

Highly interdependent organizations, different value systems, multiple business processes, and competing priorities characterize the research enterprise. These characteristics create opportunities for the enterprise, but they also present significant challenges. Some of these challenges are inherent in the nature of the enterprise, others reflect trends in the environment and their influences on the way research is conducted. The consequences of these challenges include inefficient resource utilization, missed opportunities to advance science, and reduced ability to garner public support for research.

### Inherent challenges

The research enterprise faces a number of challenges that arise from its dynamic, multi-organizational nature. They stem from the complexity of the interorganizational arena, from the rapid pace of technological change and the comparatively slow pace of organizational adaptation, and from conflicting concepts of risk.

**Organizational complexity and diversity**--Thousands of organizations with different management, technology, and policy frameworks and a wide variety of overlapping and distinct goals come together to make up the research enterprise. To some extent, these differences reflect different value propositions embedded in their individual missions and cultures. Consider these complementary, competing, and conflicting values which must be reconciled as organizations work across the enterprise: discovering new knowledge, producing practical value, conducting fair and open peer review, providing funding to the best scientists, providing opportunity to a broad range of scientists, ensuring resource availability, and achieving technical compliance and financial integrity.

Different work models and priorities among these organizations add both complexity and diversity. Some organizations are open and flexible, others are formal and structured. Some are slow to respond to change, others respond quickly to new ideas and discoveries. These different organizational designs and philosophies result in different approaches to work and different priorities with respect to the grants-funded research process. Some grants-making organizations are strongly committed to blind peer review to select the best projects. Others believe the best way to cultivate sound and important new research ideas is through ongoing working relationships between program officers and investigators. Some grants makers use both approaches. Some universities provide sophisticated administrative and technical support to researchers as they work with grants makers; others do not. Each grants-making organization deals with many different grantees, while a single grantee may need to respond to the missions and rules of multiple funders. Navigating through this web of rules and cultures adds costs and complexity to the entire system.

**Rapid technological change**--The research enterprise can take pride in technological progress. Modern technical tools and the work we can do with them are part of the legacy of scientific research. But technological change is also a source of frustration. The people, processes, and organizations that make up the research enterprise face the same issues that confront every other kind of organized endeavor. Past investments in technology create sunk costs and legacy systems which offer stable and consistent ways of working, but which eventually become barriers to the very new developments we most wish to adopt. Moreover, the many organizations within the enterprise make independent decisions about technology investments resulting in uneven infrastructure, inconsistent capacity to engage in electronic communications, and incompatible skills, standards, and work processes.

**Slow organizational and interorganizational adaptation to change**--The ways organizations define themselves, relate to the environment, approach their work, and select processes, tools, and techniques all evolve more slowly than the technology around them. The impacts of this reality are compounded when working in an interorganizational enterprise. The rates of change and the nature of change vary from one place to another. Changes in some organizations, especially in the granting agencies that are central to the enterprise, can affect the flow of information throughout the system. Electronic grants administration, for example, requires research institutions to adjust or reconcile their internal management needs with the changing organizational and management demands of the granting agencies that provide their main funding. Another organizational change has to do with the recent focus on cross-disciplinary research. Both granting agencies and universities are organized along strong disciplinary lines, yet both are working toward more multidisciplinary research programs. This evolution creates important tensions between new research goals and traditional organizational systems for designing work, allocating resources, and measuring and rewarding performance.

**Conflicting concepts of risk**--The nature of research - inquiry into the unknown - involves risk taking. This is like the risk an investor accepts in creating a mixed portfolio of assets. The performance of some of the investments are quite predictable, others less so. Some may be quite speculative, but these represent the calculated risk that either a loss or a great gain may be possible. Contrast this kind of risk assessment with the traditional compliance and accountability activities of public organizations. Rules-based systems, audit programs, and internal controls

are all put in place to ensure predictable performance and to prevent errors, fraud, or other misuse of public resources. These accountability tools have a legitimate place in the research enterprise as well, given its distribution of billions in taxpayer dollars. The juxtaposition of these two very different approaches to risk presents an ongoing conundrum for research agencies. They simultaneously need policies, procedures, and processes that assure public trust, as well as the freedom to take the risk of investing in new and untried ideas.

### Emerging challenges

Progress toward the ideal research enterprise of the future is further complicated by emerging trends that directly challenge the enterprise. These include new approaches to conducting research, increasing demands for government accountability and management performance, and misalignment of policies and practices within the enterprise.

**Interdisciplinarity and research partnerships**--Research has traditionally been conducted by individual investigators focused on a single discipline or sub-discipline. However, today's societal needs and scientific challenges demand interdisciplinary studies to uncover new knowledge, not discoverable using traditional approaches. Several major research programs have been launched recently that emphasize cross-disciplinary research partnerships. These include the National Partnership for Advanced Computational Infrastructure sponsored by NSF, the Biodefense Program at the National Institute of Allergies and Infectious Diseases at NIH, and the Multidisciplinary Research Program, sponsored by the Department of Defense's University Research Initiative (URI). Unfortunately, regardless of the logic and benefit of this new approach to science, interdisciplinary research partnerships are more difficult to form and manage than traditional studies. They are harder to assess and harder to communicate about. The formal structures of the research enterprise have not been organized to support an interdisciplinary approach. Universities are organized along traditional disciplines. Typically, grants making organizations and professional societies are organized in the same way. Traditional disciplines also largely define the reward structures and careers of individual scientists.

Interdisciplinary research is not only complicated, it is expensive. It involves higher costs for coordination and communication. It requires reaching out beyond traditional models and seeking new ways to amass and deploy resources and to build and manage research teams. Much of the burden of these new requirements falls to scientists and their organizations. They must reach beyond their long established, discipline-based networks to develop a language and a common framework for thinking about the areas where disciplines do or could overlap. To establish a partnership, they must find funders who are also interested in, willing to, and capable of supporting interdisciplinary research. Research funders who seek interdisciplinary proposals face the difficulty of evaluating the ideas either directly or through peer review panels that understand this new way of working. For the investigators, the reward systems of their universities may not recognize or reward this kind of work with tenure and promotion.

**Increasing accountability and performance requirements**--The trend in the federal government toward increased accountability and performance measurement has had a general effect on the research enterprise for many years. Specific legislation focusing on increased accountability and efficiency in the research enterprise, per se, is a more recent phenomenon. For example, the Government Paperwork Reduction Act of 1993 is focused on overall government efficiency, while the Federal Financial Management Assistance Improvement Act of 1999 (PL 106-107) is specifically focused on increasing the accountability and the efficiency of research programs. These are just two of many federal laws and policies that circumscribe the management activities of research agencies.

The President's Management Agenda is pushing all federal agencies to improve their performance in five critical areas: financial management, management of human capital, competitive sourcing, budget and performance integration, and expanded use of e-government. As a result, changes are being made in management models, work cycles, processes, and system designs within federal grants-making organizations. Because responsiveness and accountability are linked to risk management, research agencies are struggling to find useful ways to address these requirements in the context of long-term, uncertain investments in science. What needs to be measured, how it can be measured, and what the measurement tells us, are questions being considered at many organizations within the enterprise. At the same time, these initiatives may encourage agencies to better meet another long-standing need--to communicate in plain language about the value and the progress of science.

### Selected Federal Laws and Policies Affecting Grants Management

- Budget and Accounting Act, as amended (31 U.S.C. 11)
- Chief Financial Officers Act (31 U.S.C. 3512 et seq.)
- Computer Security Act (40 U.S.C. 759)
- Federal Financial Management Assistance Improvement Act of 1999 (PL 106-107)

- Federal Property and Administrative Services Act, as amended (40 U.S.C. 759 and 487)
- Government Paperwork Elimination Act of 1999 (PL 105-277)
- Government Performance and Results Act of 1993 (PL 103-62)
- Information Technology Management Reform Act of 1996 (Clinger-Cohen Act) (PL 104-106)
- OMB Circular A-130, Management of Federal Information Resources
- Paperwork Reduction Act of 1980
- Paperwork Reduction Act of 1995 (44 U.S.C. 35)
- Privacy Act, as amended (5 U.S.C. 552a)

**Misalignment of multiple policies and operating cycles--** The research enterprise invests regularly and heavily in overcoming or compensating for misalignments in the policy and regulatory environment and in the key cycles that govern work throughout the enterprise.

The policy and regulatory frameworks governing organizations throughout the enterprise are increasing in both quantity and variety. A single granting agency applies its own policies and regulations, while researchers and research institutions must comply with the rules of each granting agency they work with. Identifying, understanding, and reconciling the differences is becoming a significant burden. Many of the differences are based on unique requirements or conditions for individual granting organizations. Others are evidence of the uncharted evolution of business practices. The process of identifying, understanding, and working appropriately with these differences is costly and frustrating to most research institutions.

Repetitive but misaligned business cycles regularly challenge the enterprise. The federal budget process frequently informs granting agency program officers late in the process about how much money they will have available to them. As a result, they have to speculate about funding as they work with researchers to identify and cultivate new ideas, build innovative partnerships, and seek the wisest investment of funds. If funding levels are out of line with these discussions, either valuable time is lost working on ideas that cannot be supported or not enough groundwork is laid for programs that then need to be launched quickly. In the latter case, research scientists must be brought quickly into the pipeline through calls for proposals and reviewers. These narrow windows of opportunity limit participation and force incomplete proposal development, especially for programs that seek partnerships across disciplines or institutions. On a more operational level, award decisions are often made at awkward points in the academic year when investigators and graduate students have already committed to other work, thus delaying the start date or the full staffing of funded projects.

### Recent efforts to meet the challenges

A number of efforts are in place to address these challenges. Some are taking place within specific agencies or in small groups of agencies, some are grassroots efforts, others are driven by political leadership. Some relate to research funding, others address distribution of program funds. Some are moving into their second decade of effort, others are just beginning. All are moving forward at different paces and with different definitions of progress and success. The overall impact of these programs is not yet clear, but they are making real contributions to our understanding of the issues and possible solutions.

**Federal Demonstration Partnership (FDP)--** Launched in 1986, the FDP is a cooperative arrangement among federal granting agencies and grant recipients to improve the processes of proposal review and funding for research. Eleven federal agencies, 65 research institutions, and five professional organizations participate in the effort, which is convened by the National Academy of Sciences' Government-Industry-University Research Roundtable. The goal of FDP is to increase research productivity while maintaining responsible stewardship of federal funds by streamlining funding procedures and reducing the workloads of proposal writers and research administrators. The Partnership sponsors demonstration projects that test new ideas to achieve these goals. Early efforts focused on key rules that make it easier for grantees to launch and manage projects. Current efforts are focused on more global needs for electronic grants administration.

**Electronic grants administration projects--**Electronic grants administration has been under development in various forms for several years. The large community served by NSF, for example, has benefited from FastLane, which reduces the amount of paper processing by streamlining and automating as much of the proposal preparation, submission, and management process as possible. Similar efforts are underway at NIH in the Electronic Research Administration (ERA) program. A governmentwide effort entitled the Federal Commons project was initiated in response to Public Law 106-107 and is coordinated by the Inter-Agency Electronic Grants Committee (IAEGC). The goals of the Federal Commons project are to present a single federal face to grantee organizations and to offer easy access to information about grant opportunities, single-grantee registration and profile features, and electronic communications and transactions for both pre- and post-award processing.

**E-grants initiative.** As one of the Bush Administration's e-government efforts, the Department of Health and Human Services is leading a multi-agency project to simplify and standardize fundamental parts of the grants work of all federal agencies. These efforts are bringing many federal agencies, research institutions, and state governments to the discussion table and involving many of them in demonstration and pilot projects to test new models.

**State-based e-grants initiatives.** A number of states, including Pennsylvania and New York, are leading the field in electronic grants initiatives. These states are investing heavily in the development and implementation of processes and systems to support grants making. Both states are active members of the Interstate Advisory Group, a group of states involved in e-grants initiatives, that advises the Federal IAEGC in its Federal Commons Efforts.

### Understanding the challenges

Moving toward the ideal research enterprise requires a solid understanding of these challenges and how best to respond to them. The new knowledge needed to build that understanding and to design effective responses is not likely to come from research in a single discipline or analytical model. We need instead wide-ranging and integrative efforts to help us understand how the research enterprise works today and how it can move toward an ideal future. These efforts can be organized around five themes that are reflected in the current work of and challenges faced by the research enterprise as described on the next page:

- understanding the multiple value propositions that stakeholders bring to the enterprise and how they are aligned, are complementary, or conflict
- understanding how work is done by individuals and groups, within and across organizations
- understanding how individuals, groups, and organizations collaborate across the boundaries of structure, time, and place
- understanding how knowledge is captured, managed, and used within the enterprise
- understanding how to choose, use, manage, and support information technology investments

#### Research themes for the grants-supported research enterprise

- multiple-value propositions
- enterprise-wide workflows
- knowledge creation, capture, and management
- collaboration across boundaries
- effective use of information technology