the ITFRU Project

Concerning the Activities of the University

1. What will be the impact of this technology on the basic activities of the university, upon teaching and research?

2. How should the university integrate information technology into its educational programs at the undergraduate, graduate, and professional school level?

3. Will e-learning environments affect traditional teacher-centered instruction and promote more student-centered learning? How will the residential campus experience be affected? Will the classroom disappear?

4. Just-in-time lifelong learning and the growing desire to be educated anyplace, anytime are driving the demand for distributed education. How should the university approach the challenges and opportunities of IT-based distributed learning? What role should third-party content providers play? Should institutions partner with others to develop "virtual universities" and who might those partners include?

5. Will information technology alter the priorities among various university activities, e.g., the balance of educational activities related to socializing high school graduates

compared to the rapid growth in the need for advanced education of adults in the high performance workplace?

6. Has information technology brought us to an inflection point in recasting the social contract for scientific research and in finding and utilizing new tools and methods for tackling major research problems?

Concerning the Organization, Management, and Financing of the University

1. What kind of information technology infrastructure (hardware, software, staffing) will the research university need?

2. How will it finance the acquisition and maintenance of this infrastructure?

3. How should the university approach its operations and management to best take advantage of this technology?

4. How can institutions better link planning and decision making with likely technological developments and challenges?

5. How do university leaders get the attention of faculty and governing boards concerning the imperative nature of these issues?

6. What role should the faculty play in making the key decisions concerning IT issues? Are faculties motivated to adopt IT? What is the primary barrier to faculty adoption of technology?

7. How can one provide students, faculty, and staff with the necessary training, support, and equipment to keep pace with the rapid evolution of information technology?

8. What policies does the university need to reconsider in light of evolving information technology (e.g., intellectual property, copyright, instructional content ownership, and faculty contracts)?

Concerning the Post-Secondary Education Enterprise

1. How do colleges and universities address the rapidly evolving commercial marketplace for educational services and content, including, in particular, the for-profit and dot.com providers?

2. What alliances are useful for colleges and universities in this rapidly changing environment? With other academic institutions? With business? On a regional, national, or global scale?

3. How can colleges and universities grapple with the forces of disaggregation and aggregation associated with a possible technology-driven restructuring of the higher education enterprise? Will universities be forced to merge into larger units as the corporate world has experienced? Will they find it necessary to outsource or spinoff existing activities?

4. Will more (or perhaps most) universities find themselves competing in a global marketplace, and how will that square with the responsibilities of publicly supported universities?

5. What is the role of universities with respect to the "digital divide", the stratification of our society with respect to access to technology?

Possible Recommendations from the ITFRU Project

> To Institutions

1. To whom should we address our recommendations? University presidents? Provosts, deans, and other academic leaders? Intellectual leaders of the faculty? Trustees?

2. What do university leaders need to understand?
    The nature of the IT forces driving the evolution of the university?
    Possible future scenarios? Or paths to possible futures?
    A long term strategic context for making near term decisions?

3. What are the key decisions that university leaders need to consider?
    The IT environments that faculty and students need (and will demand)?
    How institutions position themselves, e.g. bricks vs. clicks?
    Policies governing the ownership of intellectual property (including
        courseware)?
    How important are alliances…and for addressing which issues?

4. What should research universities strive to be?
    Leaders? If so, then how is leadership achieved and sustained?
    Competitive followers? What are the benefits and risks of a conservative
        approach?
    Is the status quo still an option for some institutions?

5. How do universities address the array of cultural issues?

The diversity among disciplines and faculty in IT needs?
How to institutionalize and sustain IT-based activities?

<u>To the Higher Education Enterprise</u>

1. What needs to be done by institutions? By consortia? By governments?

2. Who pays for IT infrastructure? Students? Taxpayers? Patrons?

3. Where is leadership likely to appear in IT-based education and scholarship?

4. What resources should be provided by consortia of universities or alliances with other sectors (commercial, government, foundations)?

<u>To the States and the Nation</u>

1. What are the state and national interests in keeping the universities on pace with evolving information technology?

2. What modifications in existing state and federal policies and investments are important or necessary for higher education to flourish in the digital age?

3. What new policies and programs need to be considered (e.g., a 21st Century Learn Grant Act or a Millennium Education Trust Fund)?

Possible Next Steps for the ITFRU Project

1. The project would create an ongoing roundtable forum of leaders from higher education, industry, foundations, and government who would track this technology and its implications for the research university and the broader higher education enterprise.. The current thinking is to form a group of 20 to 25 that would be organized initially under the National Academies' Government-University-Industry Research Roundtable.

2. The project would launch and conduct a series of conversations both on the campuses and among diverse groups (of colleges and universities, disciplines, faculty and students) to raise awareness and stimulate the development of strategies. In this phase, we would invite roughly two-dozen universities to participate, asking them to identify both faculty and senior administrators to serve as campus leaders, and designing and hosting a series of events such as, townhall meetings to bring together faculty, students, and administrators to discuss how individual campuses view the challenges and opportunities presented by digital technology and how they plan to respond. At least once per year, representatives of the participating campuses would gather in an extended colloquium/workshop to share perspectives and strategies. Subgroups would be formed to develop follow-up strategies

and actions (including possible alliances). Regular communications would be shared electronically using an interactive web portal.

3. Similarly, a series of workshops would also be organized to bring together academic leaders from diverse institutional types such as research universities, liberal arts colleges, and regional colleges and universities; deans from various academic and professional disciplines, leaders of faculty governance, and university trustees. Efforts would also be made to link together and coordinate a number of related projects concerning the impact of technology on the broader postsecondary education enterprise.

4. The project would conduct a series of more focused studies that will be faced by higher education (e.g., the new business models that may be required to support research and advanced education should the for-profit sector remove the cross-subsidy from high margin activities such as general education; to use technology to enhance teaching and scholarship, developing new business models for financing higher education that take into account growing competition from for-profit, online education).

5. The Roundtable, drawing heavily on input from the various groups and activities noted above, will identify demonstration projects that might serve to illustrate the impact of digital technology on the activities of the university. (e.g., the use of very high bandwidth technologies such as Internet2 to support new activities such as multicasting and telepresence; novel approaches to using technology to enhance teaching and learning; particularly innovative approaches to sustainable financing of IT infrastructure).

6. A result of the project would be the development of online resources such as web portals and knowledge environments that assist colleges and universities in understanding issues and making key decisions.