

Proposal
on
Exploration
of the
**"The Impact of Information Technology on the Future of
the American Research Enterprise"**
to
The National Science Foundation/National Science Board
from
National Research Council Executive Committee

The National Academies seek the participation and the support of the National Science Foundation and National Science Board in launching a small, exploratory effort to examine the implications of rapidly evolving information technology on the future of the American research enterprise.

Our nation's research enterprise consists of an array of organizations, including universities, national laboratories, and corporate R&D laboratories. These produce the fundamental new knowledge, the innovation, the new technology, and the human resources so necessary to the security, prosperity, and well being of our society. This enterprise has never been static, but evolves as changing needs and priorities over time demand a new social contract between those institutions charged with producing new knowledge and educated citizens and those who benefit from and support these activities.

At times this social contract is reflected in public policies. An example is the Morrill Act of the 19th Century that established the land grant colleges aimed at providing the technology and educating the workforce necessary for an industrial society. A second example is the government-university-research partnership of the past half-century, aimed principally at preserving our national security. In more recent times, this contract has been shaped by powerful market forces, such as the rapid pace and interconnected nature of the transformation of knowledge from laboratory discovery to commercial application.

Although the change in the character and priorities of our national research enterprise usually occurs at a gradual pace that allows our existing institutions to respond and adapt, there have been periods of punctuated evolution such as during World War II when the impact of science and technology led to the research paradigm articulated in Vannevar Bush's Science, *The Endless Frontier*. The exponential pace of advances in information technology-computers, networks, telecommunications-could well result in yet another such evolutionary punctuation point in the next decade, since this technology not only affects the way we create, store, propagate, and apply new knowledge, but it also reshapes the way we interact with one another and form knowledge-generating communities.

The effort proposed here would not focus specifically on the transforming influence of information technology on the nature of scholarship, R&D, and education but rather on its implications for the research enterprise itself: its components (i.e., the research university, the national laboratory, and the corporate R&D laboratory); its resources (i.e., human, physical, and

financial); and its organization. The current paradigm of the American research enterprise has remained relatively stable for the past half-century. What will it look like in the next several decades?

While it is likely that the core functions of the research enterprise—basic and applied research, advanced education and human resource development—will remain valued by our society, the particular way we organize, conduct, and support these activities may be changed dramatically by information technology. Among the many issues likely to be affected or transformed by information technology are: 1) the locus of basic research in universities, mission-focused research in national laboratories, and applied research in corporate R&D laboratories; 2) the manner in which we educate and train the next generation of researchers including the current model of coupling together research and graduate education in research universities; and 3) our mechanisms for funding research, i.e., through the use of merit-based, peer-review federal grants for basic research, line-item federal appropriations for mission-focused research, and market driven investments for industrial R&D. Furthermore, powerful new tools of information technology might change the very nature of the research enterprise and its participants, shifting it away from discipline-focused specialization to more integrative studies and perhaps even countering the trend toward professionalization of research and scholarship by encouraging the participation of talented persons working outside traditional structures.

One possible approach to such an effort would, first, be to draw on the insight of leaders in the information technology field to develop possible technological scenarios for the conduct and organization of research and education; and second, to understand just what functions, values, and characteristics of the existing research enterprise will be most subject to change in these scenarios and which are most important to preserve. Such an effort would also consider both the appropriateness of current federal, state, and institutional research policies and the need for future policies to ensure that the evolving research enterprise will be capable of addressing national needs. For example, if the new social contract for the century ahead continues the shift from national security to human resource development as its primary focus, as some suggest, then how might the evolving research enterprise be shaped to address this priority?

Since both the National Academies and the National Science Foundation/Board have Congressional mandates that include responsibility for the health of the science and engineering enterprise, we propose that these organizations form a small, exploratory group to examine the impact of information technology on the future of the American research enterprise. Of particular interest would be possible changes in the nature and function of the research enterprise and its implications for federal policy. A goal of this exploratory effort would be to frame a proposal for longer-term studies.

This exploratory group, comprised of individuals with experience in research policy, higher education, and information technology, would meet regularly during the next year to consider key issues and identify useful next steps. The Association of American Universities would also be a partner in this effort. We anticipate that these discussions would be augmented by other viewpoints, both through the invitation of other participants and the commissioning of study papers. One of the key elements of the dialogue would be a website that would facilitate broader participation.

Appendix:
Proposed Framework and Timetable

1.	Contract Agreement	July 1999
2.	Pre-meeting to Establish Exploratory Group*	August 1999
3.	Formal Project Initiation:	September 1, 1999
4.	First Full Meeting of Exploratory Group	September, 1999
5.	Information Gathering Meetings (four)	October 1999-April 2000
6.	Identification and Description of Study Paper Topics	May, 2000
7.	Initial Draft of Study Papers	August, 2000
8.	Summary Meeting on Future Directions	September 2000

* The names of the initial core group members to be invited to participate are listed below. The remainder of the committee to be invited to participate will be identified by the core group (and/or the process determined); and an initial approach to establish the elements that need to be included on the information gathering phase will be determined.

- James Duderstadt, Chair
- Rita Colwell
- John Seely Brown
- John D'Arms
- Marye Ann Fox
- Nils Hasselmo
- Douglas Van Houweling
- Eamon Kelly
- Frank Rhodes
- William Wulf (exofficio)
- Ray Fornes (senior staff)

Proposed Budget:

Item:

Senior Staff *

Administrative Assistant Support and Fringes (40%)	\$30,000
Telephone	\$1,500
Supplies, Printing, Postage	\$3,500
Computer Support/Website Support	\$10,000
Travel	\$60,000
Meeting Arrangement Costs	\$15,000
Miscellaneous	\$2,000
Report Preparation	<u>\$5,000</u>
Subtotal	\$125,000
Overhead (63.13% of Salaries, Fringes)	<u>\$18,939</u>
Total Direct Request from NSF	\$145,939

*Senior Staff: (A senior scientist currently in a major university will be recruited to staff the project on behalf of the NRC and NSF/NSB. The person is expected to have broad experiences as a research faculty and in research administration, and is to be supported by an IPA between NSF and his university. The person will be assigned to the NRC to staff the project, but will maintain a direct liaison role with the NSB.)

Cost Sharing: The NRC will provide an equipped office for the senior staff person assigned to the project.

Original text

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At times this social contract is reflected in public policies, such as the Land Grant Act of the 19th Century that aimed at providing the technology and educating the workforce necessary for an industrial society or the government-university-research partnership of the past half-century, aimed at preserving our national security. At other times, this contract has been shaped by powerful market forces, such as the rapid pace and interconnected nature of the transformation of knowledge from laboratory discovery to commercial application.

Although the change in the character and priorities of our national research enterprise usually occurs at a gradual pace that allows our existing institutions to respond and adapt, there have been periods of punctuated evolution such as during World War II when the impact of science and technology led to the research paradigm articulated in Vannevar Bush's Science, the Endless Frontier. The exponential pace of advances in information technology-computers, networks, telecommunications-could well result in yet another such evolutionary punctuation point in the next decade, since this technology not only affects the way we create, store, propagate, and apply new knowledge, but it also reshapes the way we interact with one another and form knowledge-generating communities.

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While it is likely that the core functions of the research enterprise-basic and applied research, advanced education and human resource development-will remain valued by our society, the particular way we organize, conduct, and support these activities may be changed dramatically by information technology. Among the many issues likely to be affected or transformed by information technology are: 1) the locus of basic research in universities, mission-focused research in national laboratories, and applied research in corporate R&D laboratories; 2) the current model of

coupling together research and graduate education in research universities; 3) our mechanisms for funding research, e.g., through the use of merit-based, peer-review federal grants for basic research, line-item federal appropriations for mission-focused research, and market-driven investments for industrial R&D; and 4) the manner in which we educate and train the next generation of researchers. Furthermore, powerful new tools of information technology might change the very nature of the research enterprise and its participants, shifting it away from discipline-focused specialization to more integrative studies and perhaps even countering the trend toward professionalization of research and scholarship by allowing the participation of talented amateurs once again.

One possible approach to such an effort would be to draw first on the insight of leaders in the information technology field to develop possible technological scenarios for the conduct and organization of research and education. Next, it is important to understand just what functions, values, and characteristics of the existing research enterprise will be most subject to change in these scenarios and which are most important to preserve. Such an effort would also consider both the appropriateness of current and the need for future federal, state, and institutional research policies to ensure that the evolving research enterprise will be capable of addressing national needs. For example, if the new social contract for the century ahead shifts from national security to human resource development as its primary focus, as some suggest, then how might the evolving research enterprise be shaped to address this priority?

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