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Science Professionals: Masters Education for a Competitive World

Summary

In the course of our nation's history, our leadership has made bold moves to equip our people with the skills and knowledge needed for the future. The Morrill Land Grant Act of 1862, the Serviceman's Readjustment Act of 1944 (commonly known as the GI Bill), and the National Defense Education Act (NDEA) of 1958, each reflecting the needs of its times, spurred social, economic, and technological change through undergraduate and graduate education.

There is growing consensus that we are again at one of those moments when we need bold actions. The vitality and competitiveness of the U.S. economy is due in large measure to the investment our nation has made over five decades in research and higher education, yielding a steady stream of scientific and technical innovations. Many countries, however, now invest in research and the development of knowledgeable people who play a critical role in competitive success. The development of research capacity and productivity in Europe and Asia and the global competition for talent are now challenging U.S. technological leadership.

There has not been a singular event, such as the Soviet launch of Sputnik in October 1957, to sound a clarion call to action. Instead, the situation has developed under the radar like a "Silent Sputnik." It is a situation of deep concern nonetheless and the nation needs to act.

Americans concerned about the nation's position in the global economy have provided recommendations to fuel the competitiveness of both our economy and the scientific enterprise: steps needed to improve K–12 science and mathematics education; make the United States the most attractive setting in which to study and conduct research; sustain and strengthen the nation's commitment to long-term basic research that secures

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our country; and ensure that the United States is the premier place in the world to promote innovation. Last summer, the U.S. Congress passed and the president signed into law the America COMPETES Act laying the groundwork for the implementation of many of these recommendations. Yet more, including the necessary appropriation of funds for new or expanded programs, is needed.

Talent is one of the important keys to innovation and competitive success. Reforming K-12 science, technology, engineering, and mathematics (STEM) education and encouraging undergraduates to pursue technical education and careers are both critical. Supporting doctoral students who will undertake future research is fundamental. Yet, the master's-trained segment of the science workforce is pivotal: strengthened master's education in the natural sciences will prepare professionals who bring scientific knowledge and also the ability to anticipate, adapt, learn, and lead where and when needed in industry, government and non-profits.

Traditionally, the master's degree in the natural sciences has tended to be single-discipline in orientation, an extension of undergraduate science education, and preparatory to the doctorate. In many fields, such as the biological sciences, physics, and chemistry, the award of a master's degree has typically signified either a "stepping-stone" en route to the doctorate or a "consolation prize" for those who were not admitted to candidacy or dropped out. Exciting experiments in master's education over the last decade—the Master of Biosciences (MBS) program at the Keck Graduate Institute of Applied Life Sciences and the Professional Science Master's (PSM) initiative seeded by the Alfred P. Sloan Foundation³—have shown that graduate education in these fields can prepare students for advanced science-based work in a way that is highly desired by employers. These programs are useful and scalable.

In the COMPETES Act, the 110th Congress agreed, authorizing the National Science Foundation (NSF) to create a new program of grants to four-year institutions that will provide for the creation or expansion of professional science master's (PSM) programs. Through this authorization, Congress acknowledged the role in our economy

³ While the MBS and PSM degree programs represent different institutional approaches to effecting change in professional science master's education (see Boxes 2.3 and 2.4 in chapter 2), they are similar in goals, curricular approaches, and their interaction with employers. For purposes of this report, findings, conclusions and recommendations regarding the PSM should be seen as including the MBS as well.

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and government at this point in history of the professional who possesses a balanced breadth and depth of scientific knowledge and practical workplace skills for the productive and innovative application of that knowledge—that is, a new kind of scientist with multidisciplinary skills and experiences.

The time is now right to accelerate and spread nationally the development of this new concept—professional science master's education that is interdisciplinary in character, strongly emphasizes effective communication and problem solving, and provides an understanding of entrepreneurial skills and technical innovation. Successful programs that have responded to this challenge have engaged collaboratively a broad set of stakeholders—employers, prospective students, faculty, government agencies and other funders—in designing curricula, defining education projects and internships, and advocating this new educational opportunity.

These programs do not displace classical master's programs. Rather, faculty develop them to serve the needs of students who require a different graduate experience for the workplace: banks, insurance and financial companies, and large firms who hire graduates of PSM programs in financial and industrial mathematics; a maturing biotechnology industry with a growing need for middle managers who have both advanced scientific knowledge and broader business skills; services corporations like IBM that require employees with depth in science and breadth in business and customer skills; and government employers (particularly in the military, intelligence, and homeland security agencies) that have an increasing need for science- and technology-savvy staff, particularly those with an interdisciplinary background.

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FINDINGS

After extensive information gathering and deliberation, we recommend concerted action to accelerate the development nationally of professional science master's education. This recommendation is based on the following findings:

1. In the natural sciences, the master's degree is as varied in its purpose as it is in any broad field. Master's degrees in fields such as physics, chemistry, the biological sciences, and mathematics have typically signified either a "stepping stone" en route to the doctorate or a "consolation prize" for those who were not admitted to candidacy or dropped out. Master's degrees in computer science and the geosciences, by contrast, have typically prepared graduates for the workplace. In the early part of the twentieth century, professional and graduate education took divergent paths and physics, chemistry, and biology are exemplars of classical graduate education. Professional degrees, by contrast, served as credentials for practice. During the past 50 years, tremendous growth in master's degrees awarded in fields such as education and business administration, however, has indicated the professionalization of master's education. This trend that has recently touched natural sciences such as the biological sciences and mathematics where traditional master's programs continue—as they should—alongside the recent development of professional science master's programs.

2. Higher education institutions are responding to the increased need for professionals who bring both scientific knowledge and professional skills to the workplace by developing professional science master's programs in the natural sciences that provide:

- Advanced education in the sciences;
- Opportunities for more interdisciplinary training, often in informatics, computation, or engineering, than a typical science degree;
- Hands-on experiential learning through internships and team projects;
- Professional skills and experience in communication, teamwork, project management, business administration, innovation and commercialization, legal and regulatory issues, ethics, and/or the international environment; and

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- Strong links with employers in industry, government, and nonprofits through external advisory boards, curriculum development, internships/co-ops, mentoring, sponsored team projects, and employment.

Examples of PSM programs that were presented to the committee showed that professional master's education in the sciences can provide tailored, cost-effective, and attractive education and training to meet student and employer needs.

3. Professional master's programs can and do attract students who want to work in nonacademic sectors, interdisciplinary careers, team-oriented environments, managerial or other professional level positions, or emerging areas of science and scientific discovery. They appeal to students who typically do not pursue doctoral education, but seek career advancement, look to gain a competitive edge, or want to refine professional and technical skills in order to reenter the workforce.

4. Salary and placement data for PSM and MBS graduates indicates strong and growing current demand for master's level science professionals. Testimony to the committee provided specific examples of the demand for these graduates from biotechnology companies, banks and financial corporations, information technology firms, and government agencies. There is, moreover, broad support for expanding PSM education, voiced by the President's Council of Advisors on Science and Technology, the National Science Board, the National Governors Association, the Council on Competitiveness, the U.S. Chamber of Commerce, the Association of American Universities, and the Council of Graduate Schools. We cannot, of course, precisely project future demand as many factors influence labor markets at any particular point in time. Our experience as employers and educators, however, leads us to believe that the current strong demand will continue to grow in the long run and that the nation will benefit from the development of a cadre of science-educated professionals. The graduates of PSM and MBS programs will become process managers, service scientists, investment analysts, patent examiners, S&T acquisition managers, forensic scientists, or other types of professional scientists. From among these, in the judgment of this committee, some

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number will also emerge as leaders, executives, and in industry, government, and non-profit organizations.

5. Our review of the evolution of professional programs in other fields revealed the important role of foundations in shaping both the content and growth of programs in medicine, business, public health, and other areas. Foundation support—from the William M. Keck Foundation and the Alfred P. Sloan Foundation—has been critical as well in the development of professional master’s programs in the sciences. In the committee’s judgment, future funding and support for professional master’s programs should be a responsibility shared by the federal government, state governments, philanthropic organizations, employers, and higher education institutions.

RECOMMENDATIONS

In August 2007, Congress passed the America COMPETES Act, which authorizes the NSF to develop and implement a program of grants to higher education institutions that may use them to develop or expand professional science master’s degree programs. We see this as a step along the road toward growing a large cadre of science-trained professionals in the United States, though the program is authorized but not yet funded. Yet stakeholders—notably the federal government, state governments, philanthropic institutions, national associations, higher education institutions, employers, and students—must undertake additional steps in order to secure the long run success of our nation’s efforts to address this important workforce need.

1. To achieve specific national goals as well as meet general demand for science trained professionals, we recommend the **federal government** expand the PSM program authorized in the COMPETES Act so that it is the responsibility of the NSF and also all other major federal science agencies⁴ as well. We recommend that each agency program

⁴ The major federal science agencies are those that have the largest shares of federal research and development spending and together comprise more than 90 percent of such spending. These include, in addition to the National Science Foundation, the Departments of Defense, Energy, Health and Human Services (National Institutes of Health), Commerce (National Institute of Standards and Technology and National Oceanic and Atmospheric Administration), Agriculture, Interior, and Homeland Security, and the National Aeronautics and Space Administration.

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include two components: (1) a program of institutional PSM grants competitively awarded to four-year higher education institutions for the establishment and start-up operations of PSM programs and (2) a program of National Innovation Scholarships that provides need-based scholarships for U.S. citizens who will use them to pay for tuition and expenses when they enroll in PSM programs. It is critical that Congress appropriate funds for this multi-agency program beginning in fiscal year 2009 and at an appropriate level. If this program flourishes and demand for PSM graduates increases as much as the committee expects it will, then program funding will need to be considerably larger than the levels that Congress has so far authorized.

2. **State governments**, which have a long history of efforts in economic development, should regard professional science master's degree programs as critical to producing a cadre of science professionals who can play an important role in managing and growing science- and technology-based industries in their states. Along with the federal government, states should provide funding for the creation and expansion of these programs to target particular state and regional needs.

3. **Philanthropic institutions** should continue to play a role in creating and sustaining professional science master's degree programs and otherwise spurring innovation in master's education. Foundations can provide matching funds for federal grants, funding to assist students with financial aid, and the seed money for the establishment of a base of new programs in a specific field or in support of a specific industry.

4. Each **professional society** in the natural sciences and **industry association** in high technology or science-based industries should develop an overall strategy for addressing higher education in its field that includes the PSM and specific actions to help create and sustain PSM programs and other innovations.

5. **Higher education institutions** should continue to innovate in and support the development of master's degree programs in the natural sciences to meet the needs of students seeking science-based careers and of the employers who hire them. PSM programs will provide students with deeper, often interdisciplinary, scientific knowledge and must include opportunities for the development of professional skills and practice through courses, summer internships, and business- or government-sponsored projects that provide an invaluable workplace experience. Providing incentives to and support for

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faculty to participate in these efforts, including program design and implementation is critical.

6. **Higher education institutions** should reach out to and work as partners with employers to create and sustain programs. The use of external employer advisory councils will provide substantive, real-time input for framing of new science master's programs and practical assistance with curriculum development, mentoring, marketing, employer-sponsored projects, internships, hiring for graduates, and financial support. Institutions should also provide outreach to students, informing undergraduate students and potential graduate students of the professional science master's degree opportunity.

7. **Employers** in the for-profit, nonprofit, and government sectors should partner with higher education institutions to create and sustain PSM programs. They should participate on employer advisory councils through which they can assist with and benefit from: program conception, curriculum development, mentoring, employer-sponsored projects, internships, employment, and financial support. They should invite representatives of PSM programs to speak at local or regional business gatherings that provide a forum for communication about the existence and attributes of PSM programs and their graduates. We encourage employers to broaden their recruiting beyond traditional sources to hire graduates from new programs. This includes not only federal agencies that require Ph.D.s for their world-class research centers, but also procurement officers, acquisition officials, project and program managers and senior executives who, in their investment decision making roles, must understand the latest in technology while simultaneously ensuring competitive business management outcomes. The PSM provides an outstanding model for educating the individuals who can fill these important federal careers positions.

8. **Students** in professional science master's degree programs should take full advantage of internships and industry-sponsored team projects. We encourage alumni to provide the professional programs from which they graduated with links to and resources from their current employers who can assist with mentoring, internship opportunities, and information about employment.