Professional Science Master's

A Council of Graduate Schools Guide to Establishing Programs

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Foreword

By Debra W. Stewart, President, Council of Graduate Schools

Over the past decade, the Professional Science Master's (PSM) has emerged as a key response by the graduate community to the need for producing the workforce necessary for the U.S. to remain globally competitive. The PSM addresses this need in three essential ways: By preparing students for attractive career opportunities in non-academic settings, contributing to reducing STEM pipeline leakage, and aligning with increasingly popular professionally oriented master's degree programs. The Council of Graduate Schools (CGS) has had the privilege of providing leadership for the development of the PSM concept, which has contributed in fundamental ways to the graduate education enterprise and to the United States' innovation agenda.

Historically, the vision and commitment of the Alfred P. Sloan Foundation have been instrumental to the evolution of the Professional Science Master's (PSM) Initiative. Beginning in 1997, a series of grants were awarded by the Sloan Foundation to support the development of PSM programs in the natural sciences and mathematics. Since then, the steady growth of the PSM Initiative was stimulated by additional Sloan actions, including an emphasis on the development of bioinformatics programs (2001), a concentration on master's-focused institutions (2002), and the facilitation of movement from the "concept" stage to the "scale-up" stage by making new funding available only to larger system-wide and statewide PSM Initiatives rather than to individual, campus-based programs (2006).

In January 2006, CGS assumed primary responsibility from the Alfred P. Sloan Foundation for growing and promoting the PSM degree, with the goal of making the PSM a regular feature of U.S. graduate education. The CGS PSM Initiative's promotion of the PSM to the academic, business and policy communities, establishment and subsequent work of the National PSM Association, and CGS' partnerships with the National Science Foundation, National Conference of State Legislatures, and the National Governors Association contributed to an increase in the number and diversity of PSM programs that have been developed.

Further, the strong endorsement of the National Research Council for developing professionally oriented master's degree programs in the natural sciences to enhance U.S. competitiveness, and $15 million in federal funding through the American Recovery and Reinvestment Act offered strong support, steepening the PSM growth curve.

As the PSM Initiative gained momentum, CGS conducted a survey in 2002 funded by the Ford Foundation. The survey results indicated a parallel trend toward professionalization of master's degrees in the social sciences and humanities. In response, the Ford Foundation funded CGS to promote the development of Professional Master's (PMA) programs in the humanities and social sciences. The developments relative to the PMA, described in the "Afterword," and the rise of the PSM, signaled a need for a guide to establishing and operating professional master's programs. Thus, in 2006, CGS produced *Professional Master's Education: A CGS Guide to Establishing Programs*.

Since publication of *Professional Master's Education*, the PMA Initiative concluded. The number and diversity of PSM programs have increased rapidly to more than 240 at over 110 institutions.

This monograph brings into focus changes in the landscapes of PSM programs, the nation, and graduate education. The need for professional master's education in science, technology, engineering, and computational sciences is a demonstrable means of assuring American competitiveness. Intended to serve as a guide for developing PSM programs, this monograph includes the *Guidelines for Recognition of Professional Science Master's Programs* and a wealth of experience-based information, essential to creating and sustaining quality of PSM programs.

Acknowledgments

By Debra W. Stewart, President, Council of Graduate Schools

This publication reflects the breadth of experiences and collaborative spirit characteristic of the PSM concept and all who embrace the PSM Initiative. The collective knowledge and dedication of many individuals contributed to the development of the 2006 publication, *Professional Master's Education: A CGS Guide to Establishing Programs*, and this newly revised monograph. The Alfred P. Sloan Foundation deserves special recognition for its consistent role as a champion of the PSM and the provision of generous financial support. Michael Teitelbaum, Alfred P. Sloan PSM Project Director, in particular, has provided insightful guidance and shown invaluable commitment to the PSM.

Numerous members of the broad PSM community are to be thanked for contributions of anecdotes and exemplars drawn from their rich experience with PSM programs. In addition, Effie Maclachlan and Derek Steele (CUNY), Susan Lawton (University of Massachusetts, Lowell), and Judith Ramaley (Winona State University, Minnesota State Colleges and Universities) provided effective feasibility data collection instruments found in the Appendix.

Robert Sowell, William Weiner, Patricia McAllister, and Nathan Bell of CGS provided valuable reviews of the manuscript over the course of its preparation. I would like to express sincere thanks to Joseph Benoit and Maureen Grasso for their thorough reviews of this publication, and recognize the valuable contributions of David King, who shared so willingly from his knowledge as a PSM program director and leader of a major system-wide PSM initiative. Their collective contributions greatly improved the monograph.

A special note of gratitude is necessary for Peter Syverson and Les Sims' contributions to the professional master's initiatives and the production of the first CGS monograph on this topic.

Finally, a deep note of thanks to Sally Francis, the principal author of the book, who guided it from conception through final editing; to

Carol Lynch who so masterfully wrote the PMA *Afterword*, and to Leontyne Goodwin who wrote portions of the manuscript contributing enormously to its organizational framework.

Chapter 1
The Professional Science Master's Degree in Context

The master's degree has been referred to as a "real American success story" in its rise since the 1950s as the dominant post-baccalaureate educational model in the U.S. (LaPidus, 2000, p. 3). In 2010 about 7.5% of the U.S. population over the age of 25 years (U.S. Department of Commerce 2010a) held a master's degree (U.S. Department of Commerce 2010b)[1]. According to LaPidus, the reason for this phenomenon is that the master's degree serves the role of providing the "…specialized knowledge and skills related to jobs and careers…" post-baccalaureate students seek. Recent data indicate that "…master's education occupies the largest portion of the graduate education enterprise, currently representing 75% of all graduate students and 90% of all graduate degrees awarded" (Sowell, Bell, Francis, & Goodwin, 2010, p. 3). Further, in fields that are professionally oriented, the proportion of graduate enrollment at the master's level is quite high—95% in business, 92% in public administration and services, 83% in education, and 79% in health sciences (Bell, 2010, Table 2.15, p. 36).

Professional master's programs are playing an increasingly important role in preparing the future workforce and offering students an avenue to career pathways (Borchert, 2005, p. 7). Such programs have been characterized as being connected to the workplace by preparing students for entry level, career-oriented professional positions (Borchert, 2005 and Glazer-Raymo, 2005, p. 35). Glazer-Raymo (2005) cited the following as having contributed to trends in the emerging redesign of the master's degree: market mechanisms, the convergence of academic and professional fields across traditional disciplinary boundaries, state oversight and assessment, and technological advances (p. 99).

This chapter will place the emergence of professional master's level education in a national and international context, exploring in detail the capacity of master's education to address both workforce demand and supply, and concluding with the introduction of the Professional

1 2009 U.S. population aged 25 years and over was found at U.S. Department of Commerce, 2010b.

Science Master's degree as a response to larger competitiveness and pipeline considerations.

National and International Contexts

For the U.S. to remain globally competitive, the domestic talent pool must be assured, particularly at the graduate level. This perspective is broadly shared. President Obama (2011) has said that the United States' ability to remain globally competitive is directly connected to research and education. He asserted, "The future is ours to win. We know what it takes to compete for the jobs and industries of our time. We need to out-innovate, out-educate, and out-build the rest of the world" (Obama, 2011). He further asserted that encouraging American innovation is the key to remaining competitive and that "… if we want innovation to produce jobs in America and not overseas—then we also have to win the race to educate our kids." Earlier, the report *Graduate Education, The Backbone of American Competitiveness and Innovation* (Council of Graduate Schools, 2007) similarly posited, "A highly skilled workforce operating at the frontiers of knowledge creation and professional practice is key to America's competitiveness and national security" (p. 8). More recently, Pulitzer Prize-winning columnist George Will (2011) expressed the same view by writing, "…research is what canals and roads once were – a prerequisite for long-term economic vitality." The consensus is that a highly educated workforce capable of driving innovation is essential to America's continued competitiveness and prosperity in the twenty-first century. Unfortunately, equally consistent is the view that the U.S. is currently producing the workforce needed to remain globally competitive (Wendler, Bridgeman, Cline, Millett, Rock, Bell, & McAllister, 2010).

The current situation indicates that America is losing ground in sustaining a highly educated workforce. Many countries, including China and India, have invested heavily in higher education, recognizing its impact on innovation and competitiveness. As a result of this international investment, the U.S. share of international student enrollment in higher education dropped from about 25% in 2000 to 20% in 2006 (Wendler, et al., 2010, p. 22). Threats to our ability to sustain American preeminence in graduate education include: length of time to earn a degree (particularly

at the doctoral level), attrition, heightened international competition, and lack of clear information about career paths for graduates.

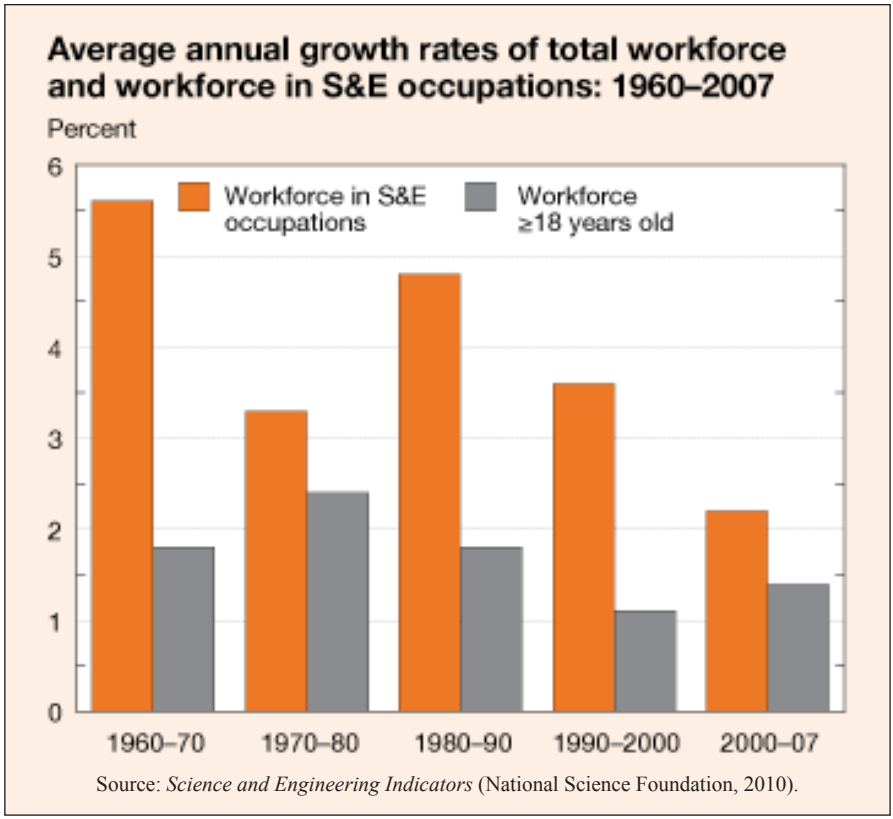
The federal government noted this potential erosion of U.S. dominance in graduate education and responded with legislation such as the America COMPETES Act of 2007, (America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science), enacted during the Bush administration, and again in 2011 during the Obama administration, indicating bipartisan support. The NSF's Science Master's Program (SMP) was authorized by the 2007 America COMPETES Act; 21 awards of about $700K were made to institutions to catalyze sustainable SMP programs and to encourage diversity in student participation.

Workforce Context

In this section we will establish the demand for a highly trained U.S. workforce and examine the present supply. How close are we to providing the highly educated workforce needed to assure the future?

The workforce demands of business, government, and non-profit organizations. The U.S. science and engineering workforce numbered between 4.3 and 5.8 million people in 2006, and has grown faster than the total workforce during each of the past six decades—increasing from about 182,000 in 1950 to its current size (National Science Foundation, 2010, Chapter 3). It is true that job growth slowed during the 1970s and again during the first decade of the 2000s as shown in Figure 1. Even so, concerns have been expressed regarding the future supply of the national science, technology, engineering, and mathematics (STEM) labor force owing to actual and anticipated changes in the factors that are believed to have driven historic trends in the STEM labor force: 1) growth in degrees earned by both domestic and international students; 2) migration of foreign educated workers to the U.S.; and, 3) low retirement rates (National Science Foundation, 2010, pp. 3-13). Going forward, greatly increased retirement rates are anticipated and competition in the international workforce has emerged. Both will continue to affect workforce demand.

Figure 1. **Workforce Growth Rates**



Source: *Science and Engineering Indicators* (National Science Foundation, 2010).

Replacement needs and projected growth combine to produce workforce demand that is higher in STEM areas than for the total workforce. The projected workforce[2] replacement rate between 2008 and 2018 is 22.72% (U.S. Department of Labor, 2010a). The *replacement rate* for the STEM workforce is projected to be higher than 22.72% in all categories except engineering although the absolute number is greater in the case of engineering: physical scientists 29.53% (814,000); mathematical science occupations 29.26% (34,000); life scientists 24.71% (691,000); and 22% for engineers (3,523,000). The projected *growth rate* for physical scientists is 15.12%, 19.79% for

2 BLS occupations are categorized using the 2008 National Employment Matrix. The data include all workers regardless of educational attainment.

mathematical science occupations, 26.70% for life scientists, and 11.35% for engineers compared to an overall projected employment growth rate of 10.12% for all occupations (U.S. Department of Labor, 2010c).

Among the 20 industries projected to exhibit the fastest growth between 2008 and 2018 are management, scientific, and technical consulting services (6.2%) and scientific research and development (2.3%) (U.S. Department of Labor, 2010d). As shown in Table 1, 20% or more workers in a number of occupations in STEM fields hold master's degrees indicating where demand for highly educated workers will likely occur.

Table 1

Percentage of Workers with Master's Degrees in Selected Occupations

Occupation	% of Workers with Master's Degree
Mathematicians	38.5
Mathematical technicians	38.5
Statisticians	38.5
Hydrologists	34.9
Geoscientists	34.9
Environmental scientists and specialists, including health	34.9
Environmental engineers	33.4
Engineering managers	31.8
Biochemists and biophysicists	30.2
Zoologists and wildlife biologists	30.2
Computer software engineers, applications	29.3
Computer software engineers, systems software	29.3
Natural sciences managers	25.6
Atmospheric and space scientists	25.3
Astronomers	24.4
Physicists	24.4
Food scientists and technologists	23.4
Operations research analysts	23.0
Actuaries	22.2
Agricultural engineers	20.2
Biomedical engineers	20.2

Source: U.S. Department of Commerce (2010b). Bureau of Labor Statistics, Employment projections, education and training measurements for workers 25 years and older by detailed occupation, 2008. Table 1.11. Retrieved 12/22/2010 from http://www.bls.gov/emp/ep_table_111.htm.

Carnevale (2010) reported that employment for master's degree recipients in STEM fields will grow 15% in the coming decade—more than the expected 10% growth in the overall economy. Carnevale projected that between 2008 and 2018, master's level employment will increase 23% in computer science and mathematics; 15% in architectural fields; 7% in engineering; and 5% in the life sciences. These projected jobs will be concentrated in professional scientific managerial industries and in manufacturing. About 24% will require education beyond the bachelor's level with some variation according to broad field. It was further pointed out that scientific innovation has accounted for about 50% of U.S. economic growth in the past 50 years.

These data establish the demand for persons with advanced preparation in natural science, technology, engineering, mathematics and/or computational sciences that can enter the U.S. workforce and contribute to the global competitiveness of business and industry and the varying needs of government and non-profit organizations.

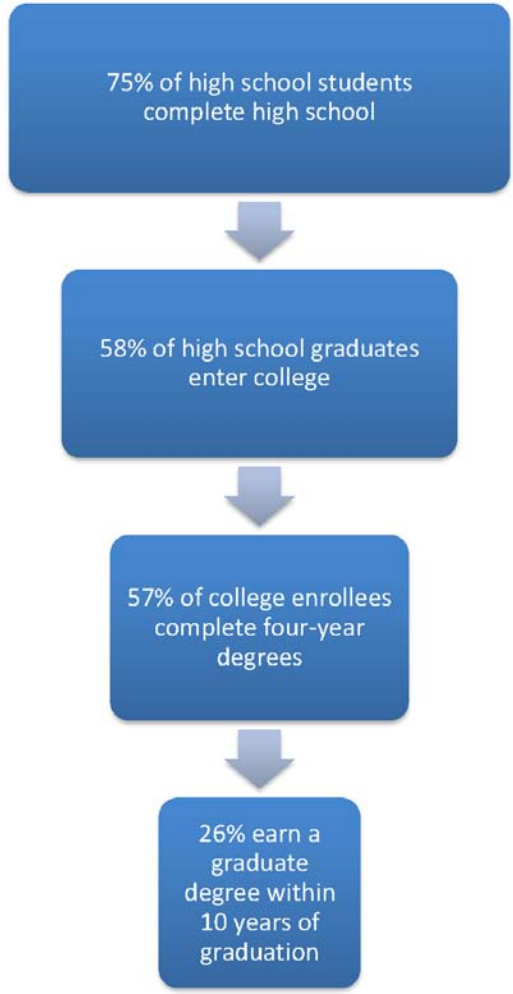
The supply of graduates from U.S. science, mathematics, and technology programs. To supply the talent to meet employer demand for highly educated workers, we must consider the narrowing U.S. education pipeline. The pipeline of talent becomes progressively narrow (see Figure 2) in the following way:

- the Averaged Freshman Graduation Rate (AFGR)[3] of high school students in 2007-08 was 75% (Snyder & Dillow, 2011b);
- In 2006, 58% of high school graduates aged 16-21 were enrolled in college (Davis & Bauman, 2008, p. 5);
- 55% of first-time, full-time college enrollees in 1998 completed four-year degrees within 150% of normal time (Knapp, Kelly-Reid & Whitmore, 2006, p. 11); and
- only 26% of 1992-93 college graduates earned a graduate degree within 10 years of graduation (Bradburn, Nevill & Cataldi, 2006).

3 The AFGR is one method used to estimate the percentage of public high school students who graduate within four years of starting 9th grade. It does not include students who earned a GED. For an explanation of the AFGR methodology, see http://nces.ed.gov/pubs2011/dropout08/findings6.asp.

This phenomenon of *narrowing* exists despite the steady growth in graduate education that will be discussed in this section. A complete analysis of the pipeline of STEM graduates and their flow into the workforce must take into account K-12 education, as the interests of high school graduates take shape and skills develop during these years. In this section we will address how at each stage there exist serious pipeline issues.

Figure 2. **Narrowing Pipeline**



Flow of high school graduates into science, mathematics, and technology programs. In 2006, 58% of high school graduates aged 16-21 who earned a regular diploma were enrolled in college (Davis & Bauman, 2008, p. 5)—38% were enrolled full-time in four-year colleges. In 2006, 56% of undergraduate students were women

(Davis & Bauman, p. 6). Probable majors reported by first-time, full-time, first-year students in baccalaureate institutions in fall, 2008, (Pryor, et al., 2008, pp. 84-85) are shown in Table 2.

Table 2

Probable College Majors of 2008 First-Year Students

Majors	Percentage
Business	16.7
Professional	13.8
Arts and Humanities	13.5
Other	13.2
Biological Sciences	9.3
Engineering	9.3
Social Science	3.5
Physical Science[a]	3.2
Technical	1.0

[a] Includes mathematics.

The extremely low percentage of students indicating probable undergraduate majors in the physical sciences, including mathematics, is of concern to business, industry, and government leaders who are worried about future shortages of technically proficient college graduates. It also has had an adverse impact on the STEM pipeline as students move from secondary school through college and graduate study. This represents the first occurrence of leakage in the overall workforce pipeline.

Trends in science/math bachelor's degrees awarded reflect the trends in students' undergraduate majors. Since 1978-79 the share of degrees earned at the master's and doctoral levels in computer sciences and engineering has increased considerably more than the increase in total degrees awarded during the same period of time. In contrast, during the same period, the share of natural sciences degrees awarded has increased substantially less at the bachelor's and master's levels compared to the total increase, but substantially more at the doctoral level as shown in Table 3. The slowest rate of increase in share has

been at the level of master's degrees, although the absolute number of master's degrees awarded has steadily increased. In contrast, the share of master's degrees in computer sciences and engineering increased by about 6% to about 8%, although the rate of change in degree share has been declining since 1987-88. Furthermore, the ratio of master's degrees to bachelor's degrees earned is low in the natural sciences (about 18% in 2007-08) and over 42% in computer sciences and engineering (with a share growth of -0.50% in natural sciences and 34% in computer science and engineering since 1977-78).

Flow of science/mathematics/technology bachelor's graduates into graduate education. Table 3 suggests that many U.S. students with appropriate undergraduate background for graduate work in the sciences do not seem to choose to pursue further study in the same field. For example, Table 3 indicates that 9.71% of bachelor's degrees awarded in 1998-99 were in the natural sciences compared to only 3.16% of master's degrees in natural sciences awarded in 2008-09. Many are not pursuing graduate study at all.

In a longitudinal study, 43% of 1992-93 bachelor's degree recipients with undergraduate majors in mathematics and other sciences and about 61% with majors in engineering had never enrolled in any advanced degree program by 2003 (Bradburn, et al., 2006, Table 1, p. 7). Biological sciences was the broad major field associated with the highest likelihood (67%) of enrollment in advanced education (Nevill & Chen, 2007, Table 2, pp. 12-13). However, the largest proportion of graduates with undergraduate majors in the biological sciences, who were engaged in advanced education, was pursuing first professional degrees at the master's or doctoral levels.

Table 3

Share of Degrees Awarded in Science and Engineering, 1978-2008

	Percentage of Degrees Awarded by Broad Field				Number of Degrees	Percent Change 1979-2009
	1978-79	1988-89	1998-99	2008-09	2008-09	
Total Bachelor's Degrees	921,390	1,018,755	1,200,303	1,601,368	1,601,368	73.80%
Natural Sciences[4]	9.08%	6.69%	9.71%	7.41%	118,718	41.89%
Computer Sciences & Engineering[5]	7.77%	11.44%	8.69%	7.66%	122,329	71.23%
Total Master's Degrees	301,079	310,621	439,986	656,784	656,784	100.57%
Natural Sciences	5.01%	4.54%	3.48%	3.16%	20,767	37.67%
Computer Sciences & Engineering	6.33%	11.10%	9.00%	8.54%	56,112	194.29%
Total PhD Degrees	37,730	35,720	44,077	67,716	63,712	68.87%
Natural Sciences	19.09%	22.96%	23.27%	20.00%	13,540	88.03%
Computer Sciences & Engineering	7.37%	14.34%	14.21%	14.13%	9,570	244.12%
Total Master's/ Total Bachelor's	32.68%	30.49%	36.66%	41.01%		25.48%
Natural Sciences	18.03%	20.70%	13.15%	17.49%		-0.97%
Computer Sciences & Engineering	26.62%	29.59%	38.35%	45.76%		71.90%

Source: Snyder & Dillow (2011e).

Among 1999-2000 bachelor's degree recipients who enrolled in graduate school within one year of receiving their bachelor's degrees, a substantial proportion of life sciences (49.8%) graduates pursued post-baccalaureate study in the health professions compared to only about 17% who continued in the biological sciences (Bradburn, Berger, Li, Peter, & Rooney, 2003, p. 155). Among those who received bachelor's degrees in the physical sciences, mathematics, and computer/information science, about 39%, 56% and 52% respectively, continued in the same field for graduate study. Instead of continuing in the same field, physical science majors shifted to engineering (17%) and health professions (22%); mathematics majors shifted to

4 Includes biological & biomedical sciences, mathematics & statistics, and physical sciences and science technologies.

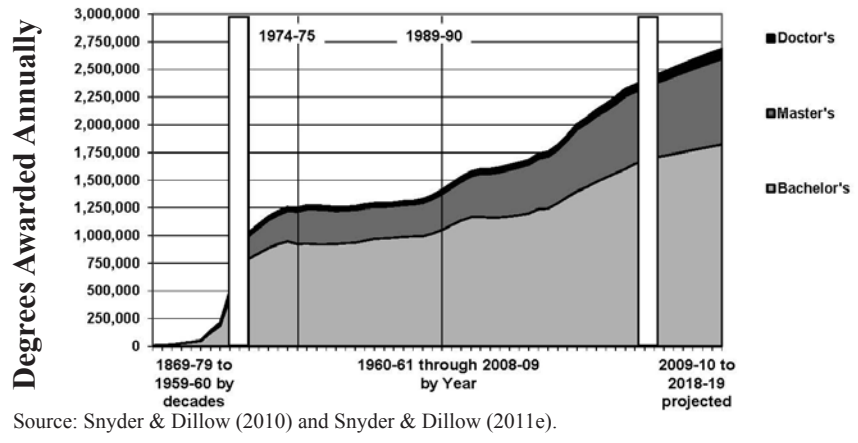
5 Includes computer and information sciences, engineering, and engineering technologies.

education (24%), and computer/information science majors shifted to business/management (24%). In comparison, 75% of education majors, 66% of engineering majors, and 61% of business/management majors continued in the same field for graduate study. Thus, there is additional leakage in the STEM workforce pipeline at this stage.

Graduate Degree Production

The primary development of U.S. graduate education occurred during the second half of the twentieth century. Graduate degrees increased from approximately 18% of all university degrees in 1959-60 to about 31% in 2007-08, while master's degrees increased from 88% of all graduate degrees to about 91% (Snyder & Dillow, 2011e). As illustrated in Figure 3, beginning in the mid 1970's, graduate degree production stabilized for approximately 15 years. Since 1990, growth in graduate degree production has recommenced, a trend that is predicted to continue for the next decade. The rate of increased degree production has been highest at the master's degree level: +45% between 1997-98 and 2007-08 and +109% between 1987-88 and 2007-08 (Snyder & Dillow, 2011e). Between 2007-08 and 2015-16, master's degree production is projected to increase between 2007-08 and 2015-16 by about 17% (Snyder & Dillow, 2010*)*.

Figure 3. **Growth in U.S. Higher Education Degrees, 1869-70 to 2018-19**

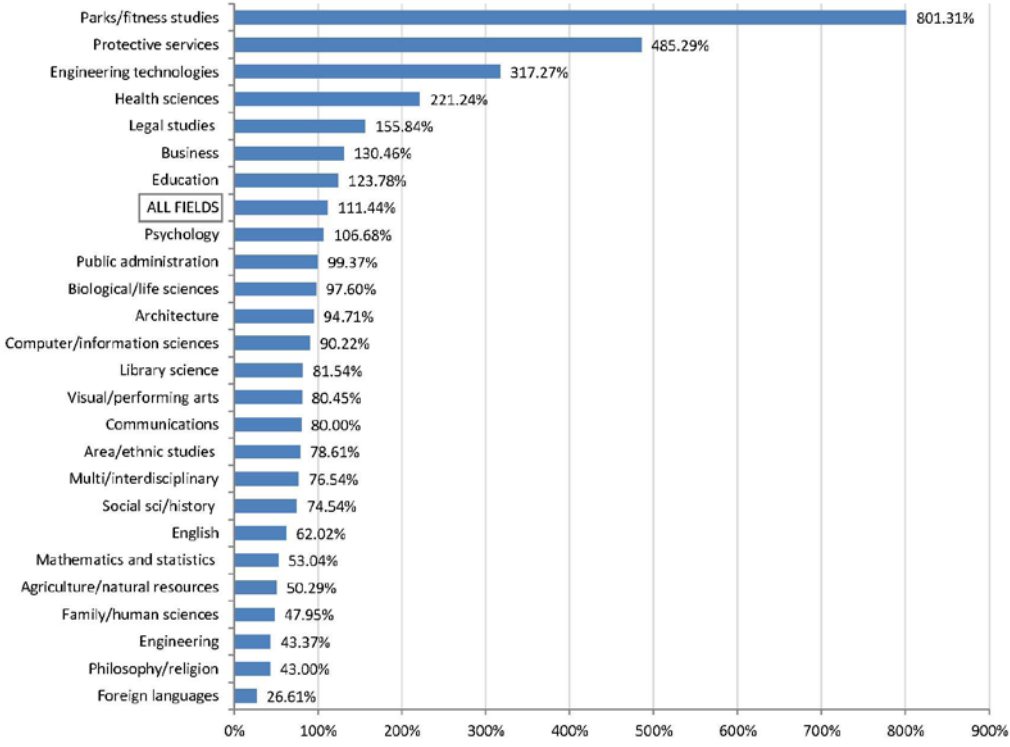


Source: Snyder & Dillow (2010) and Snyder & Dillow (2011e).

As stated previously, master's degrees are projected to continue to grow by about 17% through 2015-16. There are reasons why this trend may continue even beyond current projections. Trends indicate both larger high school graduating classes (Snyder & Dillow, 2011a) and increasing high school completion rates through 2008 (Chapman, Laird, & KewalRamani, 2010) followed by projected declines in the number of high school graduates until another upswing in 2018-19 (Snyder & Dillow, 2011a). The 2008 estimated postsecondary rate of attendance of 2007-08 high school graduates was about 64% (Snyder & Dillow, 2011d); and about 42% of entering freshmen in 2008 indicated that they planned to obtain a master's degree (Pryor, Hurtado, DeAngelo, Blake & Tran, 2009). Thus, projected increases in high school graduation rates among increasingly larger high school classes, coupled with a fairly stable post-secondary rate of attendance will combine to produce growth in master's education.

The growth in master's degree production over the past two decades, for which data are available, exhibits marked variation by field. As shown in Figure 4, fields that experienced the highest growth rates in master's degree production during this 20-year period may be characterized by a professional orientation—parks, recreation, leisure and fitness studies; security and protective services; health professions and related clinical sciences; legal professions and studies; engineering technologies; business; education; and computer and information sciences.

Figure 4. **Changes in Master's Degrees Awarded by Discipline, 1989-2009**



Sources: U.S. Department of Education, National Center for Education Statistics, Higher Education General Information Survey, "Degrees and Other Formal Awards Conferred," 1970-71 through 1985-86; and "Completions Survey" (IPEDS-C:91-99), 1990-91 through 2008-09 and Fall 2000-2009. These data were provided upon request January 2011.

The Public Good and Social Contexts

Despite the growth in graduate education and its importance to individuals, business and government, and society at large, there may be a lingering public perception that a graduate degree is more of a "private good" benefiting individuals, rather than a "public good" that benefits broader society (Stewart, 2005). It has been noted that government policy has not always stressed the role of higher education in economic and workforce development but instead has often emphasized personal development. The private good is easy to demonstrate. Graduate degree holders exhibit increased earnings. In

2009, median weekly earnings for full-time wage and salary workers were $626 among high school graduates, $1,025 among bachelor's degree holders, $1,257 among master's degree holders, and $1,532 for doctoral degree holders (Bureau of Labor Statistics, 2010e). Additionally, the unemployment rate among high school graduates was 9.7 compared to 5.2 among bachelor's degree holders, 3.9 among master's degree holders, and 2.5 among doctoral degree holders.

But the public benefit of graduate education is most clearly reflected in growing concerns (primarily expressed by the corporate sector) about the future U.S. workforce. Other nations strategically make graduate education a national priority in the quest for economic competitiveness (Stewart, 2005). Zhang (2007) reported that a 1% gain in people in post-baccalaureate education produced a 5-7% increase in metropolitan economic growth (Zhang, 2007). More broadly, Stewart (2005) argued that the benefits of a highly educated populace that accrue to the nation generally include "…increased tax revenues, greater productivity, increased workforce flexibility, decreased reliance on government financial assistance, and improved ability to adapt to and use technology…" (Council of Graduate Schools, 2008, p. 6). In reinforcing various arguments regarding the vital relationship between innovativeness and prosperity, one report enumerated ways in which graduate education catalyzes innovation including:

- Creating the workforce for the new global economy;
- Conducting groundbreaking research;
- Facilitating technology transfer;
- Developing entrepreneurs and innovators;
- Developing leaders for business, non-profit, and government sectors;
- Establishing new start-ups that create jobs; and,
- Promoting health initiatives (Council of Graduate Schools, 2008, p. 13).

Emergence of the Professional Science Master's Degree

The PSM emerged as a key response of the graduate enterprise to the need to produce the workforce necessary for the U.S. to remain globally competitive, providing private benefits to individuals while

contributing substantially to the public good. Professional Science Master's degree programs (PSM) include a core of advanced disciplinary course work equivalent to a traditional master's program, learning activities designed to develop essential professional knowledge and skills, an external advisory board, team-oriented projects, and an internship. The reasons for development of the PSM are summarized in the following sections.

Workforce demand. The PSM is key to a viable workforce and derived from the recognition that the supply of persons with adequate preparation to meet workforce demand is insufficient.

Pipeline leakage. The PSM is designed to address the serious pipeline leakage discussed earlier. PSM programs are considered to have the potential of increasing undergraduate persistence because students see that PSM degrees lead to career options outside of academia, the career outcome traditionally perceived to be associated with advanced degrees in STEM fields (Business Roundtable, 2005). In addition, a professional master's option for science, mathematics, and engineering students has the potential to encourage a larger percentage of bachelor's degree recipients to pursue graduate education in the field of their undergraduate major in which they have invested their interests, efforts, and resources. However, this shift will require that faculty members mentor STEM students into applied or professional career paths. A small overall share of undergraduates majoring in these fields—and subsequently electing to pursue a professional science degree—would represent a substantial increase in the supply of graduates with the background and advanced training to meet the demands of non-academic employers. Anecdotal evidence indicates that almost all of the estimated 5,000 graduates of PSM programs to date are employed in career track positions relevant to their study.

Popularity of professionally oriented programs. The PSM responds to the increasing popularity of master's degrees that are more professionally oriented. This shift toward professional master's degrees occurs as: 1) employers seek employees with background and training exceeding that acquired through typical bachelor's programs,

while, 2) employees seek career advancement in some fields, and, 3) as hiring of graduates with bachelor's degrees becomes depressed during economic downturns. A practice-oriented or applied master's is now the accepted entry-level degree for professional practice in business, social work, public administration, engineering, some areas of education, and, more recently in accounting and physical therapy. Practice-oriented or applied master's programs have some professional attributes, although they are not as common or as integrated into the curriculum as is the case for the PSM. PSM programs include: a core of advanced disciplinary course work equivalent to a traditional master's program, integrated course work and/or learning activities designed to develop essential professional knowledge and skills, an external advisory board that is actively involved with the program, team-oriented projects often designed in collaboration with employers, and an internship.

Career opportunities. Graduates of PSM programs are employable. PSM program directors have said that graduates of their programs are highly employable because the PSM curriculum combines a rigorous STEM background with professional skills designed in consultation with prospective employers. The value to employers of the PSM blend of science and professional skills was described by two representatives (Benzion & Babic, 2005) of the U.S. Patent and Trademark Office as resulting from graduates having the following skill set:

- Ability to read and understand cutting edge science;
- Technical experience with the tools of modern science;
- Superior analytical skills;
- Ability to communicate well in writing and by the spoken word; and,
- Ability to grasp and apply legal concepts pertaining to patent law.

The authors of a study commissioned by the National Academies (Board on Higher Education and Workforce and Policy and Global Affairs, 2008) heard testimony indicating a strong demand for PSM graduates in fields including finance, business intelligence, biotechnology, defense, and regulatory affairs. In addition, the committee's analysis of

2003 National Science Foundation data revealed that median salaries of master's degree recipients were higher than median salaries of doctoral degree recipients in four of six broad fields[6] and were higher than median salaries of bachelor's degree recipients in all six fields one-five years from the receipt of the degree, and that the salaries of STEM master's recipients had grown faster between 1993 and 2003 in comparison to the increase in median salaries of doctorate and bachelor's degree recipients during the same period of time (p. 41).

Conclusion

Historically, the focus of graduate education in most arts and sciences disciplines has been either on doctoral education or on master's programs that prepare students for entry into doctoral or first professional programs. Within this environment, the development of professional master's degrees represents a substantive change in the academic culture among faculty, departments, and disciplines, especially at research universities, but also at master's-focused universities where such programs represent a significant shift from the traditional discipline-based, research-focused model.

The rapid expansion of the PSM from a handful of programs a little more than a decade ago to more than 235 PSM programs in June 2011 can be attributed to several events. Successfully promoting the establishment of PSM programs has been a CGS initiative supported by the Alfred P. Sloan Foundation for almost a decade. Also, with Sloan Foundation support, the National PSM Association was established, boosting the success of the CGS initiative. The decision of the Sloan Foundation to scale up the development of PSM programs by focusing its funding on system-wide and statewide PSM initiatives has further contributed to the PSM growth curve. Finally, the strong endorsement of the National Research Council and the National Science Foundation's Science Master's Program (SMP) grant program were powerful catalysts. In addition to these events, the rapid growth and success of the PSM is attributable to its timely response to labor demands and student interests.

6 The broad fields are engineering, life sciences, mathematics/computer sciences, physical sciences, social sciences, and non S&E.

This volume is intended to guide those who are considering establishing PSM programs at their institutions. We discuss feasibility analysis, program development and operation, formal PSM affiliation, and program sustainability.

Chapter 2
Feasibility Planning for a Professional Science Master's Program

In Chapter 1 we described the context in which the founding and implementation of the PSM degree has been situated. By mid-2011, more than 235 PSM programs had been established at 110 institutions. Of these, about 100 were created with support from the Sloan Foundation. About 64% of the 235 programs were offered at doctoral research institutions, including 88 programs at research universities (Very High Research Activity[7]). The remaining programs were offered at master's-focused institutions. The best practice content provided in Chapters 3, 4, and 5 is based on the experiences of deans and program directors at PSM-granting institutions, conference presentations, and the published literature.

Initial Planning

Creating a professional master's degree program requires feasibility planning, program and curriculum development, institutional program approval, program initiation or start-up, and planning to address issues related to operation, evaluation and assessment, and sustainability—the topics to be covered in this volume. Determining the feasibility of creating a professional master's program demands heightened attention to a number of factors. Key among them are the professional development or "plus" curricular component, the importance of workforce relevance to the program, the necessity of establishing a broad base of support among the diverse faculty members directly involved in delivering the program or affected by it, and the integral role of an external advisory board composed of leaders from industry, business, government, or non-profit sectors.

These considerations apply both to the creation of entirely new programs and to the revision of existing programs to conform to the PSM model. Program development models include developing PSM programs based on existing programs, such as "professionalizing" an existing master's program by adding the professional development component, adding a professional track to an existing program,

7 See http://classifications.carnegiefoundation.org/ for Carnegie classifications.

or developing a program that builds substantially on an existing related master's or graduate certificate program. Approaches that do not require entirely new degree authority or certification may be more likely to gain institutional approval than creating entirely new programs. Initial costs may be lower in the former case because much of the curricular core and faculty resources are in place. In addition, adding a professional track to an existing program has the added political advantage of leaving a more traditional track in place which may have appeal to faculty members who resist professionalization of STEM degrees. Connections to existing programs with strong reputations may also offer a recruitment advantage. The remainder of this book is intended to apply to *all* approaches to developing professional master's programs unless specific differences between new and revised master's programs are noted.

In all approaches, initial planning activities should focus on the following issues:

- Employment projections
- The expertise, interests, background, commitment, and availability of qualified faculty members;
- Departmental, collegiate, university, and/or system level support;
- University priorities and culture including possible challenges to creating new programs;
- Available pool of appropriate prospects willing to serve on an external advisory council;
- Qualifications and requirements sought in new employees;
- Prospective applicant pools;
- Student demand for the program;
- Adequacy of available program resources (internal and external) and sources of student funding; and,
- Sustainability.

These issues are discussed in the following sections. Selected exemplars are provided. More information can be obtained by contacting individual programs found in Appendix A or by visiting the Sloan PSM site (www.sciencemasters.com).

Developing a financial plan. Institutional commitment includes consideration of the costs that will be specifically associated with developing and launching the new professional master's degree program—that is, differential costs that would not otherwise have been incurred. Costs vary among institutions and programs and include both one-time or start-up costs as well as recurring costs. Potential sources of funding may include internal university allocations, industry and business support, external grant funds, state legislative support, contributions from advisory board members, and tuition and fee revenues. The probability of securing various sources of funding varies depending on the proposed expenditure category.

Differential costs may be higher for the development of an entirely new degree program than for "professionalizing" an existing disciplinary master's degree by revising the curriculum through the addition of extra-disciplinary professional elements. As mentioned earlier, the reason for this is that developing new PSM programs frequently involves a greater need to garner both internal and external support than may be the case for professionalizing an existing program. Garnering support may include activities such as conferences, meetings, and/or workshops aimed at building buy-in for the program. Costs of these one-time activities include items such as meeting room rental, transportation for attendees, equipment rental, materials, staff support, and meals. Sources of funding of these activities may include external grants, university allocations, industry support, and/or state legislative support. Similarly, gaining necessary approvals to offer an entirely new graduate degree is generally more complex and takes longer than is the process of either revising an existing degree or creating a professionalized track in parallel to an existing degree. The primary cost associated with program approval is the time of the person(s) responsible for shepherding the proposal through the approval process.

Both new and revised programs must assess workforce needs, student demand, and institutional capacity. Assessing workforce needs may require market surveys of potential employers and analyzing existing secondary data, incurring substantial personnel and operations

costs. Similarly, assessing student demand for the new program may necessitate interest surveys or focus groups. Possible sources of funding of these activities may include external grants, university allocations, or state legislative support.

External advisory boards are key components of PSM programs, yet there are clear costs associated with their creation and maintenance. Creating the board involves the cost of researching and identifying prospects for board membership. Associated costs are primarily faculty and staff time; these costs will recur over time as membership evolves and changes, but at a reduced level. Costs of board meetings may include meeting room rental, transportation for attendees, equipment rental, materials, staff support, and meals depending on the membership of the board and the structure of the meeting—these costs are both start-up and recurring. Potential sources of funding may include external grants, university allocations, and state legislative support. After the start-up phase, business and industry or board members themselves may contribute financial support for the work of the advisory board.

Following program approval, costs will be incurred for seeking formal PSM affiliation and for marketing and advertising activities aimed at recruiting students. Costs associated with the optional PSM affiliation process (see Chapter 4) are primarily faculty and staff time involved in preparing documentation. At present there is no charge associated with applying for PSM affiliation; however, it is conceivable that a fee could be introduced in the future. Marketing and advertising includes a wide variety of activities such as development of a communication plan, design and development of a website, production of print materials, participation in recruiting fairs, sponsorship of applicant visits, sponsorship of recruiting fairs, advertising placement, and making presentations at professional meetings. The costs associated with these activities are both start-up and recurring, and will be incurred for both new and professionalized programs. Costs of these activities vary widely depending on local decisions; they include items such as meeting room rental, transportation/meals for attendees and/or participants, equipment rental, preparation of materials, staff support, advertising fees, and technical and design support.

Personnel needs include faculty expertise to develop and deliver the curriculum, administrative expertise, staff support, IT expertise, and staff members who perform numerous student services functions (e.g. admissions, records, health services, payroll, and accounting). All personnel needs will be recurring although the demands on personnel will be somewhat greater during the start-up phase than over the long term and may be greater in the case of new programs than in the case of professionalized programs depending on the extent of revisions required.

Salaries of existing faculty members represent a current expense incurred for faculty effort that would have been directed elsewhere; hence, these costs represent a reallocation of existing internal human resources from a previously assigned activity to activities related to the PSM. Generally, the need to hire new personnel is more likely in the case of newly created programs than for professionalized programs because the latter model typically arises from a recognized opportunity to leverage existing resources by creating the new program. Costs of hiring new faculty members needed to offer the program or of hiring adjunct faculty members needed to cover previously assigned duties of participating existing faculty may result in substantial differential costs associated with establishing the new program.

Depending on available instructional capacity, the budgeting approach of the institution, and the interest of participating units, the cost of delivering the professional skills component of the curriculum may require negotiation. For example, there may be limited capacity to accommodate PSM students in existing business classes at institutions accredited by the Association to Advance Collegiate Schools of Business because of limitations on class size or students who have not met prerequisites for courses. In such cases, a substantial expense may be associated with securing qualified faculty members to deliver such courses. In other cases, participating departments may welcome the opportunity to increase class enrollments by including PSM students in classes. Discussions with deans and department heads of participating colleges and departments should take place early in the planning process to determine whether the capacity and interest exist to deliver

the necessary curricular content and, if not, to develop a financial plan. An alternative is to locate online professional skills courses offered by other institutions that are accessible to PSM students thereby avoiding the need to arrange local financial support for this coursework.

A general indication of costs can be estimated based on previous grant activity. With support from the Sloan Foundation, in 2002, the Council of Graduate Schools offered $7,500 grants to as many as 50 master's-focused institutions to support the conduct of regional technical workforce needs assessments, student interest surveys, and dialogue between faculty, university administrators, and leaders from business, government and other employment sectors to assess the feasibility of working together to develop PSM programs. In 2003, CGS offered grants to a subset of the original grantees for implementing a new PSM program or "professionalizing" an existing master's program. These "seed" grants were intended to catalyze creation of new programs, not to cover the differential costs of establishing a new program. Grants ranged from about $34,000 to $58,000 (or about $80,000-$160,000 including university matching funds for tuition scholarships, fellowships, or assistantships reserved for students in the proposed program and a few instances of salaries for adjunct faculty members). Grant funds could be used for nearly any activity or expense other than faculty salaries, student stipends, or basic infrastructure because these costs were considered to be appropriate responsibilities of the grantee institutions. Lessons learned from the financial history of the Sloan-sponsored PSM programs indicate that start-up costs have usually been considerably less than first estimated, particularly if no new faculty hires are required. Also, after the modest seed grants ended most (about 80%) of the programs created have remained active.

It has generally been the case that if the faculty and the institution are fully committed to developing PSM programs in response to student interests and workforce needs, the cost of creating them has not posed a barrier to their development. It has been pointed out that "…some of the most dynamic programs are in the public systems of states with the very worst financial situations, like New York,

Florida, and California. Farsighted legislators will see that the modest support needed to maintain rapid expansion of the programs should not become a victim of budget cuts (Teitelbaum & Lynch, 2010)." PSM programs can help drive the economic engines of these states by preparing needed scientific personnel. Hence, as Teitelbaum and Lynch further pointed out, "…there is need for a sustained source of financing to support development of additional programs. Creating new degrees is not costly for universities that already offer much of the course work required, and once established, the programs have proved to be financially self-sustaining. Still, an initial investment is needed (Teitelbaum & Lynch, 2010)." Estimating recurring operational costs is critically important to the long-term sustainability of professional master's programs.

Finally, securing financial support for PSM programs and PSM students is very challenging for several reasons. The early vision that PSM students would be willing to pay their own tuition, anticipating an attractive career trajectory, has been stymied by the financial crisis of the late 2000s. Also, program directors have observed that doctoral students often are given higher priority for limited institutional funds. Hence, it is important that creativity be brought to bear in the search for funding. Funding opportunities specifically directed to PSM programs have been limited to a FIPSE program and the NSF Science Master's Program (SMP) program. Nevertheless a number of PSM program directors have been successful in garnering financial support as illustrated in the following examples.

An analysis of total projected costs and total projected revenue will reveal the extent to which costs will be offset by income derived from tuition revenue resulting from increased enrollment, differential tuition rates and other sources of income.

Garnering support. The feasibility of mounting a PSM program includes garnering the support of various groups including the faculty, college and university administrators, and system-wide or state level support. Considerations associated with each of these groups are discussed in the following section.

Examples of Financial Awards or Grants Received by PSM Programs

The Biostatistics and Biotechnology PSM programs at Middle Tennessee State University received a NSF S-STEM award for a project titled, "MTSU STEM Master's Scholarship Program" (#0728522). The $599,850 award provided need based scholarships of $5000/semester to talented full-time students. An S-STEM award was also made to the University of Connecticut for a project titled, "Preparing Promising Students for the 21st Century Scientific Workforce" (#0850120). The $560,427 award "…provides scholarship support to enable up to 53 academically talented, financially needy students to pursue a Professional Science Master's (PSM) degree in Applied Genomics or Microbial Systems Analysis…."

San Diego State University won an NSF Ethics Education in Science and Engineering award for a project titled, "Ethics Education for Professional Science Master's Programs" (#0932795). The $300,000 award has been used to develop ethics education materials to be made available for use throughout the California State University system-wide PSM initiative.

Rutgers, the State University of New Jersey, received a FIPSE grant in the amount of $600,000 titled, "Developing Leaders for New Jersey's Science-Based Industries: Creating a Statewide System of Professional Science Master's Degrees." The funds have been used to establish new PSM programs in bioengineering.

Garnering faculty support. Faculty buy-in is essential to the success of new program development—"top down" approaches and administrative buy-in alone are insufficient. The presence of a PSM faculty member champion can be extremely important in fostering faculty support. Because the curriculum is the domain of the faculty, it is critical to engage the faculty with the basic model of professional master's education. Even though it is likely that not every individual faculty member in a given department will be involved in the direct delivery of the PSM program, for the program to be successful it requires that the faculty as a whole understands the philosophy and

structure of the PSM and supports the creation of such a program. Historically, many faculty members in STEM fields have had little exposure to professional education models in general and to the PSM in particular; they tend to be more familiar with the research master's and doctorate and more comfortable with these degree models. Faculty members' familiarity and comfort with the PSM model is increasing along with the growth in the number of PSM programs. Nevertheless, faculty members may persist in various concerns that time devoted to PSM students will detract from their research productivity, or engaging with prospective employers will require learning new skills, or managing internships will require developing new pedagogical expertise, or students will be siphoned away from Ph.D. programs, or that the PSM will lack academic and scientific rigor.

To allay such concerns, an explanation of the rationale underlying the PSM is imperative. The Sloan website, www.sciencemasters.com, presents the following description of the PSM model along with a wealth of information about the PSM degree.

> The Professional Science Master's (PSM) is an innovative, new graduate degree designed to allow students to pursue advanced training in science or mathematics, while simultaneously developing workplace skills highly valued by employers. PSM programs consist of two years of academic training in an emerging or interdisciplinary area, along with a professional component that may include internships and "cross-training" in workplace skills, such as business, communications, and regulatory affairs. All have been developed in concert with employers and are designed to dovetail into present and future professional career opportunities. Retrieved 11/4/2010 from http://www.sciencemasters.com/ScienceMastersHome/tabid/36/Default.aspx.

The site features a navigation tab for faculty and is an excellent resource for helping faculty members learn about the PSM. The list of current PSM programs is searchable by field of study, institution, geographic region, and number of programs. It also provides hotlinks to individual programs so that faculty members can readily

find programs at peer institutions, at institutions within geographic proximity to their campus, or with missions similar to that of their campus and in particular fields of study.

Impact on research productivity. Faculty members at research universities may be concerned about how introducing a PSM might affect their research productivity. Over one-third of current PSM programs are offered at universities classified by the Carnegie Foundation for the Advancement of Teaching as Very High Research Activity and an additional 21% are offered by universities classified as High Research Activity. The fact that over half of current PSM programs are thriving at universities where faculty members have a high research expectation is evidence of the compatibility of the PSM model within the research and doctoral education environment.

Applied Genomics
University of Connecticut

The students enrolled in the PSM program are not the "traditional" graduate students matriculating into a master's program. These students are certainly goal oriented, but find themselves faced with two goals—meeting the graduation requirements of a master's level degree and performing at a level that places them in high-level positions in the biotech industry. This latter goal is what sets this cohort of students apart; they each are keenly aware that business runs at a faster pace than academia and competition for positions at biotech companies is often fierce. As such, PSM students are engaged in all facets of the biological laboratory, from experimental design and data analyses to lab management practices, and are eager to produce a quantifiable body of work (whether it is a publication, SOP, or new technique. In my experience, PSM students often exceed their master's and Ph.D.-level peers in terms of productivity and more often than not produce publications from their laboratory experience). – O'Neill (Personal communication, June, 2011)

External engagement. Faculty members may feel unprepared to engage in the external outreach needed to establish and sustain a successful PSM program. However, one of the criteria applied in the review of grant proposals to the National Science Foundation is the broader impacts of the activities delineated in the proposed project. Ways in which researchers might address the "broader impacts"

criterion include activities like establishing partnerships with external organizations such as museums, involving industry in research activities, or making presentations to the external community in formats accessible to policy makers (retrieved 11/4/2010 from http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf). As a result, many faculty members are increasing their experience in working collaboratively with external entities and are increasingly more comfortable in establishing external partnerships than was the case previously. This experience can be effectively transferred to the PSM context as in the Instrumentation PSM at Stony Brook University (retrieved 11/4/2010 from http://graduate.physics.sunysb.edu/msi2009/program/department.shtml).

Additionally, over the past decade, regional accrediting bodies, funding agencies, and other entities have been placing increased importance on external engagement. In 2006, the Carnegie Foundation established an elective classification category, Community Engagement.

> Curricular Engagement includes institutions where teaching, learning and scholarship engage faculty, students, and community in mutually beneficial and respectful collaboration. Their interactions address community-identified needs, deepen students' civic and academic learning, enhance community well-being, and enrich the scholarship of the institution. (retrieved 11/4/2010 from http://classifications.carnegiefoundation.org/descriptions/community_engagement.php?key=1213)

Efforts will be needed to make contacts with leaders from business, industry, government, and non-profit organizations and to facilitate early discussions between the faculty and representatives of these external groups. The faculty is key to stimulating interest in the PSM among external groups. Those groups outside the institution must be persuaded that the faculty is committed to reflecting their needs in designing a program that will produce the graduates they seek to move their organizations forward. Successful meetings between these groups can create a climate in which productive collaboration can occur in planning a professional master's degree program. It is very important for faculty to actively listen to employers regarding their expression of the skill sets they seek in new employees. Faculty

and dean/department head champions can assist these efforts; the graduate dean may be a particularly helpful agent for working with both internal and external groups to forge effective collaborations for a planning process.

Pedagogy. The core intellectual content of a PSM degree is natural sciences, technology, engineering, and/or mathematical/computational sciences. Hence, in most cases, the majority of the intellectual content is delivered through existing courses which faculty members have been teaching. Little, if any, change in pedagogy relative to delivery of science content is necessitated because of the introduction of a PSM. It is in the professional skills and experiential learning areas where the PSM curriculum deviates from traditional master's programs, particularly the inclusion of the internship experience which is discussed in greater detail in Chapter 3. The other professional content should be delivered by non-science faculty members with appropriate expertise.

There are many resources that can provide guidance for faculty members who have responsibility for developing an internship that provides an appropriate experiential learning opportunity for students. At the Sixth Professional Science Master's Biennial Meeting (*Proceedings*, 2010) held in 2009, several excellent posters provided experience-based information about the internship component of the PSM (Babco, Mahler & Tobias, 2009; Valafar, 2009; Khan, 2009). Another resource is university colleagues in fields such as business, dietetics, or public administration that have a substantial history and depth of experience in operating rigorous internships who may also be excellent resource persons and should be consulted for guidance. In addition, much can be learned from colleagues who have responsibility for internship or other service learning activities at the undergraduate level.

Impact on doctoral programs. The experience of directors of established PSM programs provides very strong anecdotal evidence that the PSM degree does not compete against the Ph.D. degree for highly qualified students. PSM directors report that students who

choose the PSM degree are those for whom the Ph.D. would not have been an attractive option. PSM students are seeking careers outside of academia, are unable or unwilling to invest the time required to complete a doctoral degree, and are drawn to the blend of science and professional skills components that are the hallmark of the PSM degree.

Although some PSM directors say that doctoral students have expressed interest in the "plus" components of the PSM, the widespread transfer of doctoral students to PSM programs has not been observed. However, faculty members in some doctoral departments have recognized the advantages to their Ph.D. students of earning a PSM degree or certificate in the "plus" skills en route to their Ph.D. degree or completing selected professional courses. This is consistent with the high level of doctoral student interest in programs designed to enhance career readiness of doctoral students (e.g. Preparing Future Faculty—see http://www.cgsnet.org /Default.aspx?tabid=226 retrieved 11/4/2010). Indeed, in 2000, a recommendation emerged from a conference associated with the "Re-envisioning the Ph.D. Initiative" (see http://www.grad.washington.edu/envision/index.html retrieved 11/4/2010) that, "More robust and better-integrated professional development experiences must be developed (see http://www.grad.washington.edu/envision/project_resources/metathemes.html retrieved 11/4/2010)." It appears there is an opportunity to leverage elements of the PSM model by extending its benefits to Ph.D. students without damaging enrollment in doctoral programs, which contribute in enormously important ways to meeting our national needs.

Scientific rigor. In her remarks at the 2009 PSM Biennial Meeting, Rita Colwell, Distinguished University Professor, University of Maryland, College Park and The Johns Hopkins University Bloomberg School of Public Health, and former Director of the National Science Foundation, stated that, "Talent is one of the most important keys to innovation and competitive success" (Colwell, 2009). Colwell further indicated that the master's degree is pivotal in this regard in addition to K-12, undergraduate, and doctoral education. Colwell chaired a national committee charged to study the role of the master's

degree in the natural sciences. In her remarks, Colwell discussed the committee's recommendation to build professional master's programs in the sciences that are characterized by a deep scientific base, an emphasis on communication and problem solving and include a professional skills component (National Research Council, 2008). The committee's report articulated a need for professional science master's education beyond the baccalaureate level.

PSM Rigor

The PSM is a rigorous graduate degree that differs from traditional master's degree programs not in its rigor, but in its focus on preparing students for scientific careers in business, industry, government, and non-profit agencies. The PSM model has been very carefully developed with explicit expectations for program quality including a strong foundation in a STEM discipline at the same standards of excellence against which traditional STEM graduate programs are measured. – Rita Colwell (personal communication, June, 2011)

The PSM model requires an intellectual foundation in natural sciences, technology, engineering, mathematics, and/or computational sciences. Specifically, at least 50% of the content of the program must be science content. Well-qualified PSM applicants will hold undergraduate degrees in appropriate natural science fields in order to be prepared to undertake graduate work in these disciplines within the framework of the PSM.

Once a group of faculty acknowledges the advantages of possible alternative models of master's education and has its concerns allayed, one of the most important next steps is to identify a faculty "champion" willing to lead the planning effort and to secure the backing of the department(s) and the participation of a critical mass of faculty members. As stated earlier, programs that rely on one or a small number of faculty without wider faculty/departmental support are less likely to succeed and be sustained. As many directors of interdisciplinary professional master's programs have pointed out, it is vital that one faculty member be given responsibility and credit for coordinating these programs, which have complexities that exceed those of disciplinary- or department-based master's programs. They

also argue that it is important to have a designated program director who is a member of the faculty. The program director should have full responsibility, with dedicated time and effort, to adequately manage the day-to-day operations of the program and to interface with program faculty, students, university partners, and external stakeholders.

The viability of a new degree program requires a group of faculty members who share an interest in the program and are willing to commit their efforts to program planning and implementation. As will be discussed later, professional master's programs require the participation of faculty members from such areas as business, communications, and ethics, as well as adjunct faculty from the employment sector. Some of these persons should be included in an initial planning group. The graduate dean is in an excellent position to encourage and facilitate initial discussions among faculty from relevant departments and to nurture any developing interest in creating a new degree program

Garnering the support of college and university administrators. A college dean or department head champion is equally as important as a faculty champion. Although it is unwise that an administrator be the only PSM champion on campus, a dean or department head advocate can be influential for securing both internal and external support for the proposed program. Within the university, a dean or department head may be able to facilitate the internal review process and secure provost and/or presidential support; externally, he/she is likely to have contacts at levels that are less accessible to faculty members. In the case of professional master's programs, a college dean might be especially helpful in obtaining consensus support and backing of fellow deans or heads of participating colleges and departments. The graduate dean's endorsement is key to determining the extent of administrative support needed for multidisciplinary programs such as the PSM, to promote the planning process, and provide a critical tie to broad-based institutional strategic plans/goals that provide legitimacy and the imprimatur of the university.

Aligning the proposed professional master's program with institutional strategic plans and priorities is usually required to obtain the Provost- and/or Presidential-level approvals essential for obtaining authorization to offer a new graduate degree program. Linking the proposed program to related institutional, regional, and state initiatives can be a compelling additional basis for gaining university approval. The example in the box on the following page is illustrative of the effectiveness of how strategic positioning can leverage multiple initiatives and resources to the net benefit of all participants.

Garnering system or state level support. For institutions under the auspices of an education system or state government, gaining support at those levels is critical to the success of the program, particularly in states where a system-wide or statewide coordinated PSM initiative has been or may be undertaken (see page 32, "Scaling to Statewide or System-wide Level"). System level support can be very helpful in encouraging and facilitating the development of inter-institutional collaborations, providing access to potential advisory board members, developing governmental support, securing financial resources, and disseminating information. Efforts to secure system level support must be connected to system priorities and system-wide strategic directions that have been established. Generally, demonstrating the role of the PSM in contributing to economic development within the state through innovative, advanced workforce development is an approach that resonates well within system and state level contexts. Leaders at the system level are in an excellent position to engage state legislators in recognizing the economic development value of the PSM as an outcome of partnerships between the higher education and employment sectors.

According to Elizabeth Ambos, Assistant Vice Chancellor of the California State University[8] (CSU), "The system's development of the PSM reflects a strategic commitment to building alliances with industry and forming partnerships that advance the state's workforce development, and reflects the priorities of the CSU long-term academic plan, Access to Excellence" (2009). Advantages such as the potential

8 The California State University is a 23 campus system.

to achieve multi campus efficiencies and the ability to focus new PSM programs on state needs such as the life science sector form a large part of the rationale underlying the decision of CSU to embark on a PSM initiative. Similarly, obtaining strong endorsements of leadership at the system level of both the State University of New York and the City University of New York has been a great aid in the scale up of PSM programs from campus to campus in both systems.

Biostatistics, Cell and Molecular Biology, and Medical and Bioinformatics
Grand Valley State University (GVSU)

Grand Valley State University linked a request for permission to plan new PSM degree programs in biotechnology, biostatistics, and bioinformatics to several other initiatives.

- Two state of Michigan initiatives: The "Life Sciences Research Corridor," which runs 150 miles from southeast Michigan to Grand Rapids; and the Michigan Economic Development Corporation "SmartZones" of partnerships of high-tech businesses and resources, a university, and a municipality. GVSU partnered with Grand Rapids on a major SmartZone focusing on growth in the biotechnology sector;
- A local initiative: the Van Andel Research Institute (VARI), a privately funded institute exclusively focused on cutting edge biomedical research. The VARI, along with the Life Sciences Research Corridor and the SmartZones initiatives, heightened the regional demand for an educated and technologically capable scientific workforce. Additional local initiatives that support Grand Valley State University's PSM programs are the expansion of the Van Andel Research Institute and its merger with Translational Genomics Research Institute (TGen), the move of Michigan State University's College of Human Medicine to Grand Rapids, and the construction of two new hospitals as part of the $1 billion investment in Grand Rapids' Medical Mile. GVSU's Cook-DeVos Center for Health Sciences building, which houses the PSM programs, is part of the Medical Mile; and
- A University initiative: GVSU's Center for Health Sciences houses the three new PSM programs. This $58 million, five-story, 215,000 square foot state-of-the-art instructional facility is located on GVSU's Grand Rapids campus, in close proximity to internship sites in the laboratories and facilities of the VARI, Spectrum Health, St. Mary's Mercy Medical Center, and neighboring biotechnology spin-off companies. This facility contains a specifically designed bioinformatics laboratory equipped with computers that can accommodate bioinformatics and biomedical informatics software; an integrated "biotechnology laboratory suite" designed and equipped specifically to support upper-level and graduate interdisciplinary cell and molecular biology and biotechnology instruction; adequate instructional space and computer laboratories to support the PSM program in biostatistics; and dedicated project rooms and spaces to encourage students and faculty to meet and work together on team projects.

Unique local or state-based factors related to the nature of the professional master's program under consideration may contribute to the rationale for developing the program. Institutional partnerships, location, and local forces can help support decisions to create professional master's programs.

Graduate deans are well positioned to inform presidents and provosts of national trends and best practices and to keep them briefed on local progress. Institutional presidents and provosts are in the best position to engage system and governmental leaders in conversations about the potential of the PSM, usually in cooperation or coordination with the graduate dean.

Considering university culture, priorities, and challenges to creating new programs. "Every organization has a culture" (Sporn, 1996). However, as Sporn pointed out, university culture is difficult to assess because it is "…grounded in the taken-for-granted shared values and beliefs of individuals and groups in the organization…" and because subcultures exist at various levels throughout the university from the disciplinary to the administrative level. Sporn proposed a two dimensional (i.e. strength and orientation) typology of university culture that can help an institution evaluate its potential for change. Sporn's resulting four categories are:

> **Weak, internally-focused** cultures have divergent values, beliefs, and attitudes. They are dominated by subcultures with their work being concentrated on internal affairs. The university members concentrate on their own work and do not identify with the university as a whole. Few members of the university community are willing to adapt the university to changing conditions in the environment.
>
> **Weak cultures with an external orientation** also have subcultures with divergent values and beliefs, but the subcultures are focused on the external environment. However, the activities of the different subcultures are not coordinated. With this orientation, the university can still adapt in a changing environment. To stay successful though, a strong university culture will have to be developed while the external orientation is retained.

> In **strong, internally-focused cultures**, uniform values, beliefs, and attitudes dominate. The university members and groups generally share the same patterns of behaviors and values concerning internal activities. Organizational adaptation to external changes is only poorly supported by the culture. This type of culture is adequate in stable environments, but it will encounter problems as soon as external changes arise.
>
> The members of **strong and externally oriented cultures** share the same values, beliefs, and attitudes. Their activities are externally oriented. They show the same patterns of behavior and they have the capability of reacting flexibly to changes. This cultural type is the most suitable for enhancing adaptation. Although this culture can consist of subcultures, they are integrated in the university as a whole. In this situation the university can reach its goals effectively by coordinated activities of the subcultures. (Sporn, 1996, pp. 55-56)

Clearly, strong and externally oriented departments and universities are best positioned to embrace an innovative graduate program such as the PSM and are most likely to engage in the entrepreneurial behaviors necessary to ensure its success and sustainability.

Institutional culture also includes how graduate and professional programs are perceived and supported by the faculty, administration, and governing body. The more closely a proposed program fits within this aspect of the general university culture, the greater the likelihood of its success.

In addition to institutional culture, another important early consideration is the extent to which the concept of a professional master's degree program is designed specifically for meeting local, regional, and state workforce needs consistent with the mission and strategic priorities of the university. The more closely a proposed program aligns with the university's mission statement and strategic plan, as well as with those of the sponsoring or participating department(s) and college(s), the more likely it is that approval to plan the new degree will be granted and that subsequent support for a new program will be provided.

In times of economic and concomitant resource constraints, many universities are undertaking serious examinations of their strategic priorities and assessing the extent to which programs are in alignment with priorities. Howard University is a recent example of such university-wide program examination and review (Berrett, 2010). Early discussions with the central administration of the university should reveal whether or not the proposed program is consistent with the mission and current strategic priorities of the university and whether there are any restrictions to planning new degree programs. These can range from financial limitations of the institution or the state—which often can be addressed successfully by careful planning and development of a good business/financing plan—to freezes sufficiently serious as to preclude proceeding with plans to develop a new program. Programs that can demonstrate sustainable business plans that are revenue neutral or have the potential to generate positive revenue often have a greater likelihood of being approved.

Determining local/regional employer workforce needs[9]. Establishing an advisory board of leaders from business, industry, government, and non-profit agencies early in the planning process is the most important means of acquiring information about anticipated future workforce needs. Members of a well-appointed advisory board are excellent sources of information about the types of positions that will be needed in the near term, the employment sectors where growth is anticipated, and the qualifications that will be sought in prospective employees.

In addition to establishing the advisory board, the following activities and strategies have been found to be useful in determining the needs of local/regional employers:

- Invite potential employers to participate in focus groups regarding employment needs. (see Appendix E for a focus group protocol used by the Minnesota State Colleges and Universities.);

9 See Appendix D for a list of current PSM Program Directors who are willing to share employer and/or student surveys they developed and used effectively in determining the feasibility of establishing the PSM program(s) now in place at their institutions.

- Consult internet sites such as www.ajb.org (America's Job Bank), www.wherethejobsare.org, www.usajobs.gov;
- Compile data on local/regional R&D expenditures;
- Join local/regional business roundtables and similar organizations;
- Survey a selected group of local/regional employers concerning their projections of needs for new employees and required qualifications. Involving the advisory board in both the design of the data collection instrument and in the data collection process will greatly enhance the usefulness of the results. (see Appendix F for an employer survey used by the City University of New York);
- Consult with alumni who are in a position to provide relevant information;
- Consult BLS statistical reports (www.bls.gov) and organizations focused on workforce issues such as Georgetown University's Center on Education and the Workforce (see http://cew.georgetown.edu/ retrieved 11/5/2010); and,
- Confer with regional economic development agencies which usually have compiled relevant data.

Conducting some of these activities prior to directly interacting with advisory board members or other employer representatives will greatly enhance the effectiveness of those discussions.

Faculty members and appropriate administrators who are involved in program planning should engage in discussions with the advisory board or other appropriate group of selected potential employers about the data compiled. These conversations will not only contribute to substantiating workforce needs but also will be likely to increase employers' cooperation in providing realistic projections of employment needs, willingness to commit to being involved in planning the program, sponsorship of student internships, development of student projects, encouragement of employees to pursue the degree, facilitation of meetings with key employers within their established professional networks, and other activities that support the program and enhance its probability of success. For example, board members can provide testimonials at industry events or to be used on PSM websites.

High-level executives such as the director of research, the CEO (especially of smaller businesses), or the director of a government agency are more likely to provide useful input into the planning process, to make commitments on behalf of their organizations, and to provide realistic projections of workforce needs. Once engaged through the planning process, these executives are more likely to transmit information about the new program to human resource personnel in ways that will benefit consideration of PSM graduates as potential employees or consideration of current employees as potential students.

One technique for identifying workforce needs is conducting an employer survey. Employer surveys can garner local information such as job openings, earnings data, characteristics of job vacancies, and hiring practices and policies (Winword, 2001). Obtaining a reasonable response rate requires a very targeted and robust list of potential respondents, established relationships with business and industry organizations, expertise in survey research methodology, and knowledge of time cycles likely to generate maximum response rates (Nair and Mertova, 2009). However, employer surveys are challenging to design and to implement. Goldschmidt (2005) pointed out that employer surveys involve "…straddling two very different cultures…"—academia and business—which increases the complexity of such an undertaking. For this reason, Goldschmidt used a consulting firm to conduct an employer survey. A key function performed by the consulting firm was to generate an employer list by securing confidential lists from selected professional associations. If resources are not available to permit the use of an external firm, faculty members who are experts in survey design and data collection strategies can provide valuable assistance that may improve the quality of the data collected and increase the response rate.

Because of the complexities and challenges associated with conducting employer surveys, Winword advised exhausting all other techniques for obtaining data on workforce needs before conducting an employer survey. He stated, "Some compare running an employer survey to committing a crime: think twice before doing it because there

are innumerable ways to get caught!" Even so, Winword provided excellent practical guidance regarding the design and conduct of employer surveys. An alternative method for assessing workforce needs was used at Towson University.

Forensic Science
Towson University

Towson University engaged a consultant with substantial crime lab experience to identify and contact lab directors and arrange for interviews with the PSM planning committee. Interviews produced consistent projections of about a 33% increase in demand for forensic scientists over the next several years, which provided strong support to proceed with planning and subsequently led to a CGS/PSM implementation grant. The process also generated general support for the proposed program across the forensic community in the Maryland/Washington DC area, identified several persons who agreed to serve as advisory committee members and/or adjunct faculty members, commitments of student internships, and informed projections of full-time employment opportunities for graduates of the program.

The Forensic Science program has reached its maximum enrollment of 40 students with a graduate placement rate that is near 90%. It has been accredited by the Forensic Science Education Program Accreditation Commission (FEPAC) which is sponsored by The American Academy of Forensic Sciences. The program is a PSM and is also one of only four graduate forensic programs that are both FEPAC accredited.

Working closely with trade associations and economic development agencies can yield a great deal of data (David King, personal communication, June 2011). King's experience has been that the SUNY PSM leaders are regularly invited to trade events as a result of their outreach efforts. Further, King indicated that such relationships can yield not only data, but also contact information and email lists of potential employers.

Determining student interest and identifying applicant pools[10]. Professional science master's programs appeal to current students and to the employed. Among current students are undergraduates who are considering options following completion of their bachelor's degrees including entering the workforce, pursuing graduate studies, or other possible endeavors. For undergraduate students who had not considered graduate study, a PSM program may be a very attractive option because it represents a course of study developed specifically to meet professional workforce needs and it can be completed in two years. Another group of current students are those who are pursuing Ph.D. degrees and have career goals outside of academia. The professional skills component of the PSM degree is becoming increasingly attractive to this group of doctoral students because of its relevance to their professional career goals and its unique professional content. For this group of students, earning a PSM degree en route to the Ph.D., or access to the professional skills component, has been found to be an additional source of class enrollment. Some institutions offer the professional component as a freestanding graduate certificate that is open to various groups of students. Packaging the professional elements as a graduate certificate offers an accessible point of entry to graduate study that subsequently may lead some students to choose to continue in pursuit of a full PSM or other graduate degree. Graduate certificates also may generate incremental student enrollment that can be very helpful from a sustainability perspective.

10 See Appendix D for a list of current PSM Program Directors who are willing to share employer and/or student surveys that they developed and used effectively in establishing the feasibility of establishing the PSM program(s) that is now in place at their institutions.

Management for Science Professionals Graduate Certificate
Oregon State University

The graduate certificate in Management for Science Professionals at Oregon State University is designed for individuals in science or science-related fields seeking professional development. Formal training in business management, communications, ethics and technical skills allows graduates of the certificate program to broadly communicate with diverse groups of people and move into leadership positions within their organizations and is ideal for students of professional science tracks like veterinary medicine or pharmacy, current industry or agency employees who want to advance in their careers, or continuing students envisioning careers with future managerial responsibilities. The certificate requires 18 quarter credits offered through the Professional Science Master's degree program and can be taken on campus or online.

Another group of potential PSM students are current students who are pursuing other master's degrees but have career goals more closely aligned with the PSM. For example, students in a thesis-required master's program may find that the PSM program better suits their academic needs. Or, students in a master's program in a root discipline may find that a newly developed PSM program that applies disciplinary content to a specific problem better supports their career goals and elect to transfer into the new program. While meeting students' academic and career goals should be the chief principle, attracting net *new* students to the university is often advantageous in gaining administrative support and approval.

In addition to current students, currently employed adults comprise another group of potential PSM students. Some employees are at a stage in their career paths at which earning a master's degree would be advantageous or essential to career advancement. Others are ready for a career change that would be facilitated by earning a PSM. Both groups include potential full-time and part-time students, as well as those who would be able to pursue the program only if offered on-site at their place of employment or on-line. Many employers may offer their employees either pre-pay or reimbursement programs for partial or full tuition particularly for programs designed to closely relate to their specific workforce needs. Current IRS rules permit companies

to offer up to $5,250 per year to each employee tax-free. Companies may limit their financial support to this amount and/or may stipulate other policies regarding access to this employee benefit. Establishing an advisory board early in the planning process creates an opportunity to interact directly with potential employers of graduates of the program to elicit their views on employees as potential students and to ascertain their knowledge of employer tuition assistance programs. Currently, there is also a tax incentive for employees who pursue higher education. As mentioned previously, employer tuition assistance up to $5,250 can be excluded but amounts in excess of $5,250 are taxed (http://www.irs.gov/pub/irs-pdf/p970.pdf, p. 76). Taxpayers who have adjusted incomes of less than $80,000 may deduct up to $4,000 tuition and fees expenses on their federal income tax returns (http://www.irs.gov/pub/irs-pdf/p970.pdf, p. 49). It should be noted that all such tax benefits are subject to change and should be monitored.

Veterans comprise another category of potential students. Veterans are of particular interest because of the educational support provided by the GI Bill. The GI Bill supports qualifying veterans by assisting with the cost of tuition and fees, providing a housing allowance, and covering the cost of books and supplies up to a fixed annual amount[11]. The California State University system-wide PSM program includes an initiative targeted toward veterans. "The purpose of the initiative is to make Professional Science Master's Degree and Certificate programs available to veterans, active duty military, and other members of the military community. The focus is on preparing military personnel who have backgrounds in science, technology, engineering and mathematics (STEM) fields for employment in high demand science and technology positions in the civilian sector (http://www.calstate.edu/psm/military/)."

All likely categories of potential students and combinations of categories should be considered when planning a program. Decisions will be required regarding the extent to which the program will be focused exclusively or primarily to attract one or more categories of potential students. The implications of these considerations and

11 For more information see http://www.todaysgibill.org/ and http://www.gibill.va.gov/.

decisions will play out in more detail in subsequent chapters in sections on curriculum development and the business plan.

But identification of applicant pools and determination of actual interest within groups must be primarily conducted by direct contact with students. Among the strategies employed by professional master's programs to assess student demand and interests are:

- Focus groups with selected students from the university regarding their level of interest in the proposed program;
- Focus groups of students at "feeder" universities to the university's graduate programs regarding their level of interest in the proposed program;
- Surveys of the university's own students or those of other universities regarding their post-undergraduate plans and interest in the proposed program;
- Intake as a result of contacts with students at recruitment fairs, professional meetings, or other venues;
- Focus groups with selected employees at work sites of potential students for the proposed program regarding their level of interest in the program;
- Focus groups of surveys of working adults from local/regional industries that the proposed program is designed to serve; and,
- Focus groups or surveys of current students enrolled in graduate or certificate programs who might transfer or enroll in the new program (an example of a student survey instrument is included in Appendix G).

Determining institutional capacity. Institutional capacity is dependent on having secured the commitment of the institution's leadership and also on the availability of the resources necessary to ensure the success of the program. These resources include faculty expertise (e.g. pedagogical skills, intellectual expertise, internship supervision skills); staff support; laboratory facilities; library resources and IT support; classroom, office, and administrative space; student support services (e.g. advising, career counseling, job search services, health services, academic support services); financial aid for students; administrative support services (e.g. admissions processing, enrollment services, international student services, registrar's

services, human resource services); personnel policies that provide rewards/credit for faculty members' participation in the program; and others. Resource requirements and capacity vary among institutions and programs but generally tend to cross departmental, collegiate, and administrative boundaries. For this reason, access to general departmental infrastructure may not be readily available and access to central university services must be clarified and confirmed. Up-front consideration and arrangements are particularly crucial to successfully planning and implementing a new professional master's program.

Unique resources related to the nature of the professional master's program being considered should be leveraged strategically. Geographic location and local or regional societal forces often stimulate and guide decisions to create professional master's programs as the following example illustrates.

Physics Sub-Plan in Technical Management
University of Houston-Clear Lake

The University of Houston-Clear Lake took advantage of its location near the Johnson Space Flight Center and space industries to create a PSM program in Professional Physics Sub-Plan in Technical Management. The program has graduated three students in 2010 and will graduate two in 2011. Most of the students in this PSM program work full-time and take approximately three or more years to graduate.

The primary resource of a university is the expertise and interests of its faculty. Evaluation of faculty strengths and interests may reveal areas for recruitment of new faculty that could support a proposed program and benefit the institution. If new faculty members are needed to mount a new degree program, firm commitments for the faculty lines should be secured prior to development of detailed plans. In other situations, the planning process may provide the required documentation to secure faculty line commitments after the planning period but before program development and implementation are underway. Faculty with appropriate backgrounds for and interests in a new program do not constitute a sufficient base if they lack the time to plan, implement, offer, and sustain the program. Thus, realistic

faculty effort must be determined and secured through commitments of departments, colleges and the university. Faculty energy and enthusiasm during the excitement that is characteristic of the planning phase may not be sufficient to assure the program's long-term success.

It is preferable that tenured or tenure-track faculty members constitute the core of the program. However, professional master's programs are generally inter- or multidisciplinary in nature and require the participation of faculty members from related disciplinary areas and/or disparate disciplines to assure the proper mix of disciplinary depth and professional components such as business, communications, project management, regulatory or legal requirements, ethical principles, and so forth. Multiple conversations may be required at the faculty, department head, and dean levels to secure necessary commitments of faculty and other resources from various participating units. Supplementing the efforts of tenure-track faculty members with part-time or adjunct faculty members, who are practicing professionals, allows staffing flexibility and may reduce start-up costs. The use of some part-time or adjunct faculty members who are practicing professionals to supplement the efforts of tenure-track faculty members has been found to offer staffing flexibility and may reduce initial costs of starting new programs.

Creating an External Advisory Board

Although external boards serve in an advisory capacity, their active engagement is critical to the success of PSM programs; therefore, the criteria for recognition as a PSM program include the establishment of an active advisory board. Most program directors have indicated that it has been critically important to their success to establish and involve an advisory board at the earliest indication of eventual program approval. Such involvement is credited with improving the program curriculum and structure. An effective way to work with advisory boards regarding curricular development is to place faculty members in a central role. Faculty should take the lead by preparing a draft curriculum for comment and input by board members, thus providing an opportunity for meaningful interaction between faculty

and board members. Framing the conversation in terms of seeking input regarding specific knowledge, skills, experiences, and behaviors employers seek in new hires is a positive way for faculty to interact with the board and respects the roles of both groups. For example, employers frequently indicate that in addition to intensive disciplinary knowledge, they also seek employees who have knowledge and skills in business fundamentals, project management, teamwork, computation, communication, ethics, and legal and regulatory issues (Teitelbaum, 2010). It is the task of the faculty to garner input such as this from the advisory board and transfer it into the curriculum by translating and organizing it within the standard university course and sequencing structures.

Scaling to Statewide or System-wide Level

The remarkable success of the PSM model of graduate education has expanded to the development of coordinated PSM initiatives at the state- or system-wide level. Generally, successful state- or system-wide initiatives have based the leadership of the initiative on a lead campus rather than in the system office. Scaling PSM programming to the state or system level generally focuses on regional workforce and economic development needs. In New York, the Governor is appointing regional economic development councils that will have PSM representation. Scale-up can aid in developing inter-institutional collaborations such as the sharing of "plus" courses, provide access to potential advisory board members at high leadership positions, leverage financial resources, and enhance information dissemination. State- and system-wide collaboration also enhances branding and recruiting effectiveness beyond what individual campuses could accomplish. This scaling has been aided by support and activities of the National Governors Association (NGA), the National Conference of State Legislatures (NCSL), the Alfred P. Sloan Foundation, and the National Association of System Heads (NASH). Drivers of system- and statewide PSM initiatives include faculty and deans at key campuses, the career experiences of PSM graduates, strong student demand, growing support among employers, support of system heads, and the embrace of the PSM by CGS, National Research Council,

Association of American Universities, and others (Teitelbaum, 2010). The Sloan Foundation began making system-wide grants in 2005 to scale up the PSM initiative and to enhance program sustainability. Early leaders were the California State University System (n=23), the University of North Carolina (n=17), and the State University of New York (SUNY, n=10).

Building infrastructure. The Sloan Foundation has provided funding to "…create statewide PSM initiatives in the large state university systems, and bring the PSM initiative to the attention of state legislatures and governors' advisors on workforce and economic development (http://www.sloan.org/program/15/page/67)." The Foundation made grants to the NCSL to "…enhance the national dialogue about the PSM degree with a key group of stakeholders-state legislators," and to the NGA to "…fund activities on the Professional Science Master's degrees as part of National Governors Association 2007 Chair's Initiative 'Innovation America.'" Both of these projects stimulated and supported statewide PSM initiatives. Specifically, the NGA sponsored a PSM Academy in June 2008 that served an important catalytic role in the creation of PSM leadership teams at the system-wide and statewide level. The states of California, Oregon, Arizona, Pennsylvania, and Virginia were selected to participate in the 2008 Academy, *State Strategies to Meet Emerging Workforce Needs through the PSM*. In a 2006 issue brief, the NGA stated, "Professional Science Master's degree programs are of interest …to states and governors because they supply the labor market with very highly skilled workers capable of working in research, development, and early stage manufacturing. PSM degree holders… produce [sic] a regional brain gain" (Crawford, 2006).

Led by Don Langenberg and Sheila Tobias, the goal of the National Association of System Heads (NASH) PSM project is "…to inspire and facilitate the rapid development of system-wide and statewide PSM initiatives…." The NASH website[12] provides helpful information for those who may be considering a state- or system-wide PSM initiative.

12 See http://www.nash-psm.org for more information.

Also, links to many existing state- and system-wide PSM programs are listed on the site.

Collaborative PSM initiatives. In addition to these grants to create infrastructure, the Sloan Foundation has provided funding to directly support the state- or system-wide development of PSM programs. Appendix C presents a list of the current state- and system-wide PSM initiatives, a brief description of each, and indicates those that have received Sloan Foundation support. The directors or coordinators of these initiatives and the associated websites are extraordinarily useful sources of information and guidance for those who are considering launching similar initiatives or scaling up an existing PSM program(s).

Of particular note is a unique, virtual, system-like initiative. Led by the Associate Provost for Research and Dean of Graduate Studies at the University of the District of Columbia, the Historically Black Colleges and Universities Mid-Atlantic PSM Alliance is a "system-like" alliance of seven HBCU institutions and one associate institution. Based on a shared commitment to diversity, the HBCU Alliance, funded by the Sloan Foundation, was formed to develop and coordinate new PSM programs in the Mid-Atlantic region, which is populated by a large number of STEM-related employers in the government, industry, and non-profit sectors, and to enroll underrepresented students (Hartline, Eckberg & Whittaker, 2009). Of the 16 proposed programs, three have been launched: Quantitative Fisheries (University of Maryland Eastern Shore), Applied Statistics (University of the District of Columbia), and Water Resources Management (University of the District of Columbia). The HBCU Alliance is noteworthy in both its form and function and stands as a model of creativity that could be replicated as a means of leveraging unique opportunities and capacities.

While scaling up to the state- or system-wide level will not be appropriate to all situations, there are certain efficiencies and opportunities that may arise through scale ups. For example, many of the PSM programs within state- or system-wide initiatives have engaged in parallel planning as there may be cost savings in

developing multiple PSM programs. This is particularly true when course content, human and other resources can be shared. There may also be added advantages to increasing program diversity by offering common coursework to students in different participating programs to cultivate multidisciplinary learning that typifies PSM programs.

Summary

Creating a Professional Science Master's degree program requires careful feasibility planning to address issues related to operation, evaluation and assessment, and sustainability of the program. Determining the feasibility of creating a PSM program must consider factors such as: the professional development (or "plus" curricular component,); the importance of workforce relevance to the program,; the necessity of establishing a broad base of support among the diverse faculty members who will be directly involved in delivering the program or affected by it,; and, the integral role of an external advisory board drawn from industry, business, government, or non-profit sectors. Many successful, well-established programs offer models of best practice.

Chapter 3
Developing and Operating a Professional Science Master's Program

The cornerstones of PSM programs are multidisciplinary curricula and collaboration between academic faculty and employers. These elements, anchored by a natural science, technology, engineering, mathematics and/or computational sciences, intellectual core and professional skills development experiences, prepare graduates for leadership roles in areas such as management, marketing, operations, policy, and entrepreneurship. The increasing numbers and diversity of PSM programs point to growth in master's education that is responsive to the needs of students and employers while bringing academia and industry in closer contact to promote and sustain innovation. Thus, this chapter discusses establishing new PSM programs and modifying existing programs that have been identified as prospective PSM programs within the context of the *Guidelines for Recognition of Professional Science Master's Programs*.

When creating a new PSM program or addressing issues encountered in the context of an established program, directors of other PSM programs should be contacted to solicit information about effective strategies that have been used during the development and/or management of their PSM programs. Established PSM program directors are very helpful in offering valuable information, resources and opportunities for networking and collaborative relationships. A complete list of existing PSM programs is available at www.sciencemasters.com.

PSM Recognition Guidelines

In 2010-11, PSM stakeholders worked with the Council of Graduate Schools (CGS) in revising the *Guidelines for Recognition of Professional Science Master's Programs* presented in Figure 5. The work culminated in the establishment of seven criteria *must* be met by all programs seeking PSM Recognition and should be closely referenced during the process of developing or revising prospective PSM programs. It is imperative that the faculty members involved in a PSM initiative monitor these Guidelines from the outset of discussions

to ensure that the program will be eligible for CGS Affiliation.

When requisite institutional approvals have been obtained, a program can become nationally recognized by the national PSM office housed at the Council of Graduate Schools. National recognition includes a separate application process that is described in detail in Chapter 4; (see www.sciencmaster.com/affiliation/psmaffiliation/tabid/61/default).

External Advisory Board

As noted in Chapter 2, an integral element of PSM program development is the early establishment of an active external advisory board. The advisory board should be actively involved with the program faculty in the process of clarifying program objectives, identifying expected learning and professional skills development outcomes, and ensuring that regional workforce needs will be met.

Figure 5. Guidelines for Recognition of Professional Science Master's Programs

1. The institution must be accredited by a regional accrediting association, or in the case of international applicants, a recognized organization or appropriate governing body that accredits or recognizes institutions of higher learning.

2. A program must have stated goals and learning outcomes appropriate to the particular degree.

3. The total number of credits must be at least equivalent to the minimal number required for a master's degree at the institution.

4. Programs must include the following three components:

    (a) a majority of the course content in the natural sciences, technology, engineering, mathematics and/or computational sciences;

    (b) a professional skills component must be developed in consultation with leaders from industry, business, government, or non-profit organizations; and,

    (c) an experiential component that must include at least one capstone project, supervised collaboratively by faculty and employers, evaluated or graded by faculty and typically developed with an employer(s), which integrates the practical application of scientific and professional knowledge, behavior, and skills. The experiential component typically includes a structured internship and provides an opportunity for students to demonstrate proficiency in written and oral communication skills.

5. Program quality assurance must be provided using the faculty-based mechanisms normally used by the institution for graduate programs in order to ensure that the program is fully integrated into the academic offerings of the institution and is sustainable over time.

6. An active and engaged advisory board of leaders from industry, business, government, or non-profit organizations is required.

7. The program must collect annual data relative to enrollment, degrees, completion, and demographics; and the employment history of graduates should be tracked to help assess program outcomes.

Advisory board roles. Advisory board members contribute to the conceptualization of the PSM program and meet on a regular basis to provide ongoing advice. Institutions with multiple PSM programs or tracks may have joint advisory boards; however, in this case, members should be chosen to represent the full breadth of targeted employment sectors.

Some additional roles of advisory boards include advocating for the PSM at the local, state, and national levels, as appropriate; assisting in the development of internship sites; identifying site-based student projects; providing financial support to the program; and hiring graduates of the program (Teitelbaum, 2010). In some cases, advisory board members may also send current employees to PSM programs and cover their tuition.

The role of the advisory board will evolve over the course of the planning, implementation, and operational phases of program development. For example, at the program approval state, advisory board members can and should provide letters of endorsement for the program. Once a program is operational and students are enrolled, the advisory board will assume an important role in ongoing evaluation and "fine-tuning" of the program to maintain its currency and attractiveness to both students and employers.

PSM Programs at the University of Maryland University College (UMUC)

University of Maryland University College has seven PSM programs. All five programs are served by a common PSM Advisory Board comprised of members from each of those programs. In addition to the advising and recruiting and industry outreach assistance from the advisory board members, the UMUC PSM Advisory Board was used effectively to provide invaluable advice and feedback in the development of an online mentoring program. Over the course of one year, the Board's exclusive charge was to help with the timely launch of the online mentoring program. Two face-to-face meetings were interspersed with two phone conferences. Each in-person meeting was two hours long and each phone conference was one hour long. Both had a full agenda with clearly marked action items. Most of the material for the program, including the website, was discussed, designed, and developed during these meetings.

It is important to choose a format for advisory board meetings that can accommodate members' busy schedules and optimize the use of their valuable time—in some cases donated from members' personal leave. It is particularly critical that the agenda be carefully planned and followed. Board members should be given the opportunity to provide input to the agenda prior to distributing the final version and accompanying materials in advance of the meeting. One example of an effective meeting format is the on-campus breakfast meeting. Another successful format is a conference that includes faculty, a cross section of campus administrators, employers, and alumni. Program directors have found that it is important to arrange some meetings at locations other than campus to demonstrate to business leaders the high value placed on their involvement. There are a number of options for planning the logistics of an advisory board meeting; however, logistical decisions are dependent on local circumstances and available resources. Meetings should be few and conducted with efficiency; email permits regular feedback between formal meetings.

Identification of members. Nearly *three-fourths* of science, mathematics, and engineering graduates obtain non-academic employment in business, industry, or government, generating a rich pool from which to pull potential advisory board members (National Science Foundation, 2006). Prior to making initial board appointments, it is important to carefully consider how the role of the board may change over time and how the characteristics and qualities needed among members will shift accordingly. For example, in the early stages of program development, curricular advice will be important; later, the board may be called upon for assistance with internship placements or student scholarships. A member who offers curricular guidance may not have decision-making authority to grant financial resources such as scholarships. Therefore, it is wise to appoint board members who are well positioned within their organizations because they have the ability to access resources and possess the authority to make key decisions. The potential role and contribution of each prospective board member should provide guidance regarding suitability of the appointment. There will be times when appointing board members from the highest levels of their organizations is advisable. This approach is often effective because such individuals usually have access to others

internal and/or external to their organizations who are able to arrange internships, give guest lectures in classes, develop student projects, and so forth. However, Stites-Doe, Tsubota, Godleski, and Barbosu (2009) recommend selecting appointees who are at a level below CEO.

> It might seem advantageous to people the board with high-level executives, but the best advice (and cooperation) will come from the project-level managers; these managers have fresh experience with new hires and their deficiencies. Try to select alumni for the board. They are likely to have greater patience and a sincere interest in a successful outcome. Choose representatives from companies, both large and small, both local and national. (p. 3)

Even though faculty members may not have courted external constituencies to support their work other than through the arms-length peer review process of obtaining research grants, they are usually a valuable source of ideas and contacts for appointees to advisory boards. Alumni employed in non-academic sectors, potential employers of graduates, regional/state economic development officers, community leaders, and students are among groups that can be contacted to explore advisory board membership. The focus, location, and other aspects of program planning may influence the process of identifying other prospective members of the advisory board. Alumni associations and development officers may also be effective resources in identifying appropriate persons for the advisory board.

It is not practical that advisory board membership will be all inclusive. Therefore, PSM campuses need to encourage university/business collaboration broadly. Throughout the process of establishing a formal advisory board, it is important and useful to involve the department head, academic dean, and graduate dean and to involve them directly when needed. Often the formal invitation to join the board issued by a dean or provost.

Number of members. Assembling an advisory board with broad representation is important; however, obtaining the best possible representation from each sector is equally important. PSM directors point out that recruitment of advisory board members requires multiple points of contact to build relationships and these relationships are maintained by regular, effective communication to sustain members' active involvement in and support of the program. Although there is considerable variation, a group of approximately 8-12 representatives from the employment and community sectors is common for advisory boards. It is also recommended that one or two students serve as advisory board members.

Personnel

One key to the success of any new program is ensuring that a highly qualified and committed staff is in place. Initial energy and enthusiasm that is present during the early stages of program planning will need to be nurtured over the long-term.

Program director or coordinator. It is necessary to identify a faculty member to serve as program director during the development phase. This individual will be charged with convening meetings, drafting requests for approval, identifying and overseeing staff and resources, and effectively managing the program development process, among other responsibilities. The program director or designee(s) should begin the process of obtaining approvals that will enable advertising the program and enrolling the students. These may include faculty or curriculum committee approvals at the department, college, and university levels; governing board approval; or State Board of Education approvals.

In some cases, the initial program director may serve on interim or short-term bases and may not necessarily continue as permanent director or coordinator once the program is launched. A change of leadership may occur because the interim director has other obligations or is not interested in continuing in this role. When a position has been occupied on an interim basis, some institutions will require a formal search, at least internally, to fill it on a permanent basis. Those who

have led the planning or assumed an interim role often possess unique qualifications advantageous in such a search process. Regardless of the hiring approach, an effective program director will have many of the following characteristics: deep commitment to the PSM philosophy; strong academic background in the area of the degree; experience in graduate education; ability to work with faculty members from disciplines outside one's own; supervisory skills; understanding of assessment approaches; familiarity with institutional processes and procedures; excellent communication skills; ability to work with prospective employers of graduates of the program; experience working with external advisory groups; and ability to develop a sustainable business model for the program. It is advantageous that the director be a tenure-track faculty member because this status affords academic recognition as well as access to individuals and organizations necessary for successful program operations.

A position description for the director must clearly articulate the specific duties and responsibilities associated with the position. Appropriate compensation must be provided.

It will be necessary to determine the proportion of the director's time that will be required to fulfill the expectations of the position in order to determine compensation. (For example, if the director's position requires 25% (part-time) of his/her time, compensation might be constructed differently than would be the case if it were a full-time position.) A common model is a part-time director position occupied by a full-time faculty member who is compensated by various approaches such as releasing time allocated to other duties (e.g. classroom teaching, committee assignments) in order to fulfill the directorship duties. Other forms of compensation could include providing a graduate teaching assistant, additional travel money, reimbursement of professional dues, or equipment money, to reward the extraordinary challenge of directing an innovative and multidisciplinary graduate program. Additionally, a salary supplement, or summer support where none exists, should be considered in recognition of the complex administrative, supervisory, and coordinating aspects of a directorship that necessarily intersects with multiple internal and external

audiences often at a high organizational level. Regardless of whether the position is part-time or full-time, travel-related funds should provide for the director's interactions with external constituencies (e.g. representatives of business, government, non-profit agencies) allowing for the director's participation at professional meetings relating to the PSM.

Support staff members. Talented support staff are often the key to mounting a successful graduate program. Support staff members represent the program to prospective students and the general public and are essential in projecting a compelling program "story." Because of the complexity of PSM curricular design and the need to build external connections, the coordination and management functions are considerably more demanding than is the case for traditional disciplinary based programs. It is essential that an adequate number of support staff members have been allocated to perform all functions necessary to successfully operate the program.

Experience has demonstrated that adequate staff support for professional master's programs is essential to program success. Staff costs vary depending upon the administrative structure adopted for the program and the local labor market. Staff for the new program should be hired as early as possible, given position descriptions with clearly delineated duties, provided appropriate orientation to university policies and procedures, and given access to resources sufficient to enable them to successfully carry out assigned duties and responsibilities.

A staff member with a primary role in program operation may assist the program director or may have full responsibility for specific functions such as; providing the primary contact point with the public, applicants, and newly admitted and enrolled students; managing recruiting and admissions; designing and managing the new student orientation program; developing internship sites; advising; providing career services (such as résumé preparation, job search, interviewing skills); and interfacing with university administrative offices on matters such as preparing catalog copy, securing financial support, managing

student fellowships/scholarships, and so forth. It is recommended that these duties be assigned to a staff member because faculty members are unlikely to be able to devote the time needed to adequately discharge such duties, nor are these activities the most effective use of faculty time and effort. In addition, many program directors testify that staff members often take personal interest in prospective and current students, creating a welcoming and supportive environment that can be one of the most important keys to the success of a professional master's program.

Curriculum

The curriculum prescribed for a particular academic degree program includes the courses and experiences students must complete for the award of the degree. The curricular requirements are determined based on the learning outcomes students will be expected to master during their course of study. As with any graduate program, elements of the PSM curriculum may carry academic credit or may be non-credit bearing. PSM curricula include academic content, both disciplinary and professional, as well as experiential components.

Academic content. Professional Science Master's degrees are generally designed to be completed by a full-time student in approximately two years, with a range of about one to three years. Generally, 36 semester credit hours required to complete the degree, with a few examples below 30 or above 45 credit hours. The variation is due to differences in credits awarded for work in areas outside the core discipline, team projects, and internships.

Professional Science Master's programs may be created by using previously existing courses and/or professional skills development activities, by developing new elements, or by developing agreements with other campus units that will contribute to delivering the curriculum through existing and/or new courses or other curricular elements. Regardless of whether elements already exist or must be newly created, the core curricular elements of PSM programs (see Figure 5, page 36, *Guidelines for Recognition of Professional Science Master's Programs*) that *must* be included are:

- A majority of the course content in the natural sciences, technology, engineering, mathematics and/or computational sciences;
- A professional skills component; and,
- An experiential component that must include at least one capstone project…and provides an opportunity for students to demonstrate proficiency in written and oral communication skills.

Experience has demonstrated that early and continuing involvement of members of an external advisory board is highly beneficial to developing a strong PSM curriculum that is aligned with "real world" industry needs. Further, the collaborative input is necessary to develop rigorous standards on which the evaluation of the professional skills components will be based. In fact, synergy between faculty and advisory board members nearly always leads to a more broadly conceived and relevant curriculum than would be possible if faculty alone craft a curriculum based upon their own experiences.

STEM content. The PSM is an innovative graduate degree designed to allow students to pursue advanced training in science or natural sciences, technology, engineering, mathematics, or computational sciences while simultaneously developing valuable professional workplace skills. Rigorous STEM content is the foundation of PSM programs. The *Guidelines for Recognition of Professional Science Master's Programs* specify that the majority of the course content must be from STEM fields. The "majority content" means the total STEM content included in the total curriculum as estimated by the program director. That is, the intellectual content is the unit of analysis, not courses or credits per se. It is desirable and not uncommon that courses from the STEM discipline that comprise PSM curricula be designed to incorporate some content that is non-STEM such as ethics or communication.

Typically, PSM curricula are multidisciplinary in nature because they are designed to address today's complex workforce needs. Therefore, PSM programs almost always incorporate intellectual content from more than one discipline. PSM programs such as Biotechnology, Broadcast Meteorology, Applied Financial Mathematics, Forensic Science, and Information Assurance draw strongly from two or more

disciplines. The Forensic Science program at Towson University pulls from forensic science and chemistry; Broadcast Meteorology at the University of Miami, from meteorology and journalism; Biotechnology at California State University, Fresno from biology and business administration; Information Assurance at University of Maryland University College draws from information technology, information assurance, and financial analysis; and the Financial Mathematics program at Florida State University includes coursework from the disciplines of mathematics, finance, statistics, and economics.

The typical PSM program has emerged from existing disciplinary strength that has been coupled with the professional and experiential components of the PSM model in response to a local or regional workforce need. Typically, existing faculty members teach the disciplinary courses except in cases of extraordinary growth that requires the hiring of additional faculty members.

Professional skills component. Professional skills components may include topics such as business basics, policy, law, regulatory affairs, entrepreneurship, technology transfer, intellectual property, project management, finance, organizational behavior, ethics, communication skills (written, oral, presentation delivery), and teamwork. These skills are commonly cited by employers as being crucial to employee success. Both existing and new courses designed specifically to support the PSM often appear within the professional skills component of the curriculum in contrast to courses in the natural sciences, technology, engineering, mathematics, and/or computational sciences which almost always are existing courses.

Computer Information Systems
College of Saint Rose

An example of a professional skills development course is "Cultural Intelligence: 'Getting Along' in the Global Workplace." This course was designed to enhance students' understanding of cultural, gender, and diversity differences through group/team projects. Guest speakers from different cultural, gender, and racial backgrounds discuss roles, personality styles, techniques for success, and pitfalls to avoid when working in a diverse global workplace. See http://www.strose.edu/academics/schoolofmathandscience/computer_science/degreeprograms/graduate/msdegree.

It is important to consider the composition of the faculty who will provide these program components, the nature of the activity, course, and/or workshop, and mode of delivery (e.g., weekend intensive sessions, traditional courses, online, web-based). Faculty members who have specific expertise and experience and/or are working professionals are needed in order to provide students with the requisite knowledge and experiential learning exercises that comprise approximately one-third of PSM program curricula. Adjunct faculty members should meet the institution's usual standards for graduate level instruction.

Usually, delivery of these program components requires that faculty from other departments and/or colleges be engaged to participate in the program. This, in turn, requires that the time and credit necessary for them to participate in the program be committed and approved by their department and, often, by their collegiate dean. Some form of compensation may be required to secure the delivery of this element of the curriculum, particularly in the case of coursework for which there is high student demand and scarce faculty resources to accommodate PSM students. These issues may be different, though not necessarily more difficult, if persons from outside the university, such as adjunct professors and other working professionals, participate in the development and delivery of professional skills development components. For these reasons, efforts are emerging to find ways to leverage existing resources to gain efficiencies of scale. For example, creation of a database of professional skills courses is being considered so that PSM program directors will have access to course content

and structure, thereby eliminating or reducing the need to create similar courses *de novo*. Depending on geographic proximity or delivery mode, it is envisioned that program directors will be able to utilize professional skills courses offered elsewhere in cases where the same or similar course is not available on their campus. This approach could be particularly valuable in the case of highly specialized courses that are expensive to sustain.

Some programs take the view that some professional skills components should be *integrated* into the disciplinary course work. It is argued that this approach emphasizes their importance and presents them in the same context as disciplinary material. In some cases, portions of the course are team taught by disciplinary faculty and faculty from the "plus" content area or a working professional with experience in that area. Regardless of the approach, the professional skills component is a distinguishing characteristic of the PSM and is pivotal to the career success its graduates will experience.

Biostatistics, Cell and Molecular Biology, and Medical and Bioinformatics
Grand Valley State University

Grand Valley State University made changes to its original PSM program in Biostatistics, Cell and Molecular Biology, and Medical and Bioinformatics based upon a shift to primarily part-time students as recommended by their industrial advisory board. These changes included an integration of some of the professional skill development content, including communication/ presentation, into science courses. Thus, the Foundations of Biotechnology core course required of students in all three programs includes two group projects, with group members balanced between those with physical science and those with computing backgrounds. One project consists of an analysis of a biotech company chosen by the group; the other is the application of a decision-guidance process to a bioethics case study of the group's choice. Both projects require a written report and an oral class presentation. In addition, each student is required to write a research paper on an emerging area of biotechnology not covered in the course.

Experiential components. The experiential components of PSM programs include at least one capstone project which integrates the practical application of scientific and professional knowledge, behavior, and skills. The project is supervised collaboratively by faculty and employers, evaluated and graded by faculty, and typically developed with an employer. The experiential component often includes a structured internship and provides an opportunity for students to demonstrate proficiency in written and oral communication skills.

*Group projects***.** Employers who have worked with CGS on the PSM Initiative rank teamwork among the highly valued skills of workers they seek and have strongly recommended that PSM programs include opportunities for teamwork experiences. The group project is a characteristic of PSM programs in contrast to the thesis or individual project that is predominant in conventional master's programs. Both serve the purpose of transmitting research methodology and skills to students. Whereas the conventional thesis is a record of original research to produce new knowledge, the group project applies existing knowledge to the solution of a problem that might be encountered in a work situation. In some cases, employers solicit specific group projects that are aimed at identifying novel approaches to real world problems. Furthermore, group projects allow peer-mentoring, particularly if the "team" consists of first- and second-year students, and provide opportunities for students to develop interpersonal, communication, and leadership skills.

Through the process of soliciting and using group projects from organizations, PSM programs develop collaborations that often lead to internship sites, support for interns, and even support for other aspects of their programs. Group projects may be directed by external persons appointed as adjunct faculty or co-directed by program and adjunct faculty. This provides students the opportunity to interact with persons from the world of work that they hope to join and introduces adjunct faculty to potential interns or employees. Thus, group projects can be profitably used to help students build network connections with persons from the employment sector.

An additional advantage exists for PSM programs to solicit support from employers through group projects. The response of employers to requests for group projects has often far exceeded the needs of PSM programs. As a result, employers whose projects are chosen may be expected to provide funds to the program to cover the team's costs in working on a solution and often considerable additional funds for general program support. Such employer "taxes" on selected group projects have in some cases provided funding to support students in the program, as the following example illustrates:

Internships. An internship is a typical experiential element of PSM programs that consists of applied learning at a business, government, or non-profit organization location. The expected learning outcome is that students will synthesize theoretical knowledge and professional skills.

Planning internship experiences includes consideration of the following issues:

- Internship length and requirements for effective outcomes and for accreditation/licensure;
- Pre-internship activities and preparation;
- Nature of internship duties and experiences;
- Quality, quantity, and nature of material to be produced by the intern;
- Advisory and evaluation responsibilities of both faculty and on-site supervisors; and,
- Required reporting by intern to host site and to academic program on campus.

Internships typically include mentoring and orientation activities the semester preceding the internship. Internships may be a summer or a semester in length but there is a wide variation ranging from three weeks to two semesters. Students who are employed are often allowed to substitute a special project for an internship, since their employment may provide many of the learning experiences generally expected of an internship. The experience of existing PSM program directors indicates that immersion in a work environment, with

appropriate levels of training, professional support, and supervision, can lead to compelling learning outcomes. The most highly valued and increasingly common internships provide compensation for the student at a level typical of a beginning salary.

Internships may occur at any time during the PSM program and most often are full-time "immersion" experiences for the student. The most common internship models are summer experiences following either the first year of the program or following both the first and second years. Other models include the second semester of the first year, either semester of the second year of the program, or both second year semesters. In the latter model, the internship is typically part-time undertaken while students participate in other aspects of the program. A few programs schedule a first internship the summer before the first semester of formal work in the program in order to provide students with a work environment experience before they begin the program. This has been especially helpful in building employers' support for programs that are just beginning. It is particularly important to seek input from the PSM advisory board regarding the optimal timing of internship experiences within the context of the specific program. Selected resources for developing internships are presented in the following box.

Examples of Resources for Developing the Internship Component

http://www.calu.edu/faculty-staff/teaching-research/faculty-internship-resources/index.htm-California University of Penn

http://www.naceweb.org/best_practices/-National Association of Colleges and Employers

http://cafnr.missouri.edu/career-services/jobs/intern-handbook.php-University of Missouri

http://sciencemasters.com/portals/0/pdfs/Internship_and_Placement.pdf-2007 PSM Biennial meeting notes from hot topic session

http://www.latech.edu/tech/liberal-arts/internship-guidelines.shtml-Louisiana Tech University

http://www.mccormack.umb.edu/academic/gerontology/docs/GERON798InternshipSyllabus.pdf

http://www.lawrence.edu/dept/student_dean/career/employers/workinterns.shtml

Programmatic Structure

Certificates. Graduate certificates are formal academic credentials that are used to officially record or register a focused area of graduate study. Requirements for graduate certificates vary by institution but generally require formal approval, about 8-12 semester credits of work or more, an integrated focus, and formal admission. Certificates may be freestanding or may be attached to or incorporated within a degree program. In 2008-09, 27,193 graduate certificates were awarded in the U.S. (Bell, 2010, Table 2.21, page 42) or about 5% of all graduate credentials awarded. In descending order, the largest numbers of certificates were granted in the fields of education, business, health sciences, social and behavioral sciences, engineering, arts and humanities, mathematics and computer sciences, public administration and services, biological and agricultural sciences, physical and earth sciences, and other fields (Bell, Figure 2.23, page 17).

Graduate certificates offer opportunities for individuals who are interested in advanced work in a focused area that could enhance their career or prepare them for a change in career but who are not pursuing a PSM degree to gain professional training in specific disciplinary areas. Certificate programs may comprise the STEM content, the professional skills component, or some combination of these elements. Students in stand-alone certificate programs can bring a wealth of practical experience to the program and help create a type of diversity that is valuable and impossible to duplicate. Finally, certificate students can increase the enrollment in professional master's programs and generate additional revenue; some programs have arranged for higher tuition for certificate students and/or for certificate-only student tuition to be returned to the program to be used for support of full-time students or other program support.

Some PSM programs have a structure that includes two or more distinct components that, taken together, comprise the PSM degree. Two examples of this approach are described in the following boxes.

Master's Degree + Certificate
University at Albany, SUNY

The structure of the PSM program in Forensic Biology and in Biodiversity, Conservation and Policy offered at the University at Albany is a master's degree + graduate certificate. PSM students complete a master's degree in the disciplinary area along with a Professional Science Management graduate certificate (9 credits) that comprises the professional skills component of the PSM. Both the degree and the certificate must be completed in order for the student to qualify for the award of the PSM degree.

PSM Programs at Michigan State University

Five PSM programs at Michigan State University (Industrial Mathematics, Biomedical Laboratory Operations, Food Safety, Integrative Pharmacology, and Zoo and Aquarium Management require the completion of the Certificate in Project Management. There is a charge (currently $3,000) separate from tuition for the PSM programs; this source of income allows MSU to pay the faculty and costs of the certificate program. Completion of the certificate is entered on the student's transcript.

Several PSM programs have structured the curricula in a manner that provides flexibility in programming, in scheduling courses/activities and student enrollment. This is particularly appealing to students who are employed.

Distance delivery. Many professional master's programs offer some coursework online and others offer courses or conduct parts of their program off campus—often at work sites. A few programs are delivered entirely via the web including all seven programs offered by University of Maryland University College. Such arrangements may be for the convenience of students and/or employers, or they may be developed to attract additional course or program enrollments. Some programs have established traditional program offerings and afterward explore some of these additional options.

To the degree that PSM programs attract students who are working professionals, adoption of online or hybrid delivery modes may be more prevalent among PSM programs than among master's programs

in general. However, universities are finding that the demand for online access to courses is not limited to students with limited geographic access. A discussion of distance delivery is well beyond the scope of this monograph, but the topic is mentioned here because of its increasingly pervasive presence at all levels of education. Regardless of the delivery mode, all PSM programs must adhere to the *Guidelines* including the usual quality assurance processes employed by their host universities.

Student Recruitment

Recruiting highly qualified and motivated students is critical to the success and long-term viability of a professional master's program. Recruiting targets and strategies will differ depending upon the focus and goals of the program, the mission of the university, and availability of resources. Enrollment targets should be established to guide recruitment efforts. Targets should include specification of the optimal mix of students by variables such as gender, geographic origin, undergraduate background, work experience, or other variables that may be important to the program's ability to achieve its goals.

Recruiting strategies. Much expertise and experience exists in the area of enrollment management. As resources have become increasingly scarce, colleges and universities have utilized professional expertise in enrollment management to guide development of enrollment targets and associated strategies for achieving the targets. However, these efforts have been largely centered at the undergraduate level because graduate enrollment and recruitment has historically been primarily within the purview of individual graduate programs. Graduate enrollment and recruitment are typically tied to the research programs of faculty members making centralization of the process inefficient to manage. Nevertheless, enrollment management professionals are an excellent source of information that PSM program directors may find to useful.

Experienced PSM program directors have stressed the power of word-of-mouth as an extremely important recruiting device (Foroudastan,

Hulsey & Hollis-Hyde, 2009; Strausbaugh, Aggison & Mirkin, 2009). Strausbaugh, et al., reported that the most common way domestic students at the University of Connecticut learned about the two biology-based PSM programs was through word-of-mouth from another student or an alumnus. Similarly, other students learned about the program through word-of-mouth from faculty members and advisers. A large proportion (63%) of students indicated on their applications that exposure to someone who was aware of the program was the basis of their decision to apply. Therefore, the authors emphasized the importance of developing "…an informed and excited pool of faculty, graduate student coordinators, and advisors who can share information about the program with undergraduates..." as a very critical recruiting strategy. They further advised that accomplishing this task requires coordinated communications with those in a position of potential influence, both internal and external to the university. Accurate, timely information and vivid and compelling anecdotes should be communicated regularly to potentially influential people. Using testimonials and video interviews with PSM students and graduates on PSM websites and social media is also recommended and may be particularly important in reaching women and members of underrepresented minorities.

Foroudastan, Hulsey, and Hollis-Hyde (2009) echoed the emphasis placed on word-of-mouth. Foroudastan, et al., also acknowledged the importance of traditional marketing methods (e.g. brochures, print advertisements) but indicated that maximizing direct word-of-mouth is extremely effective. Training current and former students to give presentations in venues such as recruiting fairs, new student orientations, classrooms, and meetings of student organizations was suggested as an effective way to expand positive word-of-mouth. The authors further advised a multi-faceted approach combining traditional approaches with new media and "…consistent advertisement to industry…" along with word-of-mouth approaches such as recommended by Strausbaugh, et al. The authors stated that the success of their PSM program, "…can be attributed to active recruitment of students and consistent advertisement to industry…" achieved primarily through the program advisory board.

It is widely accepted that the internet, including social media, is central in any recruiting strategy. Experienced PSM directors point out that today's students, including international students, are accustomed to gathering information in electronic formats (Boyum, 2007). In 2007, a group of PSM leaders concurred on the importance of maintaining an effective website and further concurred that websites should become the focus of outreach efforts such as direct mail, postcards, print advertising (e.g. airline magazines, city bus headers), online search tools, and other approaches that drive readers to the program's website.

Regardless of the approach, it is essential that the program budget includes adequate resources to develop, disseminate, and maintain effective recruiting tools.

Recruiting targets. Effective recruiting depends on tailoring the recruiting strategies, including both the message and the approach, to specific target audiences. Many programs consider factors such as geographic location, gender, ethnic/racial group, and academic/life stage in developing targeted recruitment plans designed to generate a diverse and highly qualified pool of applicants.

Current undergraduate students. Another pool of potential applicants consists of current undergraduate students at the home university or peer institutions, and new bachelor's degree recipients. As discussed previously, word-of-mouth is considered by PSM program leaders to be a very powerful technique for recruiting students. Reaching out to student clubs, advisers, and faculty members who are likely to come in contact with potential PSM applicants, and providing them with up-to-date information, has been advised as a means of generating program awareness among members of this group (Boyum, 2007). Many PSM leaders seek presentation opportunities to undergraduate classes at the home and neighboring institutions, and attend regional graduate career days/fairs for undergraduate students. The 2007 discussion group advised that these direct strategies for reaching undergraduate students and new graduates be conducted early and at various points during the student's academic program. That is, recruiting should occur during the first or second year at the

university, if not during high school[13]. The following are examples of devices used to target undergraduate students; these approaches will also be useful in reaching members of other potential applicant pools.

Approaches for Recruiting Potential PSM Students

- Social media
- Website
- Direct contact, including visits, with faculty peers at "feeder" schools
- Campus/program "open house" for invited students or those from regional universities
- Student presentations at conference/meeting sessions
- Student presentations at students' undergraduate campus
- Printed materials
- Interactive CD
- Participation in local and regional recruiting fairs
- Internet advertising
- Print advertising in venues such as student newspapers, professional journals, subways
- Business and trade shows
- Broadcast advertising

Recent graduates. Other strategies may be more effective in reaching potential applicants who received their bachelor's degrees several years previously and are not considering graduate study. Members of this group are often considering graduate school as an avenue to promotion or career advancement. Ideas for reaching this group include providing assistance in securing loans while emphasizing return on investment and providing assistance in seeking employer tuition support (Boyum, 2007). Employee friendly programs use online instructional delivery, arrange face-to-face coursework at times and locations convenient to employed adults, develop flexible approaches to internship or other capstone requirements, and may admit students to a specific cohort composed of working students. For example, the Biotechnology and Environmental Management programs at University of Maryland University College provide an online mentoring program (Khan, 2009). Novel approaches such as these should be emphasized in messages used in recruiting materials targeted to working adults.

13 Recruiting materials, including a postcard designed to reach out to high school students, are available at www.sciencemasters.com under "Speaker Materials" (http://www.sciencemasters.com/PSMOverview/SpeakerMaterials/tabid/126/Default.aspx).

Women and underrepresented minorities. When looking for potential students, do not ignore special opportunities for recruiting applicants from diverse populations. Many graduate programs are highly committed to recruiting women and students from underrepresented minority groups. Special efforts are frequently made to recruit applicants from these groups.

A great deal of attention has recently been directed to the goal of increasing the participation of women in STEM fields. The authors of a recent report, *Why So Few?*, (Hill, Corbett & St. Rose, 2010) indicate that by the time of college graduation, "…men outnumber women in nearly every science and engineering field…" (p. xiv). That imbalance increases at the graduate level and again in the workplace. The low participation of women in STEM fields is broadly considered to be an undesirable circumstance. Hill, Corbett and St. Rose stated:

> Attracting and retaining more women in the STEM workforce will maximize innovation, creativity, and competitiveness…. With a more diverse workforce, scientific and technological products, services, and solutions are likely to be better designed and more likely to represent all users." (p. 3)

The authors' general recommendations to improve the participation of women in STEM included:

- Raising awareness about bias against women in STEM fields;
- Focusing upon competence; and,
- Creating clear criteria for success and transparency. (page 87)

To help broaden participation in STEM fields, a number of agencies provided funding to support innovative projects such as the NSF sponsored Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE, solicitation 10-593) and the Research in Disabilities Education programs. The ADVANCE program has sponsored several dozen projects at universities across the country since fall 2008. Valuable contacts and

ideas can be gleaned from the abstracts of these projects available at the NSF website[14].

A set of projects sponsored by the Research in Disabilities Education program focused on increasing the participation and achievement in STEM fields among women with disabilities. For example, WAMC (Northeast Public Radio) "Women in Science, Technology, Engineering, and Mathematics On the Air!" is a unique radio series about women in STEM[15]. "On the Air!" was developed through a project, Access to Advancement, funded by grants from the National Science Foundation (HRD-0332765 and HRD-0833274). The website includes a guide to using the radio series that was developed through the project.

In addition to increasing women's participation in STEM graduate education, broader participation among underrepresented minorities (URM) is needed. Numerous authors have discussed the challenges associated with increasing URM participation in STEM fields. URM undergraduate students are just as likely to pursue STEM majors but are more likely than white students to switch majors and are less likely to complete their degrees (Tsui, 2007, p. 555). Hrabowski (2011) pointed to the need to prevent attrition among URM undergraduate STEM students and estimated that the number of URM undergraduate degrees in STEM fields would need to be quadrupled to achieve the goal that 10% of all 24-year-old Americans hold a degree in a STEM field. The Council of Graduate Schools' series of three publications on achieving inclusiveness and its publication, *Broadening Participation in Graduate Education*, offer valuable recommendations and practical ideas[16].

14 See http://www.nsf.gov/awardsearch/progSearch.do?WT.si_n=ClickedAbstractsRecentAwards&WT.si_x=1&WT.si_cs=1&WT.z_pims_id=5383&SearchType=progSearch&page=2&QueryText=&ProgOrganization=&ProgOfficer=&ProgEleCode=1738%2C+7568%2C1739&BooleanElement=true&ProgRefCode=&BooleanRef=true&ProgProgram=&ProgFoaCode=&Search=Search#results.

15 See http://www.womeninscience.org for more information.

16 See www.cgsnet.org for ordering information.

Citing previous work, Hill, Corbett, and St. Rose (2010) reported that, "Students from historically disadvantaged groups such as African American and Hispanic students, both female and male, are less likely to have access to advanced courses in math and science in high school, which negatively affects their ability to enter and successfully complete STEM majors in college (page 5)…." A report published by the National Academies (Hrabowski & Whitesides, 2011) states,

> Michigan State University's PSM in Industrial Mathematics requires students to spend one semester working on real-world problems, solicited from industrial clients. For each problem chosen, the company provides funds that the program uses to pay a faculty "team leader" and in some cases to support students. For each problem, a team of students (often both advanced and beginning students) work with a faculty leader on a particular problem. The students and faculty member then deliver the solution, or a range of approaches to solving the problem, to the company. A strategy to increase the participation of underrepresented minorities in science and engineering must play a central role in our overall approach to sustaining our capacity to conduct research and innovate. At least four reasons underscore the need for doing so: our sources for the future S&E workforce are uncertain; the demographics of our domestic population are shifting dramatically; diversity in S&E is a strength that benefits both diverse groups and the nation as a whole; and education in S&E does so as well. (p. 16)

Tsui (2007) attributed the low participation of African Americans, Native Americans, and Latinos in STEM to cultural, structural, and institutional barriers and conducted a review of the research evidence relative to intervention strategies. In predicting undergraduate URM students' intentions of enrolling in a STEM graduate program upon graduation, Eagan and Newman (2010) found that debt accumulation had a negative effect and that attendance at a private institution or an HBCU had a positive effect on intent to enroll. The authors recommended that administrators and policy makers implement financial programs aimed at preventing student debt accumulation,

a structural barrier to graduate participation. They speculated that student assistance and support services provided by HBCUs and private institutions are effective in addressing cultural barriers that negatively impact graduate participation. This view is consistent with Tsui's (2007) conclusion that to be most effective, interventions that are aimed at increasing URM participation in STEM should utilize an integrated, comprehensive approach that employs multiple strategies. Tsui surmised that this may be because, "…a holistic approach optimizes the chance that students will be provided with the academic, social, and professional development support they need to progress further along the STEM pathway." (p. 573)

Three such integrated interventions were described by Tsui: the Meyerhoff Program at the University of Maryland Baltimore County, the Minority Engineering Program, and the Mathematics Workshop. These programs integrate academic and social assistance and are widely recognized for their effectiveness. In addition, Tsui pointed out that the results of her study suggested that interventions that are effective for URM students are just as effective for all students—tutoring, internship, faculty-mentored research, quality advisement, and so forth.
(p. 572)

As part of the 2007 America COMPETES Act, Congress mandated a study of "…the role of diversity in the STEM workforce and its value in keeping America innovative and competitive…the challenges the nation currently faces in developing a strong and diverse workforce, and identify best practices..."(Hrabowski & Whitesides, 2011). The authors of the study provided recommendations to various sectors for expanding URM participation in STEM. Recommendations to the higher education community cover access, affordability, and academic and social support. Specific recommendations include (pp. 145-147):

- Establishing campus-wide commitment to inclusiveness;
- Developing graduate admissions and financial aid policies that reinforce diversity;
- Developing summer programs that provide opportunities for hands-on research experiences and the development of

a peer support system;
- Providing greater access to researchers;
- Providing professional development opportunities such as networking, participating in conferences, presenting research, and publishing;
- Setting high expectations of students;
- Developing bridging programs to assist in transition points;
- Developing social inclusion strategies including peer support, study groups, social activities, mentoring, tutoring, and so forth;
- Developing strong faculty mentors; and,
- Emulating best practices.

Several professional master's programs have recently been established at minority-serving institutions (University of the District of Columbia and University of Maryland Eastern Shore) as a result of a project, "HBCU Mid-Atlantic Professional Science Master's Alliance" (see http://www.hbcu-psm-alliance.org/). These and other minority-serving institutions are especially important institutions with which to make contact, build relationships, and recruit students for professional master's programs. A full list of HBCUs can be found at http://www2.ed.gov/about/inits/list/whhbcu/edlite-list.html; a list of Hispanic serving institutions can be found at http://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

Veterans. The Post-9/11 GI Bill and the Montgomery BI Bill provide opportunities for programs that target members of the U.S. military—another important audience. The Post-9/11 Bill (see www.gibill.va.gov) provides support for veterans[17]. The Reserve/Guard Montgomery GI Bill and the Active Duty Montgomery GI Bill provide tuition assistance for military personnel (see http://www.gibill.va.gov/post-911/montgomery-gi-bill/). The California State University (CSU) system considers veterans to be a high-priority audience (Shapiro, 2009). CSU has developed PSM programs designed for active duty personnel and veterans who have

17 Applicants must have at least 90 days of active military duty on or after September 11, 2001. Support includes 40-90% of the cost of tuition and fees depending on the length of qualifying service, a housing allowance, and up to $1,000 per year for books and supplies.

backgrounds in "…high-demand science and technology positions in the civilian sector…" (see http://www.calstate.edu/psm/military). The programs and courses are delivered online, have streamlined admission/enrollment/financing procedures, and permit transfer of credits among the 23 CSU campuses—features of high value to military personnel.

Marketing and advertising. Marketing involves determining the optimum mix of product, price, place, and promotion to achieve business goals. Advertising is subsumed within marketing because advertising is a promotional activity. About.com (see http://marketing. about.com/cs/advertising/a/marketvsad.htm) defines marketing as "…systematic planning, implementation and control of a mix of business activities intended to bring together buyers and sellers for the mutually advantageous exchange or transfer of products." Promotion includes advertising, direct mail, personal selling (e.g. recruiting fairs), sponsorships, and so forth. Advertising and promotion activities contribute to the goal of establishing the PSM as a recognizable "brand."

The ability to manipulate the marketing mix will vary across institutions. For example, some institutions permit price adjustments through differential tuition, programmatic fees, or other pricing mechanisms. Access to online infrastructure and local policies affect the element of place (i.e., delivery site and mode). Universities, higher education systems, state governments, or other oversight bodies may restrict product development for financial or other reasons. And, latitude in regard to promotion will also be constrained by local restrictions and available resources. Therefore, it is wise to consider each element in relation to the others prior to developing an advertising campaign.

Universities often have restrictions on the advertising of programs prior to formal approval. Keeping the external advisory board apprised of planning progress and eventual initiation of the proposed program is highly valuable. In addition, make information about the forthcoming program available to potential students; often the coursework is offered before the program launches and can be used to satisfy requirements after the program has been formally approved and is admitting students.

Effective advertising depends on a clear and compelling message and defined target audience. Developed to help small businesses, the following five points are helpful in developing your PSM information strategy:

- Be consistent in your ad message and…;
- Newspapers, radio and TV stations are helpful in producing the advertising that you will be running with them;
- While word-of-mouth advertising has been around a long time, it usually falls short of being able to attract the number of customers needed to be successful in business;
- Promote benefits rather than features. A benefit is the emotional satisfaction your product or service provides, or a tangible performance characteristic; and,
- Know your competitors. (SCORE, 2011)

As soon as possible, a website should be launched that describes the proposed program and announces dates when additional information will be available. Include benefits of earning a PSM degree, when applications for admission may be submitted, and the initial term of enrollment. If the website can be developed during the planning process, providing a mechanism for visitor feedback can be a valuable way to obtain useful information and early response to plans for the proposed program.

As noted previously (see "Recruiting Strategies," p. 47), PSM program directors have reported that word-of-mouth has been an effective promotion technique for recruiting current students at the home institution when faculty members and others in a position to influence these students are equipped with accurate and compelling information (Foroudastan, et al., 2009 & Strausbaugh, et al., 2009). Although powerful, word-of-mouth is often limited in its reach and is best employed in combination with other messaging techniques.

Delivering Student Services

"Student services" is a term closely associated with undergraduate education but less commonly with graduate programs, especially at public universities. Students in first professional programs, however, generally have robust and significant services available to them. Some professional master's programs have developed a portfolio of services and activities that are offered through the program.

Commitments for delivery of student services by offices such as career planning and placement, writing, mental health services, and so forth should be obtained during the process of planning new programs. Specific negotiations may be required for specialized services needed by distance students (e.g. delivery of library materials or access to other resources). In some cases, it may be desirable to negotiate certain services and associated costs—such as on-campus recreational facilities—off the service menu. Some services may be inaccessible or not required by certain student populations such as students enrolled in online programs.

Orienting new students. A common "best practice" among professional programs is a substantial orientation program for new students with program faculty fully involved. Such initial programs represent a first opportunity for students to begin the formation of a cohort identity and provide an important opportunity to set the tone desired by the faculty. In the design of orientation programs, directors should consider what defines a well-oriented student. Outcomes such as familiarity with program faculty, knowledge of where to find key resources, connection with other students, understanding of program requirements, and understanding of the policies, procedures and regulations within the larger institutional context are common goals of orientation programs. Recognize that orientation is a developmental process that is not accomplished through a single session or activity. The orientation plan should consider the information and assistance that is needed at different points along the student's academic pathway and who, how, and when to deliver that information. For example, the needs of students who are about to undertake an internship are

different from the needs of students who are completing their first term of graduate study.

A related overarching issue is creating a welcoming environment for all students in the program. This issue is ubiquitous among all graduate programs, but may have unique implications within professional master's programs, particularly as these programs emphasize teamwork and cohort identification. A welcoming and supportive environment is an important factor in recruiting and retaining a diverse student body. The following are offered as effective practices for professional science master's programs.

Elements that Can Contribute to Fostering a Welcoming Climate

Leadership committed to a supportive environment for all students

- A diverse student body;
- Diversity among guest speakers/adjunct faculty with opportunities for students to engage with them;
- Excision of all unwelcoming or biased language from all communications including course materials;
- Safe mechanism for students to report concerns and perceived bias and timely response;
- Funds and lounge area for students to gather and socialize;
- Inclusion of diversity issues in professional ethics components;
- Exit surveys or interviews with all students who complete or leave for other reasons;
- Academic, social and professional student support services

Advising students. Graduate students' experience and success depend on competent advising. The adviser may or may not be the same person who directs or oversees aspects of the student's program, such as a research project or internship, and the adviser may or may not play a mentoring role. Advising may be academic or professional and, as previously stated, may be delivered by different persons. Good advising addresses students' individual needs, is readily accessible, is reliable, and contributes to a positive student experience.

> Graduate education should be a satisfying experience for all parties involved—the student, the faculty, the department or program, even the university itself, usually through its administrative graduate school. If students know what is expected of them and the timeframes within which they will be required to complete each phase of the degree program, it is more likely that they will have a positive intellectual and personal experience and will complete the degree in a reasonable time. (DeNeef & King, 2009, p. 2)

Advising often begins with pre-advising of those who accept offers of admission to the graduate program. This role may be performed by a designated person until students are transitioned to an individual faculty adviser. Pre-advising should guide the student's course scheduling for his/her first term of enrollment and provide practical information to assist the student in transitioning Professional master's programs may differ from conventional master's programs in that they offer numerous advising opportunities for students. It is a common "best practice" for students to meet with course instructors to discuss their work once or more each semester. A meeting with each student to discuss his/her progress in the program at least once a year or once a semester is highly recommended. These meetings should always include a focus on academic progress and also on professional issues as the student progresses. Effective advising meetings will uncover underlying issues or concerns that may be of an academic, professional, or personal nature, have the potential to negatively impact the student's progress and will provide appropriate resources for addressing such issues.

A feature of the most successful professional master's programs is career advising for students, beginning with newly enrolled students and continuing as a regular feature during the program to increasingly focus on students' interests and potential internship and job opportunities. As students near completion of their programs, career advising should include job search strategy, interviewing techniques (mock interviewing), and negotiation skills (acceptance letters). These career advising services may be offered by the program, by a career services unit, or a combination of services offered by both. It may be

that the faculty members involved with the program are more familiar with the academic career search process than with the process in other sectors. A career services unit can be valuable in providing practical information for PSM students; a key role of the program director will be to educate the central career services personnel regarding the unique characteristics of the PSM to ensure that students are provided appropriate graduate level opportunities.

Developing community. It is important for professional master's programs to provide community-building experiences for their students, since peer interaction, group and team projects, and interpersonal and small group communication add academic and professional value to the program, to students' experiences in the program, and to program quality. Whether the program is cohort based or not, much can be done to build community and a cohort-like experience into the program. Orientation programs, colloquia, and lectures serve as early means of enhancing group dynamics, developing bonding among PSM students, and establishing a strong sense of identification with the program. Additional activities later in the program reinforce these early group experiences and create not only a strong sense of community, but also a "branding" of the professional character of the program that extends beyond graduation into the workplace. Community building activities and the development of program branding may be different for full-time residential students than for employed students who often are pursuing the degree on a part-time basis and for programs that are offered "on-site," either at a campus or workplace, and those offered online. Efforts to create community and to create identification with the program are even more challenging if there is a mix of full-time and part-time students, variation in employment status of students, and hybrid program delivery. In a study of sense of community among postgraduate management students in an online learning environment, (Abedin, Daneshgar, & D'Ambra, 2010) it was found that a sense of cohesion and awareness of others were two factors underlying sense of community. (Even though in this study only learner characteristics were found to have a significant effect on both sense of cohesion and awareness of others, the authors pointed out that course characteristics and technical characteristics did affect awareness of others, suggesting that strategies could

be devised to positively influence sense of community.) To inform community building efforts, programs should rely on the growing body of literature on the topic and campus resources. A strong sense of community not only enhances the PSM as an identifiable degree model but it also enhances learning and engenders program loyalty.

The emphases on rigorous curricula and training, leadership skills development, and collaboration between academia and industry are critical to PSM program development and operation. This chapter provides extensive experiences of program directors, faculty, and employers and should serve as best practices when developing and operating PSM programs.

Chapter 4
Advancing and Sustaining Quality of Professional Science Master's Programs

Assessment is critical to high-quality graduate programs that meet students' needs, achieve program goals, and produce positive outcomes. Ongoing assessment and evaluation quantified the program need while revealing stakeholders' sense of ownership and satisfaction with the program. The external members of the advisory board from the employment and community sectors are especially important resources in reviewing assessment data and in relating the goals of the program to the larger needs of the workforce and economic priorities. In addition to regular internal graduate program review, institutional accreditation review, disciplinary accreditation reviews, and specialized reviews such as National Institute of Food and Agriculture (NIFA, formerly Cooperative State Research, Education, and Extension Service) reviews, PSM programs must apply to the national PSM office housed at the Council of Graduate Schools for formal recognition as a PSM. The primary focus of this chapter is on the history, rationale, and negotiation of the PSM affiliation process.

PSM Affiliation[18]

Since assuming primary responsibility for growing and promoting the Professional Science Master's (PSM) degree in 2006, CGS has handled the affiliation process. CGS provided leadership for establishing and disseminating guidelines for PSM affiliation and reviews and approves applications for affiliation.

By ensuring that all new PSM programs meet established criteria, CGS took a leadership role in creating a recognizable brand. As an initial step in the process, CGS established a national Advisory Board composed of graduate school deans, PSM program directors, employers, and others involved in the PSM initiative. One of the early actions of the Advisory Board was to develop guidelines for formal

18 This section comprises a compilation of three CGS *Communicator* articles: November, 2009.

recognition as a PSM program in 2006. A process was developed for reviewing applications for affiliation and more than 200 PSM programs were granted recognition.

From inception, the quantity and diversity of applications for PSM affiliation increased far beyond original expectations, signaling the need for a process and organizational structure that would ensure quality assurance in the future. By 2007, CGS took on the responsibility to design a more formal, sustainable, widely recognized and accepted affiliation review process. Toward that end, CGS convened two invited groups of stakeholders for a series of three meetings. The stakeholders included graduate deans, current PSM program directors, employers from business, non-profit, government sectors, professional society leaders, PSM alumni, policymakers, and appropriate individuals from CGS and the Alfred P. Sloan Foundation. The two groups varied in representation according to the focus of the agenda.

Prior to convening the stakeholders groups, CGS prepared a report, *Quality Assurance and the Professional Science Master's,* about quality assurance practices in selected fields and their development to inform the stakeholders' discussions (Vincent, et al., 2010). This report was based on information gathered through web analysis, literature review, and personal interviews with representatives of accrediting agencies, disciplinary societies, and experts in the quality assurance field. Three generic processes were identified: internal review, external recognition, and accreditation.

Stakeholders meetings. The following section describes the deliberations and outcomes of the three meetings of invited stakeholders.

Stakeholders meeting I. The first stakeholders group included 22 representatives (Table 4) and convened on June 29, 2010. As an outcome of the meeting, a set of guiding *Principles* and new *Preamble and Guidelines for PSM Affiliation* (Figure 6) were recommended.

Table 4

Stakeholders Group I

Name	Affiliation	Constituent Group
Cheril Lin Abeel	Urban Science	PSM Alum
Warren Baker	President, California Polytechnic State University	Academic Administrator
Julie Davis Bell	National Conference of State Legislatures	Government
Joan Berkowitz	Farkas Berkowitz & Company	Industry/business
Patricia Bishop	University of Central Florida	Academic Administrator
Cliff Chancey	University of Northern Iowa	Program Director
Daryl Chubin	AAAS Center for Advancing Science & Engineering Capacity	Professional Disciplinary Society
Rita Colwell	University of Maryland, College Park, and Johns Hopkins University	Chaired NAS Master's Committee
Andrew Comrie	University of Arizona	Academic Administrator
Heather Erickson	MedTech	Industry/business
Michelle Fox	U.S. Department of Energy	Government
Sally Francis	Oregon State University	CGS Dean in Residence
Mary Kirchoff	American Chemical Society	Professional Disciplinary Society
Don Langenberg	NPSMA	Academic Administrator
Michael Mondshine	SAIC	Industry/business
Debra Stewart	Council of Graduate Schools	Higher Education Organization
Linda Strausbaugh	University of Connecticut	Program Director
Bogdan Vernescu	NPSMA and Worcester Polytechnic Institute	Program Director
David Ward	Formerly of ACE and University of Wisconsin at Madison	Academic Administrator
Joseph Whittaker	Morgan State University	Academic Administrator
Lilian Wu	IBM	Industry/business

The Guiding Principles developed by the first stakeholder group were:

- Focus the program's mission, goals, and outcomes appropriate to the particular degree;
- Demonstrate excellence in professional graduate education designed to engage and prepare students for a variety of career options in industry, business, government, or non-profit organizations;
- Demonstrate active and ongoing engagement with relevant employers;
- Specify and commit to student learning outcomes inclusive of scientific content relevant and essential to the focus of the degree program and future careers;
- Specify and commit to student learning outcomes inclusive of professional skills, behavior, ethical decision-making and practical experiences relevant and essential to the focus of the degree program and future careers; and,
- Provide ongoing assessment for continuous improvement, adaptation, and innovation.

These principles guided the stakeholders' discussions leading to the seven recommended criteria for granting PSM recognition presented in Figure 6. That is, the criteria were intended to facilitate implementation of the Guiding Principles listed above. Input from representative employers ensured that resultant criteria would meet employer needs. The stakeholders proposed that programs include course requirements for the core areas of both science/mathematics and professional skills, and determined other essential components for PSM program recognition, including the use of employer advisory boards, providing internship opportunities, developing employer sponsored learning projects, committing to annual reporting of enrollment and degree data, and tracking the employment history of graduates to support assessment of program outcomes and success.

Figure 6. Preamble and Guidelines for PSM Affiliation

The Professional Science Master's (PSM) degree is a unique professional degree grounded in natural science, technology, engineering, mathematics and/or computational sciences and designed to prepare students for direct entry into a variety of career options in industry, business, government, or non-profit organizations. It is a distinctive advanced degree for those intending to pursue a career in the practice of science. PSM programs prepare graduates for high-level careers in science that have a strong emphasis on such skill areas as management, policy, entrepreneurship. PSM graduates are expected to progress toward leadership roles. Thus, the PSM differs from both a coursework-only degree and a research master's degree in that the PSM incorporates an internship and an employer- based project. The PSM produces graduates highly valued by employers by combining advanced, graduate coursework in science and/or mathematics with an appropriate component of professional skills development and by including an experiential learning component appropriate to the targeted employment sector. The experiential learning frequently involves an internship and provides an opportunity for students to demonstrate proficiency in written and oral communication skills.

PSM programs inherently include intellectual content and learning activities from more than one field of study. As such, they are multidisciplinary in nature and may be interdisciplinary as well. For example, professional skills components may include business basics, policy, law, regulatory affairs, finance, organizational behavior, ethics, communication, and teamwork. Thus, coursework and learning activities are often developed in collaboration with appropriate academic units outside the sciences. Further, adjunct faculty members from targeted employment sectors may enhance students' learning experiences.

Because PSM programs are professionally focused, an active and engaged advisory board composed of representatives of employer organizations who are in leadership positions is essential. Functions performed by boards and/or by individual board members include providing advice on the program curriculum, assisting with student projects, assisting with student placement, and interacting individually with students.

Ordinarily, master's degree programs in fields where accrediting bodies exist or those that have been traditionally offered as training toward professional licensure or certification (such as public health, most genetic counseling, some engineering degrees) are not appropriate for PSM designation. Programs aimed at training educators are not eligible for PSM designation.

Programs recognized as PSM programs use the official PSM logo on their websites and on other marketing materials, are listed on the sciencemasters.com website, and have access to PSM promotional materials and activities offered by the Council of Graduate Schools (CGS) through a grant from the Alfred P. Sloan Foundation. PSM recognition provides assurance that the program conforms to nationally accepted criteria. Recognized PSM programs agree to use the name "Professional Science Master's" and the PSM logo on websites and other promotional materials.

The following components are essential for a master's program to qualify for PSM recognition.

- The higher education institution must be accredited by a regional accrediting agency.
- A program must have a stated mission, goals, and outcomes appropriate to the particular degree.
- The total number of credits must be at least equivalent to the minimal number required for a master's degree at the institution.
- Programs must include the following three components:
- 1) A majority of the course content in the natural sciences, technology, engineering, and/or mathematical/computational sciences in which knowledge is commonly advanced by an active research community engaged in peer-reviewed quantitative research. This coursework may be interdisciplinary or multidisciplinary. 2) A professional skills component must be developed in consultation with employers. Examples of professional skills components include business basics, policy, legal and regulatory issues, finance and marketing, organizational behavior, ethics, communication, and teamwork. These courses and/or activities are often developed in collaboration with appropriate academic units outside the sciences. Adjunct faculty members from targeted employment sectors further enhance students' learning experiences. 3) An experiential component that must include at least one capstone project, supervised and evaluated by faculty and typically developed with an employer(s), which integrates the practical application of scientific and professional knowledge, behavior, and skills. The experiential component typically includes a structured internship. The product must consist of a written proposal, a report, and an oral presentation.
- Program quality assurance must be provided using the faculty-based mechanisms normally used by the institution for graduate programs in order to ensure institutional integration and sustainability.
- An active and engaged advisory board of leaders from industry, business, government, or non-profit organizations is required.

- The program must report annual data relative to enrollment, degrees, completion, and demographics, and attempt to track the employment history of every graduate to help assess program outcomes.
- Programs agree to use the name "Professional Science Master's" and the PSM logo on websites and other promotional materials.

The recommended criteria were broadly disseminated for comment to approximately 1,000 members of the PSM community including all PSM program directors, all CGS member deans, other interested faculty members, targeted employers, policymakers, PSM alumni, and those invested in the PSM degree. The recipients were encouraged to distribute the accompanying comment form to others who would be interested and were given approximately one month to provide feedback regarding the perceived importance of each criterion and the appropriateness of the manner in which the criteria were expressed. Additionally, the comment form was available to the public on www.sciencemasters.com.

A total of 164 completed comment forms were returned to CGS. Fifty-three percent of the respondents were from a college or university with actively affiliated PSM programs and 38% were from a college or university without affiliated PSM programs or were in the process of seeking affiliation at that time. The remaining 9% of respondents were from business, non-profit, government, and other organizations such as privately funded institutions and higher education associations. More than half of the respondents (52%) were college or university administrators and 39% were faculty members. Approximately 10% of the respondents were former students, management-level employees of biotech companies, research scientists who are not affiliated with universities, and association members. The overwhelming majority of the respondents agreed that the higher education institution must be accredited by a regional accrediting agency (94%); that a program must have a stated mission, goals, and outcomes appropriate to the particular degree (92%); and that the total number of credits must be at least equivalent to the minimal number required for a master's degree at the institution (91%). The respondents were also in strong agreement with both the content of and manner in which the remaining PSM criteria were expressed (agreement ranged from 70% to 92%). It is particularly noteworthy that it is important to have national criteria for PSM recognition and the draft criteria provided a complete

picture of the essential attributes of a PSM program. The *Guidelines* were revised based on the feedback received and were subsequently disseminated to the PSM community.

Stakeholders meeting II. The second stakeholders group met on September 30, 2010, to identify an appropriate process for quality assurance and to specify characteristics of an organizational structure that would be responsible for implementing and managing the quality assurance process. Because of the nature of the agenda, the composition of this stakeholder group was more heavily representative of academia and less representative of other sectors. The group composition is presented in Table 5.

Table 5

Stakeholder Group II

Name	Affiliation	Constituent Group
Warren Baker	President, California Polytechnic State University	Academic Administrator
Scott Bass	American University	Academic Administrator
Patricia Bishop	University of Central Florida	Academic Administrator
Cliff Chancey	University of Northern Iowa	Program Director
Rita Colwell	University of Maryland, College Park, and Johns Hopkins University	Chaired NAS Master's Committee
Andrew Comrie	University of Arizona	Academic Administrator
Sally Francis	Dean Emerita, Oregon State University	CGS Senior Scholar
Jeffery Gibeling	University of California, Davis	Academic Administrator
Mary Kirchoff	American Chemical Society	Professional Disciplinary Society
Don Langenberg	NPSMA	Academic Administrator
Debra Stewart	Council of Graduate Schools	Higher Education Organization
Linda Strausbaugh	University of Connecticut	Program Director
Bogdan Vernescu	NPSMA and Worcester Polytechnic Institute	Program Director
David Ward	Former President of ACE and Chancellor of the University of Wisconsin at Madison	Academic Administrator
William Wiener	Former Dean, Marquette University	CGS Dean in Residence
Joseph Whittaker	Morgan State University	Academic Administrator
Lilian Wu	IBM	Industry/business

The stakeholders agreed that the key characteristics of an organization responsible for the oversight of the PSM recognition process were: objectivity, legitimacy, access to appropriate infrastructure, adequate financial and human resources, and the ability to effectively recruit, train, and manage a cadre of expert volunteers.

The group considered each of the three generic quality assurance processes (see box below) described in the CGS white paper, *Quality Assurance and the Professional Science Master's* (Vincent, et al., 2010) for applicability and adaptability to the PSM quality assurance process (i.e. affiliation or recognition) and identified external recognition by consensus. In addition to the applicability and adaptability of the external recognition process, this process was also deemed appropriate because it was believed that external recognition could meet the quality assurance needs of the PSM with minimal cost and bureaucracy in contrast to the other quality assurance models.

Quality Assurance Models[19]

Internal review. Internal review is a quality assurance model that is widely used and well understood within the graduate community. The locus of management control resides within the institution, usually the graduate school, rather than with an entity that is external to the institution such as an accreditation agency or disciplinary society. Although the locus of control is internal, the program review is usually conducted by a committee of peers that includes highly qualified and experienced graduate faculty members or other appropriate individuals who may be both external and internal to the institution. Key features and elements of successful program review processes are described and discussed in detail in the CGS publication *Assessment and Review of Graduate Programs* (Baker, Kind, Larick & Carter, 2005) and include: review guidelines, self-study, data collection, student participation, review committee, report and recommendations, program response, and implementation. The overall goal of program review is to enhance the quality of graduate programs in contrast to accreditation processes which may focus more on whether or not a program meets a set of minimum standards rather than on broad evaluation and qualitative judgments regarding broad programmatic goals and direction. Generally, graduate programs are required by institutions to undergo internal program review, even if they undergo external review or accreditation processes, owing to the difference in approach and orientation of the processes. Most graduate science and mathematics fields have no external quality assessment processes. Instead, such processes are solely conducted internally by the university.

External recognition. External recognition refers to a program assessment or evaluation process that is managed by an entity that is external to universities and colleges, such as a disciplinary society, but that does not result in formal accreditation. The external recognition process does not require that the external organization overseeing the assessment or evaluation be approved by the U.S. Department of Education or by the Council of Higher Education Accreditation. However, the external entity typically derives its authority from members who are active professionals in the field and who periodically review the recognition process to ensure that it represents current best practice.

Accreditation. The goal of accreditation, as described by the U.S. Department of Education, is to, "ensure that education provided by institutions of higher education meets acceptable levels of quality (U.S. Department of Education, 2010)…." Accreditation is managed by entities external to colleges and universities but not by the Department of Education. Recognized accrediting agencies lead the development of standards and procedures by which institutions and programs may seek to achieve accredited status. There are two types of

19 See Vincent, et. al, 2010, for complete citations contained in this box.

> accreditation: institutional and programmatic or specialized. Institutional accreditation may be awarded to an entire institution whereas programmatic or specialized accreditation may be awarded specifically to programs, departments, or schools that are parts of a larger institution.
>
> Vincent, *et al*., 2010

The second stakeholder group further recommended that the program review model be analogous to a "journal review" model. This model, selected in part because of its reliance upon trained, expert volunteers from the PSM community and lower central administrative and operational costs, required an organizational structure with a governing board and an employee working with trained, expert, volunteer reviewers. The governing board would be composed of representatives of organizations with deep interest in the PSM. The journal review model is particularly suited for the PSM recognition process at this stage of continuing growth because of its structural and interdisciplinary adaptability.

Stakeholder meeting III. The last of the three stakeholders' meetings occurred on November 9, 2010. At this meeting, Stakeholders Group II (see Table 5, p. 61) explored potential partnerships and assessed areas of need that will be critical for implementation of the recommended process and for organizational planning. Among other topics discussed were ideas for establishing and executing the operational model, potential elements of an administrative entity/ structure, the elements of a preliminary review cycle, and a viable business plan. The next task is for CGS to develop and implement a mechanism for soliciting candidate organizations capable of assuring management of the PSM Affiliation process on a permanent basis.

Affiliation process. The review process that has been in place under CGS' leadership is that of external review. The external review process was confirmed by the stakeholders as the appropriate process for the purpose of reviewing programs for PSM affiliation.

Affiliation procedures. The "PSM" name and logo have been trademarked by the Alfred P. Sloan Foundation and licensed to

CGS. While CGS has no position regarding whether the trademark is necessary or even desirable, the current situation is that in order to be formally recognized as a PSM, and thereby granted use of the PSM name and logo, a program must submit an application demonstrating compliance with the guidelines. The application is reviewed and a determination is made regarding whether or not the program has fulfilled each of the criteria. If so, the program is approved, listed on the www.sciencemasters.com website, and provided with promotional materials and support. In cases where there is some question as to whether a proposed PSM program meets the guidelines, an independent Affiliation Review Committee conducts a secondary review of the program application. To date, in every case but one where the PSM designation would not have been approved, the institution made the requested adjustments in order to bring the program in line with the PSM initiative and gain the designation.

Program Approvals

The process and procedure by which authority to offer a new graduate program is obtained vary by type of institution and local organizational and governance structures. Some faculty members and/or administrators find it helpful to obtain approval of PSM affiliation from CGS as part of the local approval process because the national recognition is helpful in establishing a compelling rationale for authorizing the new degree. In most cases, programs submitted to CGS for PSM affiliation have been fully reviewed locally and degree authority has been granted prior to application for PSM affiliation.

Ongoing PSM Program Assessment

Present accountability expectations demand attention to program assessment. Today, assessment is viewed primarily from an outcomes orientation as opposed to a focus on inputs or process. The Higher Learning Commission, one of several regional accreditors, sets forth five criteria for accreditation including an expectation that the institution provides "…evidence of student learning and teaching effectiveness that demonstrates it is fulfilling its educational mission." (Higher Learning Commission, 2011) The Commission requires that there are clear and measurable, differentiated student learning

outcomes stated for each program and expects that the data collected to measure the extent to which the stated outcomes are being achieved are disseminated and used for program improvement. Inasmuch as PSM programs are subject to these standards within the context of institutional accreditation, the interest of CGS is primarily on student career outcomes in addition to PSM affiliation. Career outcomes data are essential for promoting and growing the PSM brand nationally.

Monitoring student progress. It is important to be able to demonstrate that students recruited to the program meet stated admissions requirements and have the expected background and credentials to be successful in the program. The metrics employed to demonstrate these characteristics may include undergraduate GPA and transcript analysis, standardized test scores (e.g. the GRE general test), prior work experience and/or current employment, and perhaps materials such as statements of purpose for applying for the program. Data should be benchmarked against stated program expectations or goals. The experience of professional master's programs has been that data relating to student qualities are needed for proposals to external granting agencies for student or program support and as a base for discussions with employers regarding internship hosting and student/program support. These data also may be required for accreditation and institutional program review.

Good practice indicates that students' progress should be monitored during the time of their enrollment. Most institutions have regulations that govern graduate programs such as minimum enrollment requirements, GPA requirements both by term and accumulative, time limits for degree completion, and other requirements or limitations that must be carefully monitored to assure that students complete their degree programs in a timely manner. Such metrics should be monitored either at the program or institutional level. Complete and accurate completion and attrition data should also be maintained.

Much closer monitoring and student advising is required for cohort-based professional master's programs to assure that the cohort progresses on schedule as a group toward defined and time-sensitive

goals and that each student has the requisite background for courses as they are scheduled and is prepared for an internship at the specified point in the program. The responsibility for monitoring student progress is often vested in a program staff member, although faculty members also should be involved in meetings with students to review their progress and to provide guidance and advice to students based upon their record of progress. Graduates of some professional master's programs will have to pass examinations to be certified or to obtain a license for professional practice.

Tracking graduates' performance. It is essential that data are collected to provide evidence that the stated goals of the program are being achieved. Because the overarching goal of the PSM is to prepare students for careers, job placement and starting salaries of graduates in appropriate professional positions in business, industry, government, and non-profit organizations are key indicators of this goal.

CGS efforts to provide templates for assessment. CGS received funding from the Sloan Foundation in fall 2010, to launch a rigorous new data collection project. The project has two major components: 1) a survey to collect data on enrollment and degrees by PSM program, year, and key student characteristics; and 2) a survey to capture initial hiring outcomes, including fields and employers, and follow graduates for up to five years after graduation to ascertain career placements, perceived satisfaction with the PSM degree program and, to the extent possible, salary progression. Ultimately, the goal is that CGS will turn over the two surveys to an appropriate entity.

The CGS project is being conducted over a 24-month period, starting January 1, 2011, and ending December 31, 2012. It is anticipated that in order to gain access to these benchmarking data, programs and/or institutions will be willing to pay a modest fee sufficient to sustain the data collection effort going forward. That is, the subscription fee to the database will provide a small revenue stream for the organization that serves as the "host."

An annual "PSM Enrollment and Degrees Survey" has been developed. The electronic survey questionnaire is in a standard format so program directors will report the same data each year and in the same format. The questionnaire provides a confidentiality statement, instructions, definitions of all terms used and answers to frequently asked questions. The questionnaire was pre-tested, and feedback requested from PSM program directors and the CGS PSM Advisory Board. The survey collects the following core data:

- Institution name;
- PSM program name;
- Name, email and phone number of individual completing the survey;
- Applications received for Fall Term;
- Applications accepted for Fall Term;
- first-time enrollment, fall term (broken out by enrollment status, gender, citizenship, and race/ethnicity);
- Total enrollment, fall term (broken out by enrollment status, gender, citizenship, and race/ethnicity); and,
- Degrees awarded (broken out by gender, citizenship, and race/ethnicity).

Periodically, one or more special questions will be asked on topics such as the availability of online courses and financial support for students. These questions, however, will be placed after the standardized data collection template and will not be repeated on consecutive surveys. The survey design is intended to minimize the response burden on program directors by using a consistent survey questionnaire and keeping the survey length as short as possible.

The PSM Enrollment and Degrees Survey will be fielded three times over the course of the two-year project. In spring 2011, CGS collected data on fall 2010, enrollment and on degrees awarded in academic year 2009-10 (July 1, 2009 to June 30, 2010). In late fall 2011, CGS will collect data on fall 2011 enrollment and on degrees awarded in academic year 2010-11, and in late fall 2012, CGS will collect data on fall 2012 enrollment and on degrees awarded in academic year 2011-12.

When each survey is launched, a cover letter and link to the electronic survey questionnaire will be emailed to the director of each PSM program. The graduate dean (or equivalent) at each institution will be copied on the email. Based on our experience with other CGS survey efforts, we know it is important to get the buy-in of the graduate school when collecting data on graduate students. Our relationships with graduate deans will help institutionalize the survey, increase response rates, and ensure quality data.

Program directors will be given approximately 45 days to respond to the survey. Two reminder emails will be sent to non-responding program directors during this time period if needed, followed by phone calls from CGS staff to program directors who have not responded to the survey by the deadline. Using this method, which is similar to the method used for other CGS surveys, we anticipate a response of between 80% and 100%.

CGS will develop a longitudinal database in SPSS to assist with analysis and to enable year-to-year comparisons by program. CGS will produce a report on each PSM Enrollment and Degrees Survey. The report on the first survey will highlight current year trends; the reports on the second and third surveys will also show aggregate year-to-year changes for institutions responding to the survey in subsequent, consecutive years.

CGS also will develop an annual PSM Student Outcomes Survey. Through this survey, CGS will capture data on the initial employment outcomes of PSM graduates and will follow graduates for a total of five years after graduation to gather data on career paths, perceived satisfaction with the PSM degree program, and to the extent possible salary progression. The survey will collect the following core data:

- Graduate name and email address;
- PSM program;
- College or university attended;
- Graduation date;
- Employment status;
- Sector of employment;

- Job title;
- Primary work activity;
- Salary range; and,
- Satisfaction with PSM degree.

CGS will work with PSM program directors to recruit respondents. CGS will ask the program directors to forward the information about how to access the survey to their graduates when the survey is launched. The survey will be fielded electronically each summer. Program directors will be asked to email the cover letter and the link to the questionnaire to each PSM graduate. PSM program directors and graduate deans will be asked to encourage their recent graduates to complete the survey. Graduates will be given about 45 days to respond to the survey. Two reminder emails will be sent to non-respondents during this period if needed.

In 2011, CGS collected outcomes data for students who graduated in academic year 2010-11. In 2012, CGS will send the survey to individuals who graduated in academic year 2011-12, as well as to the 2010-11 graduates again (whether or not they responded in 2011).To enhance the response rate, an item will be raffled to respondents as an incentive to participate in the survey.

CGS will develop a longitudinal database in SPSS to enable year-to-year comparisons. The database will contain student names to permit analysis at the individual student level showing career and salary changes over time. All respondents will be promised confidentiality and any information released publicly will be in a format that does not allow the identification of institutions or the personal identification of students.

CGS will produce a report based on each PSM Student Outcomes Survey. The report on the first survey will highlight current year trends, and the report based on the second survey will provide data on career progression to the extent possible. Survey reports will be widely disseminated. The reports will be posted on sciencemasters.com, and a cover letter with a link to the report will be sent to all U.S. and Canadian members of CGS, all PSM program directors, and

CGS partners in the PSM initiative (e.g. NCSL). The reports will be available for use in the policy arena including advocacy for the PSM at the national and state levels (agency and government). The core purpose of the efforts in both surveys is to demonstrate that these data can be collected and to provide a template that may be used by PSM programs going forward.

Measuring satisfaction with the PSM. Measuring satisfaction with a PSM program is a methodological challenge. Satisfaction has increasingly been the focus of research during the past four decades. A number of scholars have attempted to define satisfaction and the related variables of dissatisfaction and complaining behavior as well as the interrelationships among them. Giese and Cote (2000) posited that satisfaction involves a summary affective response of varying intensity, a time-specific point of determination and limited duration, and a response directed toward focal aspects of acquisition and/or consumption. Therefore, a single, summative satisfaction item could be included on a survey of recent graduates. Examples of such items include:

- *All things considered, my PSM program met my expectations. (1-5 agree/disagree); and,*
- *I am completely satisfied with my PSM program. (1-5 agree/ disagree)*

To gain insight into individual program components (e.g. teaching effectiveness, course offerings, internship opportunities, scheduling flexibility, cost) items should be constructed such that the effectiveness of each component is rated rather than the satisfaction of the respondent with that particular component. For example, "Courses were scheduled flexibly to accommodate my schedule (1-5 agree/disagree)." This approach will prevent confusion between the differing constructs of respondents' satisfaction and respondents' evaluations and will yield information useful for the purpose of program improvement.

Measuring employer satisfaction. The typical advisory board for a PSM program consists primarily of representatives from the employment sector and their assessment of the program is valuable. Yet members of the advisory board may not have been directly involved with students or be employers of program graduates. An essential additional element of program evaluation is the view of employers as to how well the program prepared graduates for their jobs. The focus of such data collection should be on program effectiveness in preparing potential employees. Employers will likely not be able to provide data on employee performance or other data that would be considered personnel information.

Prior to developing a survey instrument, the distinction between satisfaction and evaluation of program components should be considered. Obtaining employers' evaluations of program components or satisfaction with the program depend on maintaining accurate contact information for graduates' employers. Because graduates' career progression is also of interest, employer information should be collected from new graduates along with placement information. Data can be collected from employers by various methods including the use of a survey administered online or by telephone.

Contact with employers through a survey may have the added benefit of demonstrating the commitment of the program to meeting their needs and builds relationships that can be important to the program in many ways. Employers may have unique insights into how a program performs that could be useful in making changes that maintain the currency and relevance of the program. Further, seeking employers' views about the program sends an important message that the program strives to serve their needs and is interested in their input as to how the program can best meet this goal.

Internal graduate program review. Most graduate schools require some form of regular periodic review of all graduate programs and include PSM programs in the review cycle. Such reviews are especially important in addressing the academic and intellectual quality of a program in addition to determining the extent to which

the program meets any stated workforce and economic development goals.

Maintaining high-quality PSM programs that meet student's and employers' needs is critical to achieving program goals and producing long-term positive outcomes. In this chapter we have discussed the history, rationale, and negotiation of the PSM Affiliation process—the mechanism by which the PSM brand is assured. In addition, CGS efforts to provide templates for use in collecting enrollment, degrees, and hiring outcomes data were described along with internal institutional assessment approaches. Sustaining graduate program excellence will require the use of multiple approaches.

Chapter 5
Challenges to Sustaining Professional Science Master's Programs

Recent economic challenges have created a heightened focus on sustainability at all levels of academia, including graduate programming, leading to a heightened scrutiny of proposals for new programs; most expect this perspective to remain for the foreseeable future. Nancy Zimpher, Chancellor of the State University of New York System characterized the current fiscal challenges facing institutions of higher education as, "…what looks like a long haul of self-sufficiency" (Lederman & Jaschik, 2011). Hence, both new and well-established PSM programs must include sustainability as a planning and operating principle. The following challenges related to long-term sustainability should be addressed in original program planning and monitored regularly.

- Ability to sustain institutional commitments;
- Ability to accommodate and sustain institutional requirements;
- Program flexibility to accommodate changing workforce and student needs; and,
- Long-term financial viability.

Institutional Commitments

Major commitments made by the university during the planning and implementation of a professional master's program are a good indication of probable sustainability. The following represent common institutional commitments that are positive indicators for a program's longevity.

President/governing/board/system endorsements. The sustainability of a professional master's program is more likely assured if the program is in synchrony with the mission and strategic direction of the institution as evidenced by endorsement of the program by the president of the board of trustees or other governing body, president or chancellor of the institution, the provost, or others in a position to commit the institution's support to the program. Public statements of commitment by institutional leaders are key indicators that the program will be well represented in external conversations,

at strategic planning meetings, during the budgeting process, and in setting development priorities. Formal, documented agreements should be broadly communicated to ensure they are not lost when changes in leadership occur.

Faculty positions. The allocation of new faculty positions to the program is a substantial institutional commitment that represents a considerable financial investment in the program, particularly if the positions are tenure-track positions. A key position to be filled is that of the program director. Current program directors cite an essential need for a time commitment from the universities. Allocating sufficient time to directors and staff positions in launching and sustaining a program is key to their success.

Facilities and equipment. Allocation of new or renovated space and facilities or major items of equipment are additional sustainability factors. Office space is almost always scarce. Securing modest space to house the program director and any support staff is essential and should be articulated in initial planning. A dedicated space is critical to establishing an identity and can also become the program's "home." Because several academic departments may contribute faculty members and other resources to the program, it is important that the program have a visible, dedicated office space that is separate and distinct from any space associated with a particular department or college. Depending on the nature of the program, new laboratory, classroom, or other specialized space may be necessary. Long-term commitment of dedicated space and facilities is an excellent indicator of the strength of the institution's support of the program.

Budget allocations/reallocations and financial commitments. Firm commitments of permanent or recurring budget allocations in support of a professional master's program are significant indicators of the university's intent to sustain the program. Procedures for gaining authority to offer new graduate programs typically require detailed financial plans that indicate sources of all required resources and letters of commitment for each. Further, commitments to assume financial responsibility for one-time external funds that were used to

create a new professional master's program are an important indicator that the program will be sustained beyond the end of the grant period. Many granting agencies require a statement regarding plans for long-term sustainability as part of the proposal process.

Productivity Requirements

Institutions may have requirements for program productivity that all programs must meet. Productivity metrics may include student enrollment, applications received, student credit hours generated, revenue generated, degrees awarded, or other such institutional statistics. Such requirements may be especially challenging to meet during the initial offering of a new type of degree program, when credibility and visibility are being created among students and employers.

Professional master's programs are often small by some university standards because of the need for small cohorts to foster interaction, to create teams for group projects, to place and monitor students during internships, and to develop the sorts of workplace skills that require considerable individual attention of instructors. Nevertheless, it is common practice that programs are expected to meet reasonable productivity standards or their continuation may be jeopardized. Careful feasibility analysis during the planning stage will strengthen the probability that productivity will meet expectations.

Changing Student and Workforce Needs

Given an external advisory board that is actively engaged with departmental faculty, professional master's programs are well positioned to adjust to changing needs and remain viable. Trends in workforce needs associated with the employment sector served by the program must be regularly tracked. Members of the advisory board and employers of graduates are excellent resources in this endeavor, although both may need to be reminded to focus on a longer timeline in order for faculty members to work through campus channels to make appropriate adjustments in curricula. Federal agencies are good sources of employment trend data and projections of workforce needs

that should be used along with employer projections as a basis for long-term assessment of the continuing need for and viability of a professional master's program. Similarly, patterns in student demand directly impact sustainability and must be regularly monitored. Changing student demographics may influence the flow of applications as well as the nature of program delivery that will meet their needs. For example, if a large proportion of students are working adults, delivery of at least part of the program on site or online may be important in sustaining students' ability to pursue the degree.

"Flexibility" is a term often cited by employers as a valuable trait they seek in new employees. Such flexibility is essential if organizations are to meet the challenges of a competitive economic marketplace. Professional master's programs, likewise, need to be flexible and their content and methods of preparing students must remain both effective and efficient if they are to be sustained.

Workforce trends may render a program that once was a high priority to be less so. Periodically, in cooperation with the advisory board, program faculty should take a view as far into the future as possible to gauge the continuing need for the program in its current configuration. Because academic programs exhibit short-term fluctuations in student enrollment, any consideration of closing a program due to low enrollment should take into account several years of enrollment patterns. Projections may indicate substantial revision is necessary or that plans to phase out the program make sense. Hopefully, criteria for possible discontinuance of the program were included in the overall proposal presented to the institution when approval to offer the degree was sought. Any plan to phase out a program should protect the interests of current students and assure there will be no sacrifice of quality or content of their degree program and that course and other program offerings will allow students to complete the program in a timely fashion. Universities generally have procedures for closing programs; if not, a best practice for this eventuality is to include its consideration during the development and ongoing evaluation of professional master's programs.

Developing a Robust PSM Community

Recognizing the important role institutions of higher learning play within the broader community, the Carnegie Foundation for the Advancement of Teaching and Learning (2011) now offers Community Engagement as an elective classification category. The Community Engagement classification comprises two categories, of which the first is Curricular Engagement and Outreach as defined below:

> *Curricular Engagement and Outreach* …teaching, learning and scholarship engage faculty, students, and community in mutually beneficial and respectful collaboration. Their interactions address community-identified needs, deepen students' civic and academic learning, enhance community well-being, and enrich the scholarship of the institution.

The second category is Outreach and Partnerships.

> *Outreach and Partnerships*…focuses on the application and provision of institutional resources for community use with benefits to both campus and community. Partnerships focus on collaborative interactions with community and related scholarship for the mutually beneficial exchange, exploration, and application of knowledge, information, and resources.

Because PSM programs are specifically designed to meet community workforce needs, incorporate practice-oriented curricular components, and involve close collaboration with external partners, PSM programs are inherently consistent with both Carnegie engagement categories. These attributes are vital to a program's ability to remain connected and current while fulfilling its mission and goals and retaining its viability. But, relying on the strength of these inherent programmatic qualities is insufficient. Deep engagement with the broader community demonstrates legitimacy to the institution and establishes a cadre of stakeholders who will be available to actively support the program.

Long-term Financial Viability

The cost of delivering graduate programs is a growing concern at institutions of higher education. Public universities have experienced declining state support and public as well as private universities have experienced declining portfolio values. However, programs that do not require substantial university resources while filling a regional or state workforce need are exceptionally well positioned to remain healthy and survive even in a demanding financial environment. Many PSM programs were created by repackaging existing university curricular resources with very minimal need for incremental, new resources. However, tuition costs and lack of stipend support for master's students have emerged as systemic problems for professional master's programs, especially at institutions with high tuition and fees and/or where support for master's students is a lower priority than for doctoral students. The early goal was that professional master's programs would be self-sustaining through strong employer support and mechanisms such as differential tuition levels-–justified by good placement records and starting salaries of graduates. Because PSM programs lead to attractive career pathways, strategies borrowed from other professional fields have been implemented to enhance revenues. For such strategies to work, a sound business plan that projects self-sufficiency within three to five years of operation must be developed.

Choi (2009) reported that introduction of differential tuition has been a viable revenue strategy that has not produced a negative impact on student demand. Specifically, three PSM programs at Georgia Institute of Technology impose a tuition surcharge (25% for resident students and 33% for non-resident students). The funds generated via the surcharge are returned directly to the PSM program directors and are used for administrative costs and for student support. The program in Prosthetics and Orthotics also imposes a $2,000/semester fee in addition to the surcharge to defray costs associated with the clinical aspects of the program. Choi concluded that because the imposition of the surcharge and fee did not affect student enrollment, price or cost of attendance does not appear to be a decisive factor in students' decisions regarding which graduate programs they pursue.

The University of Utah (Chapman & Schmidt, 2009) has considered imposing a fee that would be levied each semester with a cap equivalent to the total sum of the fee over four semesters. Other program directors have been able to negotiate for the return of a portion of tuition revenue to the director of the program. Such funds are generally used to support costs such as the salary of the program director, salaries of support staff, instructional costs, advertising, and student support.

Based on lessons learned over the past decade, those who are considering developing a new PSM degree should develop a sound business plan that projects a financially sustainable program by the end of the first three years the program is offered. Along with the business plan, explicit support of key administrators and stakeholders is essential.

Looking Forward

The rapid growth of PSM programs over the course of little more than a decade is a powerful indicator of the degree to which the PSM has responded to student interests and workforce needs. The degree framework has been carefully articulated, brand visibility is growing, a national organization is active, and the process by which PSM recognition may be achieved has been implemented. In addition, program directors have learned much about the development and delivery of highly effective programs. According to Rosenbloom, (2010) "Advocates of the degree say it will become a fixture at many more universities because it promises to satisfy the work force requirements of increasingly technological economies in the United States and abroad." This detailed monograph on planning for developing and sustaining the PSM was designed to assist universities as they grow and nurture the PSM, a response to the altered workforce reality.

Prelude to the "Afterword"

One of the most powerful indicators of the relevance and appeal of the PSM concept is that, even as the PSM itself was in the early stages of

development, demand arose for reflection on needs for a comparable degree in traditional humanities and social sciences disciplines. We turn next to an "Afterword" to this volume in which we consider the professionalization of master's degrees in the humanities and social sciences during the past decade.

Afterword

Other Developments in Professional Master's Degrees: The PMA

Background

While professional master's programs in the sciences have been under discussion and development for over 10 years, with active participation and encouragement from CGS since 2002, the social sciences have also been undergoing rapid change due to the impact of technology, the expanding knowledge base, and increasing student demand for graduate programs that respond to their needs for professional development. In this chapter we will present the results of a CGS project examining trends in and encouraging development of professional degrees in the social sciences and some humanities analogous to the PSM degrees. We use the term "PMA" as a convenient abbreviation, but note that it does not carry the same formal recognition as the PSM.

According to the U.S. Department of Education's National Center for Education Statistics, only 20% of social science bachelor's degree recipients who pursue graduate or professional education do so in their undergraduate social science major area, and Figure 4 (Chap. 1) shows a 12% decrease over 20 years in the number of social science/history master's degrees awarded (excluding psychology). This profile of degrees awarded in the social sciences is remarkably similar to that in the physical and mathematical sciences There is a unique factor that may partly account for some of the master's degree trends among social science disciplines: the development of specialty areas focused on professional practice, many of which have evolved into separate "spin off" professionally focused master's programs. For example, the public administration programs (the MPA) that evolved from political science, and social work programs (the MSW) that developed from sociology. Among the arts and humanities, professionally focused tracks were developed that tend to exist along with "traditional" scholarly focused master's programs within departments. Examples include the MFA in the fine and performing arts; the ESL in linguistics and languages, and master's programs in public history, creative, and non-fiction writing. Employment studies of social science and arts and humanities

bachelor's graduates indicate that only 13% of social science bachelor's graduates and 13% of arts and humanities graduates from the 1992-93 cohort reported in the 1997 follow up (NCES, B&B 93/97) that their jobs were closely related to their bachelor's degree. These percentages are among the lowest of all fields; while similar to mathematics (8%) they are significantly lower than biological sciences (26%) or physical sciences (44%). These results from graduate surveys could be seen as an indication of perhaps an even greater need among graduates in the humanities and social science than in the sciences for degree programs that prepare them for the jobs they actually get. Next we address whether these survey results are reflected in employment data.

Business/industry is the primary employment sector for master's degree holders in both science and engineering (50-60%) and in the social sciences (60% for economics and political science; 40-50% in other social sciences); they also employ 25-33% of master's graduates in the arts and humanities. Government represents the employment sector for close to 20% ($\pm$ 5%) of master's graduates across the science/technical, social science, and arts and humanities fields. Despite the similar employment statistics, there are no comparable reports of a critical shortage of humanities and social science graduates by industry/business groups or government agencies. However, the realities and trends presented above have raised concern that too few graduates with advanced work in these disciplines are being produced and that graduates are not appropriately prepared for the needs of society. A few examples will illustrate a broad consensus for the need to address concerns about advanced education in the humanities and social sciences.

A February 2001 national security commission report concludes: "Quality education in the humanities and social sciences is essential in a world made increasingly 'smaller' by advances in communication and in global commerce." Section II of this report highlights the urgent national need for outstanding science and technology professionals: "So, too, does government need high-quality people with expertise in the social sciences, foreign languages, and humanities" (Commission on National Security/21st Century, Phase III Report,

2001). One of the Commission's recommendations is to expand support (including both undergraduate and graduate fellowships) for social sciences, humanities, and foreign languages.

The importance of the social sciences has also been highlighted in remarks of John Marburger, formerly Director of the Office of Science and Technology Policy (OSTP) in the Executive Office of the President (Marburger, April 11, 2002). Marburger reinforced the importance of science and technology research and education and added:

> The social sciences in general have much more to offer on the difficult problems of our time than we are currently acknowledging in our federally funded programs. No issue deserves more attention from the social sciences than that of the future of the technology workforce, [an issue] that is more complicated than we have yet acknowledged. We will need wise advice on this issue from the social science community.

In remarks given at the Annual Meeting of the Consortium of Social Science Associations, Marburger (November 18, 2002) said:

> …the social sciences themselves, as subjects of research and scholarship are undervalued. I think we can take more advantage of the social sciences, and that the challenges of our times can be engaged more effectively if we use the knowledge and the techniques developed in [these] fields.

Data for the social sciences and humanities are similar to those employed in the rationale to develop professional science master's programs. These data may thus serve as a basis for creating similar programs in the humanities and social sciences. There also are public policy concerns about the extent and nature of advanced education in these fields that parallel those in the sciences and mathematics. However, in the absence of direct evidence of need by business and industry, CGS proposed in 2002 to investigate whether such needs indeed exist and to what extent they are reflected in the prevalence of professional elements (i.e., those related to workplace needs and skills) within master's degree programs offered by social science

and humanities academic departments. Assuming such evidence was attainable, a second goal of the proposed research project was to determine if the evidence warranted feasibility studies for developing Professional Master's (PMA) degree programs that include components designed to develop workplace-based skills and some knowledge and appreciation for business/industry, government and non-profit organizations that employ a significant fraction of graduates in these fields.

With the support of the Ford Foundation, CGS conducted a research study, with advice from the relevant disciplinary societies, that addressed these and other issues related to the nature of professional social science master's programs, including the level of program innovation, the extent and multi- or inter-disciplinary nature of programs, and the role of external stakeholders in the programs. The study consisted of a detailed analysis of a sample of master's programs in order to determine if they meet the characteristics ascribed to professional master's programs.

The study employed a multi-stage sample design. The first stage of the sample focused on selecting doctoral or master's comprehensive universities based on two criteria. Universities selected were CGS members in 2002 that were among the 120 largest producers of students who received master's degrees in the included social science disciplines over the (then) most recent three-year period. From these 120 universities, a purposive sample of 68 graduate schools was selected. The 2007 study re-evaluates departmental websites for the same 68 institutions, updated to reflect the addition or closure of programs within the 10 disciplines of interest.

Within universities, departments in each discipline were selected if they admitted students directly to a master's program, rather than programs that focused exclusively on preparation for the Ph.D. In addition, only programs housed in a department of one of the 10 selected social science disciplines were included. In 2007, 385 programs were included and analyzed.

The results of the study form a significant basis for the rationale of considering the need for and viability of PMA programs.

A Website Analysis of Professionalization of Social Science Master's Degrees[20]

The bulk of the data for the analysis of the social science master's came from an exploratory study of departmental websites to determine the extent to which "professional" master's programs were offered or highlighted on websites of traditional social science departments. Programs were considered professional if they were designed with advice from prospective employers as preparation for entry into a career, generally in non-academic sectors, such as business, industry, government, or non-profit organizations. The 2002 study evaluated the constraints of and potential for the development of professional master's programs distinct from "classical" offerings (e.g. master's programs conceived as preparation for doctoral study) within social science departments. With the support of the Ford Foundation, CGS addressed the issues related to the nature of professional social science master's programs through a detailed analysis of a sample of master's programs in order to determine if they met the characteristics ascribed to professional master's programs.

Five years later, CGS revisited the website survey of master's programs in the social sciences with a comparative review of the professional nature of programs. Using the same study approach as the 2002 website analysis, the 2007 analysis compared the professional attributes of social science programs based upon predefined indicators. A summary of this five-year comparison study was published in the *CGS Communicator (Frasier and Mahler, 2007)*. For the purposes of this study, as with the previous study, "classical" master's programs were conceived as preparation for doctoral study, whereas "professional" master's programs were those that prepare graduates for entry into a non-academic career. Specifically, the study excluded departments that did not offer a master's or doctoral degree.

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20 Josh Mahler and Roberta Spalder-Roth made invaluable contributions to this section by collecting data through research of departmental websites.

The social science disciplines included in both the 2002 and 2007 studies were anthropology, economics, geography, history, linguistics, political science, psychology, and sociology. In addition, the applied fields of communications and public administration were included because master's programs in these areas were developed as professionally oriented degrees, and the comparative aspects of these programs were thought to be useful in the conduct of this study. Each of the respective social science disciplinary societies was consulted in formulating the study, and the methodology resulted in part from those conversations.

Programs were categorized according to a set of indicators that are commonly used to characterize a professional-level social science master's program[21]. These characteristics include:

- skills requirements across discipline boundaries;
- an emphasis upon outside relations and orientation toward practice or experience;
- linkages to the labor market and an emphasis on tracking graduates and building alumni networks; and,
- methods of determining mastery of material and skills needed for professional practice or accreditation of the program.

The CGS initiative on the Professional Master's in the Social Sciences and Humanities, supported by the Ford Foundation, described more fully below, provided the opportunity to help member institutions respond to documented local and regional workforce needs and student interest/demand for master's programs that prepare graduates for careers in business, government and non-profit (BGN) employment sectors. Therefore, CGS predicted significant changes in the overall presence of indicators used to determine the professionalization of the participating institutions' social sciences programs. CGS expected program websites evaluated in 2007 to exhibit more professional indicators than found in 2002, while acknowledging the

21 The *Guidelines* established for professional master's programs in the sciences and mathematics (www.sciencemasters.com) were the starting point for discussion between CGS and the social science disciplinary societies, which resulted in the indicators employed in this study.

fact that relatively few programs would exhibit all the indicators of the professional master's, but many would have some aspects of a professional degree.

Study plan. The 2007 study was conducted in two stages. In the first stage, project staff revisited and re-conducted the survey of social science master's degree program websites. Following the review of program websites, the second stage of the study focused on analysis of the website survey results to determine if programs demonstrated an increase or decrease in the professional indicators. Table 6 lists descriptions of the professional indicators employed in the study.

Table 6

Indicators of Professional Level Master's Degree Programs

1. Offered skills-based courses (e.g. marketing, management, statistics) as well as interdisciplinary courses
2. Emphasized writing and communication skills through a specific writing course especially aimed at writing for non-academics or if such writing skills were indicated to be an important part of the program.
3. Had a final project rather than (or in addition to) a thesis with a research experience conducted for a client or as a team research experience
4. Advisory board of industry/government/ non-profit employers
5. Required business/industry/organizational internship
6. Had at least one faculty member with professional or non-academic employment or volunteer activity through examination of faculty websites
7. Students had the opportunity or were encouraged to participate in off-campus activities that enhanced professional skills, aside from a required internship.
8. Marketed careers on the website as evidenced by listing the kinds of jobs available to master's (not Ph.D.) graduates, or had a link to career or placement services, or both
9. Tracked or conducted surveys of graduates evidenced by a listing of alumni and a description of their careers and/or if there was a website survey for alumni to complete.
10. Assessment, quality control through outside professional accreditation or licensing

Research Results

A continuum of programs: classical – applied – professional. Survey results were analyzed by determining the average number and the distribution of professional indicators within programs of a discipline. In spite of titles and mission statements to the contrary, few of the programs analyzed exhibited all of the characteristics of a professional master's program. As we perused the website data, three types of programs emerged, which we characterize as classical, applied, and professional, with the former two being more prevalent than the latter.

A **classical program** is either a stepping-stone to the Ph.D. (e.g., sociology programs requiring graduate level theory and research methods later applicable to dissertation research) or has characteristics of a classical program—whether or not it is a terminal master's. This is often found when a university does not offer a Ph.D. program in the discipline.

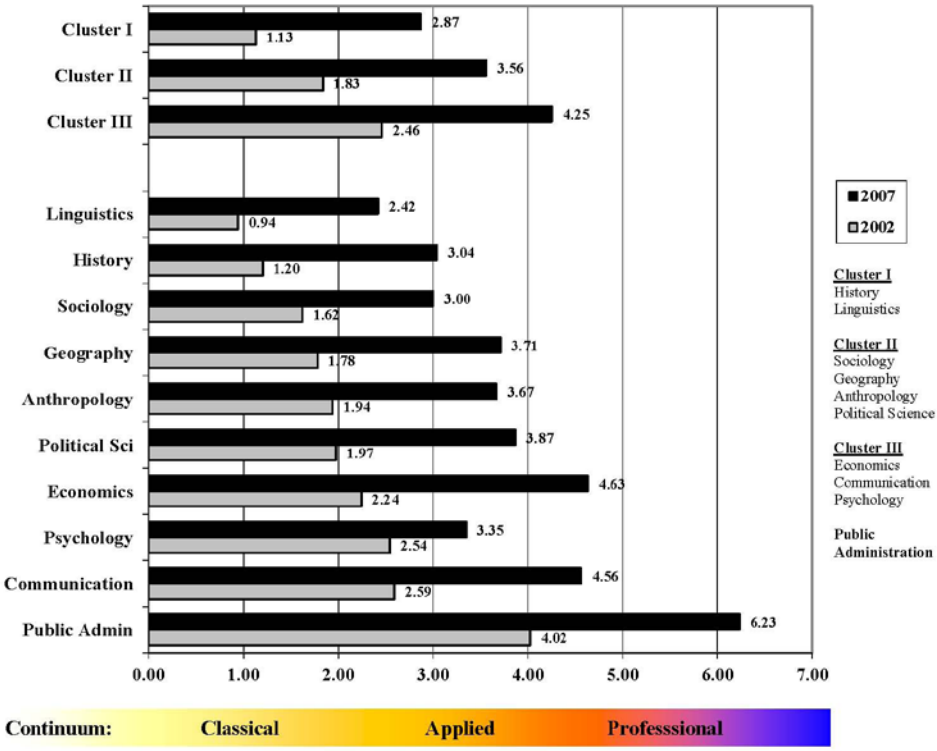
An **applied program** focuses upon application of the fundamentals of the discipline to a specific area of practice (e.g., aging studies programs within sociology). Such programs often require work entirely within or minimal work outside of the department. Some programs also may lead to a specific, focused career track, but generally do not have a direct relationship to prospective employers (such as an external advisory board, internship opportunities for students, etc.)

By contrast, a **professional master's degree program** often includes activities and relationships that cross the boundaries between departments and between the university and employers. An active interaction with potential employers provides opportunities for skills development, experience, and contacts that are closely aligned with marketplace demand.

The average number of professional indicators in Table 6 exhibited on program websites in each discipline for both phases of the survey is shown in Figure 7 (data in all figures come from the Council of

Graduate Schools 2002 and 2007 Surveys of Social Science Master's websites). The data indicate significant changes from 2002 to 2007, highlighting increases in the number of professional indicators exhibited on program websites across all 10 disciplines. In 2002, the number of indicators ranged from a low of less than 1.0 for linguistics, to approximately 2.5 for psychology and 2.6 for communications, and 4.0 for public administration, the discipline chosen as the clearest example of a professional master's program among the social sciences. However, in 2007, the scale of the range jumped dramatically with a low of almost 2.5 for linguistics, still displaying the fewest number of professional indicators, approximately 3.3 for psychology, over 4.5 for communications, and finally public administration with over 6, a third higher than the previous study.

Figure 7. **Average Number of Professional Master's Indicators per Program**



One can infer from these data that the websites for social science programs, and presumably the programs themselves, are exhibiting more professional characteristics. Although many programs undoubtedly responded to increased reliance of applicants on websites by increasing the amount of information available there, this would not account for changes in the curriculum, and CGS believes that the increase is a reflection of efforts by those programs analyzed to integrate skills and resources necessary and essential for graduate students to become marketable to potential employers in non-academic settings.

Of particular note is the remarkable increase in website indicators of professionalism for the social science disciplines that usually present the fewest number of indicators: linguistics and history. Although these two disciplines continue to demonstrate the fewest number of professional indicators, the increase for linguistics from .94 in 2002 to 2.42 in 2007, and the corresponding increase for history from 1.20 in 2002 to 3.04 in 2007 allude to progress toward increasing the professionalization of these programs. The increase may be attributed to the expressed interest by students and faculty to incorporate and develop more professional programs, such as public history, into the institution's curriculum.

Frequency of professional indicators among social science programs among cluster departments. Overall, CGS observed strong efforts to make programs once defined as "classical" more professionalized, giving these degree options a sense of fluidity and diversity in terms of the curriculum. The average number of indicators exhibited by programs within a discipline, however, masks certain features that are revealed only by examining the distribution of professional indicators within programs of a discipline. These features allow characterization of programs into three clusters whose master's programs exhibit similar frequencies of professional indicators, as shown in Table 7.

Table 7

Definition of Professional Components

Component		Professional Program Indicators
Skills	1-3	skills-based courses; communications/writing activities; team project
Advisory Board	4	external advisory board of industry/government/non-profit employers
External	5-7	internship; off-campus activities; faculty with non-academic experience
Careers	8-9	marketing of careers on website; tracking/surveying of graduates
Assessment	10	external professional organization accreditation/ licensing/evaluation

As expected, the websites of public administration programs clearly exhibit a greater degree of professional attributes than do any of the discipline clusters. In general, the extent to which each component is exhibited by programs increases regularly in order by cluster: **Cluster I** (history and linguistics): **Cluster II** (sociology, geography, anthropology and political science): **Cluster III** (economics, communications and psychology): **public administration** - the professional master's exemplar.

Figure 8a. **Frequency of Professional Components among Cluster Departments in 2002**

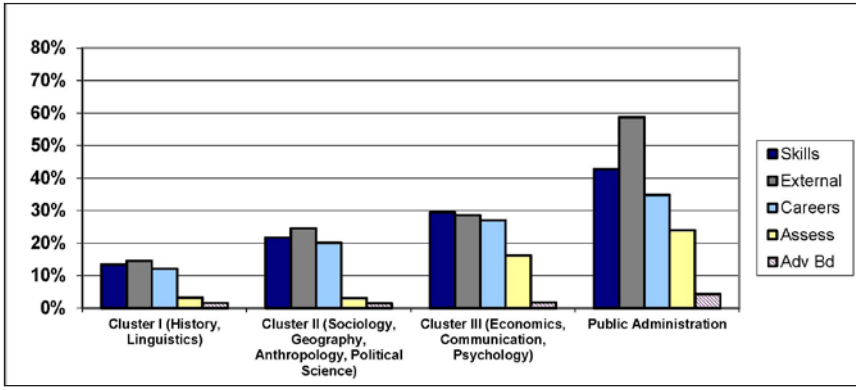
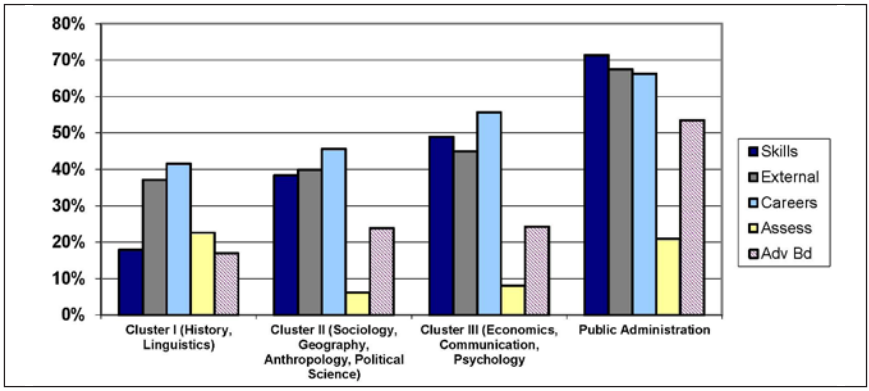


Figure 8b. **Frequency of Professional Components among Cluster Departments in 2007**



While the professional components of websites demonstrate significant increases across all clusters and public administration from 2002 to 2007 (shown in Figures 8a and 8b), it is the marketing of careers on program websites and the presence of an external advisory board that have changed the most. Using public administration programs as an example, the presence of an advisory board in 2002 was slightly higher than 4%; however, by 2007 the number had increased to over 50%.

The increase is perhaps attributed to the listing of either a new or an existing advisory board on the program's website. In regard to the marketing of careers on the website, the presence of the indicator doubled, and in some instances more than doubled, from 2002 to 2007 for all clusters and public administration. For example, by 2007 more than 41% of the programs in Cluster I disciplines marketed careers on their websites, an increase of nearly 29 percentage points from 12.1% observed in the 2002 survey.

It is important to note the change in the offering of skills-based courses by all disciplines. In the 2007 analysis, Cluster I increased by more than four percentage points, Cluster II by nearly 17 points, Cluster III by almost 20 points, and public administration showed the biggest difference with a nearly 29 point increase. These results reinforce the belief that many social science programs are aiming to increase the professional appeal of their programs for students and

potential employers by offering programs that suit their desire for those skills. It is evident that programs are growing and changing with professionalization in mind. Specifically, the increase in indicators in public administration shows that the website or "public face" of the exemplar social science program is getting even more professional.

Distribution of professional program indicators among social science clusters. As stated previously, skills-based courses among all the clusters have shown the highest increase. In 2002, just over 30% of programs in Cluster II showed signs of offering skills-based courses. However, in 2007, approximately 71% of the programs offered courses skills with professional attributes. The same can be true for Cluster III programs, with nearly 40% of the disciplines in the 2002 analysis offered skills-based courses, whereas in the 2007 survey, approximately 85% had evidence of skills-based courses (Figs. 9a and 9b).

Figure 9a. **Distribution of Professional Program Indicators among Social Science Clusters in 2002**

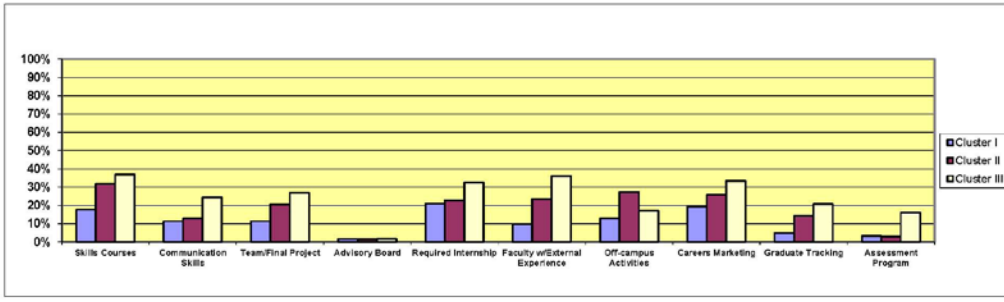
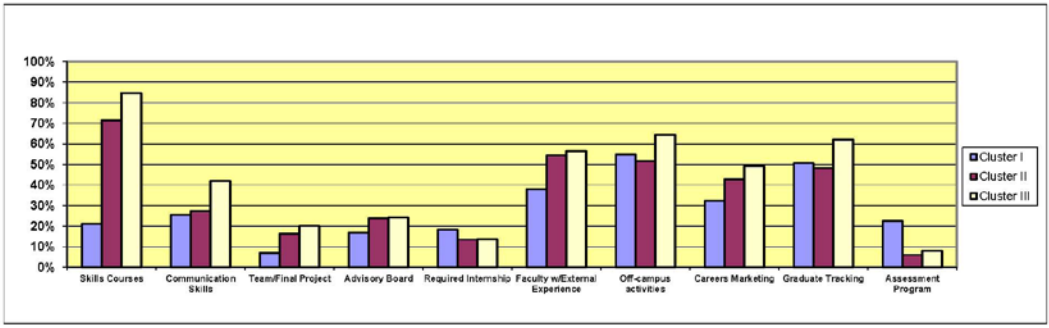


Figure 9b. **Distribution of Professional Program Indicators among Social Science Clusters in 2007**



Other notable increases in each of the clusters include the promotion of off-campus activities and graduate student tracking. The presence of professional indicators has doubled, and some instances more than doubled in terms of percentage points, from the previous survey. However, it must be noted that some decreases did occur, specifically in programs requiring an internship. In 2002, disciplines offering a master's required an internship approximately 20-30% of the time, with Cluster III (programs assumed to be most professional) displaying the most evidence.

However, the 2007 analysis showed a decrease in required internships with the range falling roughly 10 percentage points. Cluster III, once the highest, fell to just above 13%, and Cluster I, those disciplines that generally exhibit the least number of professional indicators, was the highest at approximately 18%. The reduction in programs requiring internships is interesting; based on a qualitative analysis of program descriptions, CGS found that nearly all the programs in the social science disciplines offered an internship in some capacity, but that the internship was not necessary or required for degree completion. However, in promoting the development of "PMA" programs by CGS, internships were strongly encouraged.

Percent of departments exhibiting professional program curriculum indicators. The increase in skills-based course offerings appears to be a common trend among all the disciplines in the 2007

analysis (Figs. 10a and 10b). Sociology and geography saw the greatest jumps from 2002 to 2007, with 61% of sociology programs and 81% of geography programs offering skills-based courses, more than doubling in percentage points from the 2002 analysis. The presence of communication skills for each of the two studies appears to be fairly consistent, with the exception of communication and public administration. Not surprisingly, programs in the communication department had the highest number of programs offering communication skills, with over 82% in 2007, up nearly 30 percentage points from the 2002 study. Public administration increased in skills-based course offerings by more than 45 percentage points in the 2007, up from approximately 59% in 2002. In other words, every institution that admits students to a master's degree program in public administration offers skills-based courses, thus reinforcing the notion that the most professional program is getting even more professional.

The presence of a team/final project was fairly consistent between the two analyses, albeit with some slight variations. Overall, disciplines exhibiting professional program curriculum indicators are up, with significant increases in some areas, indicating that programs are trying to incorporate a professional, job-oriented approach to their degree offerings.

Figure 10a. **Percent of Departments Exhibiting Professional Program Curriculum Indicators in 2002**

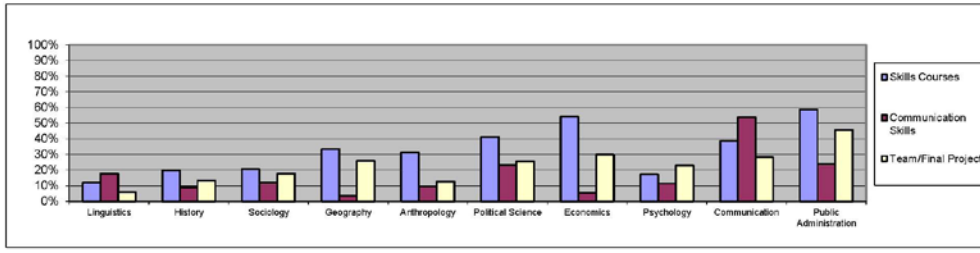
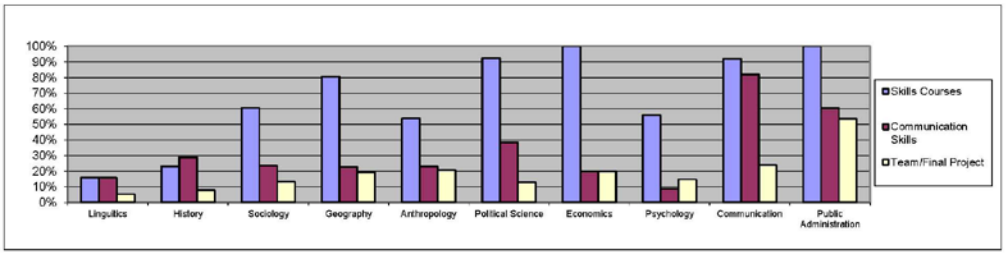


Figure 10b. **Percent of Departments Exhibiting Professional Program Curriculum Indicators in 2007**



Percent of departments exhibiting professional program indicators of external relations. While the percentage of faculty with non-academic experience teaching in master's programs has increased, with several disciplines showing significant changes, specifically linguistics, geography, and economics, required internships are down for nearly all disciplines, with the exception of public administration, anthropology, and history. Other noteworthy changes include the presence of off-campus activities, specifically in economics, with 88% in 2007 showing some evidence, an increase of nearly 83 percentage points from 5.4% observed in the 2002 survey (Figs. 11a and 11b).

Figure 11a. **Percent of Departments Exhibiting Professional Program Indicators of External Relations in 2002**

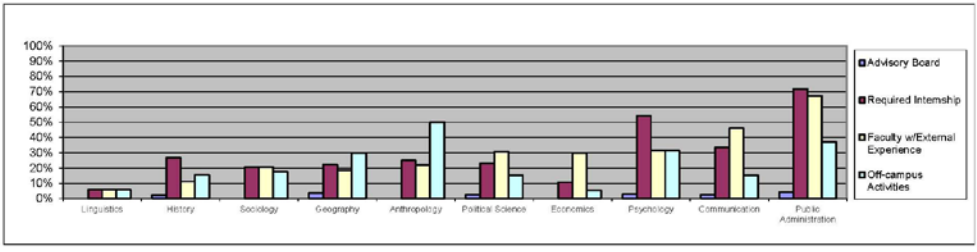
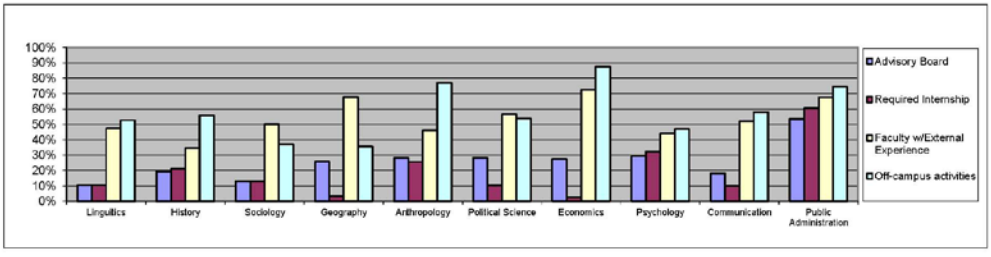


Figure 11b. **Percent of Departments Exhibiting Professional Program Indicators of External Relations in 2007**



Evidence and observations from the 2007 website survey suggests that most of these increases can be attributed to departments requiring or requesting programs to provide links or information to off-campus activities on their websites. The same is true regarding the increase in faculty with non-academic experience. It should be noted that public administration and psychology actually exhibited declines in the percent of programs requiring internships, with public administration also seeing a decrease in faculty with non-academic experience and the presence of off-campus activities.

Percent of departments exhibiting professional program outcome indicators. Most noticeable between Figures 12a and 12b is the increase in graduate student tracking. This can be attributed to increased administrative requirements to collect these data and/or requiring programs to be transparent and provide this information on their websites. The presence of an assessment program is fairly consistent with all the disciplines, with the exception of history, where 25% of the programs show some evidence of this indicator, up 23 percentage points from 2% reported in the 2002 study. Psychology saw a decrease of over 20 percentage points to 18% in the 2007 analysis, as compared to the 40% reported in the 2002 survey.

Figure 12a. **Percent of Departments Exhibiting Professional Program Outcome Indicators in 2002**

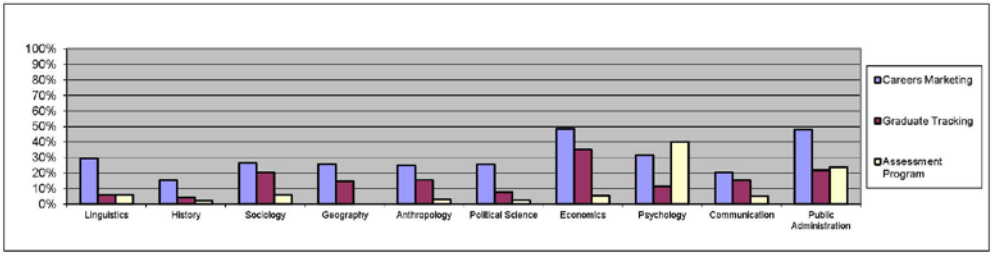
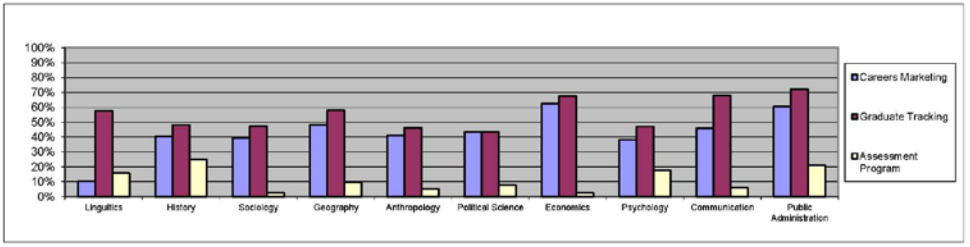


Figure 12b. **Percent of Departments Exhibiting Professional Program Outcome Indicators in 2007**



CGS attributes the increase in the marketing of careers to departments requiring programs to link to one or more career services websites, or providing detailed information about what job opportunities graduate students can pursue or expect to be available upon graduation. Overall, while the increases are certainly beneficial and consistent with the positive differences between the 2002 and 2007 analyses, many of the program outcome indicator changes could be the reflection of students' need and desire for additional resources related to their degree program, and the increased reliance and use of the Internet for information consumption.

Public administration: A unique social science discipline. Among the social sciences, public administration remains the benchmark as an example of a professional field, exhibiting several unique aspects. In the 2007 analysis, as a discipline, it is the most likely to:

- Admit students to master's programs;
- Offer programs that exhibit the components of a professional master's program:
  - 100% of all programs exhibit at least two of the components of a professional master's degree;
  - almost 90% exhibit at least four professional components;
  - 28% exhibit at least eight professional components;
- Include a skills component in its master's programs (100% of all programs surveyed);
- Include external relations and instruction or activities outside the university (67%), with a careers component (66%), and an outside

assessment mechanism (21% of programs; public administration programs are accredited by National Association of Schools of Public Affairs and Administration (NASPAA);
- Offer a final project or team experience (54%);
- Require an internship or external employment (61%); and,
- Involve faculty with non-academic experience (67%).

None of the public administration programs surveyed could be categorized as possessing no professional characteristics.

Public administration programs did not develop as a discipline under the Ph.D. model, as have many of the master's disciplines, but grew during the 1970s with a more practical, applied mission. This may account, to some extent, for the field's unique position with respect to professional master's education.

However, it must be noted that several other social science programs are beginning to show signs of increased professionalization in regard to exhibiting professional indicators. The website information and public presentation of degree features for economics (4.63) and communications (4.56) have passed the average number of indicators public administration displayed in the 2002 analysis. Economics programs exhibited at least two indicators in 98% of the programs that admitted students to a master's degree program, while 96% of the 50 communication programs exhibited the same.

Other findings of the 2007 analysis

- CGS found that many of the study expectations were confirmed. The indicators of professional programs do vary by discipline; however, there has been a considerable increase in the indicators of professionalism on program websites and documented curriculum. Fields such as public administration continue to exhibit the highest level of professional indicators, but communications, economics, and political science are fast-becoming more professionalized;
- Unlike in the 2002 analysis where virtually no programs appeared to have developed advisory panels representing an important external group of stakeholders in graduate education, the 2007 analysis showed that many programs within the disciplines studied have

taken the necessary steps to ensure that visitors to their websites are aware of and familiar with their advisory boards;

- Many programs strived to create courses aimed squarely at developing students for professional, non-academic employment opportunities. Based on the 2007 study, public administration is still the benchmark; however, economics is also taking steps to increase professionalization. Of the programs that offered a master's degree, public administration and economics posted a 100% for offering skills-based courses. However, other disciplines often considered less professional are incorporating more professionalized programs into their curriculum, such as those participating in the CGS Professional Master's Initiative in the Social Sciences and Humanities;
- Linguistics and history programs, those generally thought to be the least professional, have shown improvements with each discipline exhibiting more professional indicators including the external relations area and tracking alumni. It is evident that work still needs to be done to balance the demand and need for professional components within these disciplines and their respective programs;
- The visual presentation and comprehensiveness of a program's website impact whether it can be deemed professional. If a program website did not present information associated with professional indicators, a positive score was not recorded, regardless of whether the information existed in some capacity on the institutional website. The narrow definition adopted by CGS addressed concerns that prospective graduate students would search only the content found within the program site itself, thus, if the information could not be found, it did not exist. The layout and presentation of this information further factored in a program's overall score. As the Internet evolves and replaces other outlets as the main source of information for potential graduate students, it is absolutely imperative that departments change with the times and update and modernize their websites.

Discussion, conclusions and future research. Professional master's programs in the sciences are developing within the context of social forces including globalization, the relative decline in federal funding and growth of private industry funding during the 1990s, increased institutional accountability to the state for public institutions, increased competition for students, and demographic changes in the composition of graduate students. The purpose of this

study was to increase awareness and understanding of the components and potential of professional master's programs in the social sciences, and to understand the constraints that mitigate their development. Do these programs prepare students to compete in the global market, such that they can be described as professional master's programs? Can they be characterized by multi-disciplinary skills, an emphasis on practice, external relations with stakeholders, including alumni and employers? Is there evidence that employers hire master's graduates, especially during periods of economic growth?

Despite the subjective nature of the analysis, the website survey provides tentative answers to some of these questions. The findings indicate that master's degrees that meet many of the criteria of a professional degree are increasingly common. A substantial share of master's programs appear to offer students more than a stepping stone to a Ph.D. or an award to students who do not complete a Ph.D. program. However, this study does not provide direct evidence of the growth of such programs or whether they were initiated as a response to globalization, restructuring, or changing funding streams.

Overall, the findings indicate that master's degrees are meeting the criteria of what constitutes a professional degree. While this certainly can be attributed to program changes within the institution, it must also be noted that the increase in professionalization could be due to improved, more complete websites. However, there is without question opportunity for continued growth in program curriculum to support the need and desire for degree options with professional characteristics. In addition, continued growth is needed regarding the use of technology to disseminate information on programs in order to maximize the marketability of a professional master's degree in the social sciences.

The CGS/Ford PMA Initiative

With the PSM as a model, and data from the 2002 web analysis indicating some professionalization across social science disciplines, the recommendation emerged, both from the graduate community and

from the professional societies engaged in the discussion, to define elements of best practice in "PMA" programs. In the first phase of this project, CGS, with funding from the Ford Foundation, made planning grants to 38 CGS member institutions during 2004 to determine the feasibility of creating new "PMA" programs or adding professional elements to existing master's programs across an array of social science and humanities departments. Specifically, CGS/Ford PMA planning grants required graduate schools and social science and humanities departments to:

- Engage local/regional employers in discussions concerning workforce projections and the nature of entry-level professional employees they required;
- Establish an external advisory board with alumni/employers and community leaders to work with faculty to conduct feasibility studies and design programs;
- Identify likely applicant pools and survey interest levels for a PMA program to prepare for specific professional employment;
- Assess institutional, departmental and faculty commitment to, and resources available for, developing programs that are focused on preparing the domestic workforce to meet local/regional needs; and,
- If deemed feasible, to prepare a business plan to implement the PMA program(s), including proposed tuition appropriate for the identified applicant pool(s), commitments of support and/or internships from prospective employers, and commitments of institutional resources to create and sustain the programs.

Based upon the initial results of these planning efforts and the continued strong interest among universities in establishing PMA programs in the social sciences and humanities, a second phase of the project was funded, allowing CGS to make grants to 18 universities to implement 26 PMA programs proposed as a result of the CGS/Ford PMA planning grants, from 2005-07.

At a capstone meeting, graduate deans and faculty directors of the CGS/Ford PMA programs shared their recommendations for best practices and lessons learned from this project, as follows.[22] The following sections capture the key points from the capstone meeting.

22 Mary Treisbach was engaged to facilitate the discussion at the capstone meeting. The "lessons learned" were distilled from her report.

Advisory boards. Successful PMA programs draw advisory board participants from the ranks of professionals, academics, and employers. Before reaching out to potential advisory board members, PMA program directors and deans realized they needed to target specific areas of expertise and think through the operational logistics of the advisory board. For example, early on, an advisory board's efforts may be focused significantly on program development. Later tasks may require more effort in networking by advisory board members to help secure internships for current students or positions for graduates. Ongoing skills required of advisory boards include providing a business or industry perspective, for example elaborating the type of practical training that may complement the academic components of the curriculum. Offering an external "reality check" may also help programs correct course as marketplace demands change. Community organizations, think tanks, and the ranks of alumni—all may have potential advisory board members who can shape and influence a successful PMA program.

Potential advisory board candidates were identified largely through personal contact. Some suggested using an exciting "script" to generate interest and enthusiasm, including a clear description of the PMA program along with an explanation of the duties and time required of an advisory board member.

Lesson Learned

The composition of advisory boards is of critical importance in launching and guiding PMA programs. Successful programs have advisory boards that represent a wide variety of perspectives and include participants from many walks of life.

Sometimes a telephone call or other personal contact from a department chair, well-known faculty member, or high-ranking university official helped to pave the way for advisory board participation. A combination of persistence, nurturing, and follow-up was a necessary part of securing the services of the right advisory board members.

There is an element of "social capital" offered to advisory board members; they become part of something innovative and valuable to the community through their participation. By opening itself up to outside voices, including perspectives beyond the university, the university reinforces its relevance socially and in the marketplace.

Lesson Learned

Advisory boards can have a significant impact on many aspects of a PMA program's success.

In general, advisory boards can serve as a bridge for students between academic and "real world" work. With duties spanning program development input and marketing, to placement of graduates, the advisory board is a necessary component of a successful PMA program.

Working with an advisory board can create unusual marketing opportunities. For example, through collaboration with advisory board members, one institution's PMA program in public health was featured on local public television and in a video produced by a community health collaborative.

Lesson Learned

There is no "one size fits all" rule for advisory boards.

The size of advisory boards varied, with some in the 10- to 12-member range, while at least one has 25. Each program should identify an advisory board size that works effectively. Some considerations should be the talents, skills, range of influence (national, local, discipline-specific or broader), and networking potential for each member. Some participants recommended that the advisory board be "small enough" to reach agreement on key issues, but large enough to reach outside the bounds of the institution for placement of students and graduates.

The timing and frequency of meetings may range from monthly to quarterly, and defined agendas are important. Given the conflicting time commitments of many advisory board members, some participants suggested meetings with subsets or committees within the advisory board, along with conference calls, online meetings, and alternative venues (for example "piggybacking" on other organizational meetings).

Lesson Learned

Advisory boards may need to evolve along with PMA programs.

When discussing the potential downsides of advisory boards, participants identified situations in which the needs of the PMA program may have evolved, requiring a change in advisory board composition. For example, a primary focus on initial curriculum development may have given way to other needs, including a more singular focus on funding for students or job placement for graduates. If the current advisory board does not have the skill set required, changes may be necessary.

Some strategies for changing advisory board membership included:

- Set term limits on advisory board participation. This may be helpful in recruiting as well, given some potential advisory board members' concerns about an open-ended commitment;
- Explain the evolving role of the advisory board and ask for commitments on specific projects. If members cannot commit, thank them for their service—and keep the lines of communication open for future participation; and,
- Assign "emeritus" status to advisory board members who may rotate off the panel, ensuring an ongoing connection to the program and its alumni.

Lesson Learned

The advisory board may take time, commitment and nurturing, but it is a valuable component of PMA success.

For some, the advisory board opened up additional opportunities for the university, its students, and staff to collaborate with other institutions, community organizations, non-profits, and businesses.

Program directors with trepidation about opening up the PMA process to "outsiders" found the advisory board process to be extremely helpful. Claremont Graduate University describes building an advisory board as surprisingly successful and one of their most successful components of implementing a PMA:

> This is one of the most time-consuming but rewarding ways to accomplish multiple goals in new program development. It 'forces' you to reach out to professionals in the fields, it brings in multiple perspectives that help in curriculum decisions, program development, recruitment of students and faculty, creates opportunities for partnerships and internships, and it even generates fellowship money!

Program marketing. The challenge of marketing is threefold: first, within the university these programs may be perceived as a drain on resources and competing for students who may be lured away from a Ph.D. track. However, most participants at the workshop found that students who pursue PMAs are motivated by different goals, largely to use advanced education as a way to achieve a career objective outside of research and teaching. The PMA offers them a bridge, combining rigorous academic training, critical thinking, and practical application of concepts in the field. Second, finding the "right" students for such programs is often difficult, as PMA programs are not as well-known as their Ph.D. counterparts.

Finally, opening the institution up to non-academic perspectives and practitioner-oriented coursework—particularly in the social sciences and the humanities—often makes academic professionals uncomfortable, and concerned about the "selling out" of higher education to business interests.

Successful PMA programs are sensitive to all of these issues, and develop PMA marketing efforts that enhance the overall position of the university as socially responsible and committed to high-quality academic standards.

Identifying viable programs. A first step in marketing PMA programs is product development. An understanding of societal and discipline needs often informs the development of PMA programs. Many program directors found succinct ways to describe PMA programs, describing societal changes and ultimate employment opportunities for graduates as context for the programs. Some examples:

- Because "society needs professionals with critical and creative analytical skills, honed in real-world settings, to work toward viable solutions to social problems," American University developed the MAPS (Master of Arts in Public Sociology). This degree program is "designed to provide students with training to use theories and methods of sociology in a wide range of work settings, including social activism and advocacy;" and,

- University of Colorado-Boulder, in creating its Master's in Development Studies-Geography, noted, "Agencies involved in promoting socio-economic development are expanding rapidly in this country and globally. Supranational, national and non-government agencies have expressed a need for highly trained professionals at the graduate level. Students have indicated a desire for an option between an academic career and a professional career in the field of development studies."

Lesson Learned

Marketing starts with clear and cogent product identification and positioning.

Growth in professional opportunities, responding to changes in the discipline, or identifying emerging fields where little formal training is available are other reasons to create new programs. Some examples:

- The Cleveland State University Master of Arts in Global Interactions (MAGI) has "a 'demand driven' design, responding to the interests of both students and employers." The program "balances academic and analytic thinking with practical, professional, problem-solving skills;" and,

- The goal of the University of North Carolina, Wilmington's Master's in Applied Gerontology is "to improve the quality of life for the region's older adults by adequately training leaders in the workforce."

Some mentioned that programs often are initiated by a faculty member who is a leading expert in the field; one example is SUNY Albany's program director for its Economic Forecasting program who is an internationally known specialist. Another is the previously mentioned program director for Fordham's International Political Economy and Development program.

In cases where professional master's programs have multiplied at institutions, some have tried to group the new programs under one banner to assist in marketing the programs and to look for program efficiency, with shared resources.

Building support within the institution. Top administrators often see the external institutional benefits in terms of ties to business and the community; they recognize internal challenges as well. Often, top level support translates into funding—for faculty, students, and marketing programs. Engaging colleagues across the institution in program and curriculum development can gain support for the PMA, and administrators can help make this happen.

Lesson Learned

Building interdisciplinary support starts at the top.

Lesson Learned

Communication and collaboration can build institutional support.

A key component in building support is to have an effective internal communication plan in place. Assuming that others within the institution will hear about a new or developing PMA program is not enough—program directors realize that internal as well as external communications can go a long way toward creating legitimacy and vitality for a new program.

Building support can also take the form of collaborative research opportunities that link the PMA program and students with other areas within the institution

Assessing competition and creating points of differentiation. Just as prospective students do not select a PMA program in a vacuum, directors and deans know that a new or existing PMA program must be evaluated in the context of competition. In some fields, several PMA programs similar in type can coexist, satisfying the needs of large numbers of students and far-flung employers. But successful program directors have found that comparing programs to similar offerings often helps an institution clarify its positioning and identify reasons for students to select a particular institution and program.

Lesson Learned

Creating a unique position for a PMA program requires extensive knowledge of competitive programs and marketplace needs.

Participants offered these examples of program differentiation, either through being a program "first" or having a regional advantage in a field:

- The Master's of Geographic Information Science (GISci) program at the University of Minnesota was one of the first professional master's degrees in GISci in the nation and remains one of the best by offering a combination of substantive depth and cutting-edge technical training. The program is part of a larger movement in which GISci as a discipline is exploding in both academia and beyond;

- University of North Carolina Wilmington's master's program helps fill the need of North Carolina employers for behavior analysts and closes the gap in program availability that currently exists in the southeastern region of the United States;

- The (TESOL – Teachers of English to Speakers of Other Languages) curriculum at the University of Colorado, Boulder avoids duplication with other higher education programs in the state and region geared more towards K-12 educators; and ,

- The MA program in Criminology & Public Sociology (CAPS) at UNC Wilmington, will be the first MA Public Sociology program in the United States. Members of the graduate committee, comprising faculty in the Department of Sociology and Criminal Justice, used input from a community advisory board, to create a challenging and current curriculum.

Program directors and deans noted the need to keep up with developments in the field. These may cause programs to grow and evolve, and require changes to curriculum. Competitive encroachment—in terms of new programs and a small number of paid internships—may require ongoing adjustments to the PMA "product" as well.

Seemingly minor aspects can become important, such as the descriptive name of the degree. If the name is not clear to potential students and employers, the value of the degree itself could be lost

or underestimated. There may also be unforeseen internal issues in naming, as the program director at Southern Illinois University Edwardsville found: "For example, we had originally conceived of the program as 'Technical and Professional Communication' a term which is becoming more common in the field. However, we agreed not to use the term 'communication' so as not to create a perceived confusion with other graduate programs in other departments. We changed the program's name to 'Technical and Scientific Writing.' This change will have positive impact, we think, because it more clearly defines the program to potential students and directs students to our program as they conduct online searches. The name change has also given us support from the sciences in a way that we had not anticipated."

Implementing a targeted and effective student recruitment strategy. Deans and program directors placed a strong emphasis on effective student recruitment. "If you build it, they will come" is not a recommended recruitment strategy for PMA programs.

Lesson Learned

Recruiting PMA students requires creativity, persistence, belief in the "product" and significant outreach.

Sometimes, the PMA responds to a market need, but is ahead of student awareness. For example, Claremont Graduate University found some of its Applied Humanities programs "entering new territory, especially in the case of arts and cultural management, presents special problems with communications, marketing, and recruitment. In effect, although the market need is there, we are having to create the student market."

Key elements in this aspect of marketing include targeting students specifically: e.g., holders of specific undergraduate degrees, mid-career professionals in need of skills upgrading, career changers, etc.

Certificate programs can be effective marketing tools. Often they are cutting-edge, and extremely useful in terms of their content. They

appeal to an important audience: working adults who return to the academic arena after a significant gap in time. These students often **re-enter** the academic environment through certificate programs to meet continuing education requirements or to satisfy some professional or personal needs. After this experience, some have been inspired to pursue a master's. A certificate program can be designed to fulfill requirements (e.g., business skills) needed for the PMA graduate—particularly in cases where the PMA curriculum has no room for such classes. Finally, certificate programs can be incubators for potential master's programs.

Sources of potential students are everywhere—some participants recommended outreach to undergraduates matriculating in programs in-state, and to alumni, through community partners, and employees within the local community. The career counseling office on campus is a way to reach alumni who may be considering a career change, or reviewing post-baccalaureate education options. The career counseling office of neighboring institutions, where no program conflict exists, is another avenue for reaching qualified prospective students.

Lesson Learned

Professional meetings can provide a cost-effective marketing approach, as they draw like-minded individuals together and present an opportunity for the institution to position itself and its programs.

Conferences and targeted local and national events with student and faculty participation provide good recruiting opportunities because they build awareness about programs, faculty, students, and graduates. Participation has multiple benefits. Students are exposed to thought leaders in the field first hand; this is an opportunity to add to their academic training. Secondly, if they present papers or projects, students can demonstrate the quality of the PMA program. Finally, the institution can capitalize on the quality of its faculty through their involvement in such conferences.

Lesson Learned

Traditional and non-traditional marketing tactics can be used to promote PMA programs.

Participants emphasized websites, recognizing that most potential students use the Internet as part of their search process for graduate programs. It is important to keep the website up-to-date and attractive. Some recommended listing program requirements and application information on the site (see bullet 5 on page 89.) Some programs utilize the Web as an avenue for current and former students to communicate with faculty, thus building a sense of community around the PMA program.

Sometimes, graduate student activities can create opportunities for outreach as well and develop interest in PMA programs: "An undergraduate philosophy conference, coordinated by our new Graduate Student Association, was held primarily for the purpose of soliciting applications to the new master's program from students graduating from regional colleges and universities." *(University of North Carolina Charlotte)*

Finally, some deans and program directors advocated joint marketing efforts with the institution as a whole. Reaching students who are aware of the institution, through certificate programs, continuing education classes, and other points of contact, can be an effective way to market PMA programs.

Building business and industry partnerships. Some successful programs point to location as a critical factor in securing ideal positions for students, e.g. the state capital for political internships. Some programs report that remote opportunities are viable too, especially when they add a component of practical applied learning to the student's résumé.

- Florida State University cited its Tallahassee location as a positive factor in the success of the Applied American Politics and Policy master's program: "The capital is home to large numbers of potential students whose chief interest is practical politics and public policy and who believe the degree enhances their career prospects… Location in the capital puts students in touch with internships and employment opportunities in their field of interest"; and,

- Appalachian State University considered its location—distant from key metropolitan areas—as a liability in identifying internships. But the university capitalized on its assets, including university-owned housing in Washington, DC and New York City, along with contacts through faculty and advisory board to develop internships for Applied Public History students at Colonial Williamsburg, Historic Charleston Foundation, The White House, Old Salem/Museum of Early Southern Decorative Arts, Mount Vernon, Smithsonian Institution and The National Museum of American History.

Making the best use of advisory board networking contacts is one way to build business and industry connections that will benefit students and the program.

Lesson Learned

An integral part of marketing the PMA is developing internship and employment opportunities for students. Often, the advisory board is one of the program's best conduits to employment.

Resource allocation

Faculty issues. Many deans and program directors reported interdisciplinary programs as key to PMA success. The best programs are built on faculty support and commitment. Including faculty in product development is key to building support. Including tenure-track professors as core faculty has positive benefits as well:

- "A (success) factor is the seriousness with which the degree is treated by the regular members of the faculty in the Department of Political Science. Full-time tenure-earning faculty teach courses in

the program and its director is a professor in the department. This commitment by the faculty lends academic legitimacy to the program and demonstrates both to students and to the wider community that the degree is a serious professional enterprise." *(Florida State University)*;

- "Opportunities were presented at multiple junctures for the department faculty to review and discuss different steps in the planning and implementation…of the proposed program." *(University of Colorado, Boulder, Linguistics for TESOL program)*;

- Advisory boards are sometimes a source for faculty. Many others rely on a local pool of talent who serve as adjunct professors. The experiential aspects of many PMA curricula encourage the use of practitioner faculty who can bring relevant field experience to the classroom;

- Some open their programs to *"distinguished visitors"* and *"guest speakers"* who offer timely and relevant perspectives to students. This lessens the reliance on overburdened faculty "shared" with other programs or departments; and,

- Teaching the sometimes diverse student body in PMA programs can be a challenge for some faculty, especially as they balance the needs of experienced professionals and current master's students in one classroom.

Lesson Learned

Interdisciplinary programs put significant demands on faculty, but can create credibility and support for PMA programs.

Funding of students and activities. The most common funding sources for students are scholarships, paid internships, including work-study and grant-funded internships. Some reported the need to fund activities of students, and other outreach opportunities for the program, such as student travel to professional meetings. However, it should be noted that PMA students help maximize course enrollments in many departments and, more importantly, provide intellectual synergy with graduate students

from other graduate programs. They can be a key resource for research and policy initiatives that require skilled professionals.

Lesson Learned

Many PMA programs struggle to secure sufficient funding for students.

Lesson Learned

Funding shortfalls can hamper a program's growth.

Some funding obstacles are systemic, requiring significant effort, institutional change, or access to outside funding to resolve. Other resource challenges mentioned by the PMA participants included:

- High tuition costs combined with small fellowship pools cause programs to lose students and prospects; and,
- Little support for distant internships, expenses of opportunities abroad and unpaid internships create stresses.

Other funding issues identified included:

- Release time for faculty who are developing infrastructure and materials and factoring in internship supervision into teaching load; and,
- Adequate and ongoing compensation for faculty and guest speakers.

Lesson Learned

Not all funding challenges can be met with limited resources available to some PMA programs.

To address insufficient resources for marketing and other efforts, participants recommended:

- An active role on the part of the graduate dean in marketing and recruitment, and in securing staff help;

- Use of student employees, or excess staff that is seasonally busy in other areas as a shared resource; and,
- Making multiple uses of marketing materials—for example, advisory board, students, and academic audiences may be three targets for program materials.

Institutionalization of Programs

As with most successful academic ventures, the commitment of the top leadership of the institution is essential in establishing and promoting superior PMA programs.

Many talked about the need to build consensus and buy-in for professional master's programs—in part because of the need for interdisciplinary academic support and potential sharing of resources, and in part because such programs present a different face of the institution to the community both within and outside the walls of the institution.

Several realized that institutionalizing PMA programs meant building a sense of identity and ownership for the programs. They work hard to build community with students and faculty. Others recommend tangible means: setting aside space for graduate students to congregate, finding ways to celebrate the achievements of graduates, reinforcing alumni connections with the program and the institution.

Outcomes

Participants reported many positive outcomes related to program and student achievements:

- **Degree completion**—usually on time and close to 100%;
- **Successful internship program**—high satisfaction of both students and faculty with the experiential learning component, often leading to better evaluation and advising tools;
- **Placement of graduates**—appropriate employment post-degree in the targeted profession. Occasional entry into Ph.D. programs;
- **Faculty and student presentations at professional meetings**; and ,
- **Success in tracking graduates.**

Lesson Learned: Best Practices

1. Secure support from top administrators; demonstrate ways that the PMA enhances the image and visibility of the university.
2. Build on the existing reputation of the institution or a key department when building new PMA programs.
3. Incorporate collaborative efforts into program design; engage faculty from the start, and respond to their concerns and needs. Aim for small faculty/student ratios.
4. Monitor and promote program successes; make adjustments as needed in program design, curriculum, and positioning. Develop a method to capture ongoing institutional attention, interest, and ownership of PMA innovations and successes.
5. Actively solicit university support for interdisciplinary efforts; ask for necessary funding, for example for joint hires across two departments or colleges, and other resources as required.
6. Be attuned to reorganization of departments; they may present opportunities for new program development and collaborative efforts.
7. Be sensitive to competitive movements, and offer PMA programs as an avenue for the university to be on the leading edge of academic and employment trends.
8. Address curriculum issues on an ongoing basis. Specify student learning outcomes. Revisit and revise curriculum as necessary. Instill an automatic sunset rule on curriculum. Ensure that curriculum balances the academic and the practical. Address issues that emerge around pre-requisites.
9. Resolve issues that arise from an interdisciplinary approach including promotion and tenure, dual advising, support staff, teaching load. Document and share interdisciplinary success stories.
10. Promote PMA student aptitude and performance as a way to help others within the institution understand what an asset PMA students are.
11. Capitalize on any external recognition, such as the CGS/Ford Foundation program support, as a way to raise visibility and credibility for the PMA program both internally and externally.
12. Keep relevant academic deans well informed and included.

Obstacles to Success

In discussing outcomes, participants identified several obstacles to PMA success. Often they echoed previous issues related to insufficient resources. Some obstacles were unique to individual programs; others were shared among institutions, including:

- Graduate school organizational changes/turnover that slowed or halted program development and growth;
- Time and effort involved to develop consensus for program descriptions and course descriptions, and other implementation tactics;
- Time required to get program approvals—both from within the institution and from state accrediting bodies;
- Keeping a focus on a shared mission within the institution;
- Faculty issues, including;
    - Resistance to master's programs, especially when they require more work for faculty, but not more money;
    - A deficit in faculty awareness of market and employer needs;
    - Programs that don't "fit" with traditional paths or department expectations.
- Ongoing funding;
- Challenges that come with program maturity, particularly maintaining forward momentum;
- Over reliance on a single faculty champion with no plans for succession; and,
- Difficulty in tracking graduates, especially as incomplete employment records and a lack of communication post-degree may make follow-up difficult.

Summary

Overall, those who participated in the capstone meeting were enthusiastic and encouraged about the prospects for professional master's degrees. They used the meeting as an opportunity to share successes and challenges and to gain insight and encouragement from others. When asked what aspects of their PMA programs are most easily duplicated, participants mentioned:

- Initial planning, assessment and developing implementation plans. In particular, some mentioned the value of the CGS model. In a few cases, programs did not move forward because they failed to meet criteria for potential success during the planning phase;

- Connection to regional workforce needs. Several program directors talked about ways to gain data about employment needs, and to use this information in fine tuning program offerings to meet the needs of regional employers; and,

- The discovery that faculty have transferable skills. Often the development and implementation of a PMA program is a way to highlight the capabilities and potential of key faculty members.

Some participants identified aspects of successful programs that may be harder to duplicate, including:

- Unique geography, e.g. state capitals for politics;
- Faculty (leading expert); and,
- Workforce needs that may be distinctly regional.

When asked to describe the components of the PMA that are easiest to implement, and provide the most significant positive impact for programs, participants reiterated an appreciation of the CGS/Ford foundation model that promotes a year of planning and program evaluation prior to launch. They also mentioned:

- The excitement of an engaged advisory board;
- Successful internship programs; and,
- CGS/Ford Foundation funding, along with the prestige associated with the program and the network of support available to program directors and deans (as is the case now with the PSM degrees, it will be a challenge going forward to obtain start-up funding for these types of professional programs.)

Conclusion

This study of the professionalization of the social sciences and humanities demonstrates that institutions are responding to the employment and knowledge demands of the 21st century by retooling the master's degree. Present-day graduates possess skill sets addressing employers' needs, yet grounded in disciplinary content. These kinds of degrees provide an important educational credential for graduates seeking employment in a variety of non-academic settings. Similar to the growth of the Professional Science Master's, professionalization across the disciplines provides a new genre of "destination" degree valued by employers and graduates alike.

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Appendix A: List of Professional Science Master's Programs[23]

PSM Institution	PSM Program
Air Force Institute of Technology	Combating Weapons of Mass Destruction
American University	Biotechnology
American University	Applied Computing
American University	Environmental Science/Assessment
Antioch University New England	Sustainable Development and Climate Change
Appalachian State University	Instrumentation and Automation
Appalachian State University	Nanoscience for Advanced Materials
Arizona State University	Computational Biosciences
Arizona State University	Nanoscience
Baker College	Information Systems
Barry University	Medical Biotechnology
Binghamton University	Cartography & Geographical Information Systems
Binghamton University	Materials Science and Engineering
Brandeis University	Biotechnology
Buffalo State College	Professional Applied and Computational Mathematics
California State University, Channel Islands	Biotechnology and Bioinformatics
California State University, Chico	Environmental Sciences
California State University, East Bay	Biostatistics
California State University, Fresno	Biotechnology
California State University, Fresno	Forensic Science
California State University-Inter Campus*	Applied Biotechnology Studies (PABS)
California State University, Monterey Bay	Coastal and Watershed Science and Policy
California State University, Northridge	Assistive Technology Engineering
California State University, Sacramento	Biological Sciences, Stem Cell Concentration
California State University, San Bernardino	Environmental Sciences
California State University, San Marcos	Biotechnology
California State University, Stanislaus	Genetic Counseling
Case Western Reserve University	Entrepreneurial Biotechnology

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Case Western Reserve University	Chemistry for Entrepreneurship
Case Western Reserve University	Statistics for Entrepreneurship
Case Western Reserve University	Mathematics for Entrepreneurship
Case Western Reserve University	Physics for Entrepreneurship
College at Brockport, State University of New	Biology
College of Saint Rose	Computer Information Systems
Creighton University	Bioscience Management
Elmhurst College	Computer Information Systems
Florida Atlantic University	Medical Physics
Florida State University	Aquatic Environmental Science
Florida State University	Financial Mathematics
Florida State University	Biomathematics
Fort Hays State University	Biological Sciences
George Washington University	Molecular Biotechnology
Georgia Institute of Technology	Computational Molecular Biology/ Bioinformatics
Georgia Institute of Technology	Human-Computer Interaction
Georgia Institute of Technology	Quantitative Computational Finance
Georgia Institute of Technology	Prosthetics and Orthotics
Grand Valley State University	Cell and Molecular Biology - Biotechnology Emphasis
Grand Valley State University	Medical and Bioinformatics
Grand Valley State University	Biostatistics
Illinois Institute of Technology	Biology
Illinois Institute of Technology	Analytical Chemistry
Illinois Institute of Technology	Materials and Chemical Synthesis
Illinois Institute of Technology	Health Physics
Joint School of Nanoscience and Nanoengineering*	Nanoscience
Keck Graduate Institute of Applied Life Science	Bioprocessing
Keck Graduate Institute of Applied Life Science	Clinical and Regulatory Affairs
Keck Graduate Institute of Applied Life Science	Medical Devices and Diagnostics
Keck Graduate Institute of Applied Life Science	Pharmaceutical Discovery and Development
Michigan State University	Industrial Microbiology

Michigan State University	Zoo and Aquarium Management
Michigan State University	Computational Chemistry
Michigan State University	Food Safety and Toxicology
Michigan State University	Industrial Mathematics
Michigan State University	Integrative Pharmacology
Michigan State University	Biomedical Laboratory Operations
Middle Tennessee State University	Biotechnology
Middle Tennessee State University	Biostatistics
Middle Tennessee State University	Health Care Informatics
New York University	Physics
North Carolina State University	Nutrition
North Carolina State University	Microbial Biotechnology
North Carolina State University	Biomanufacturing
North Carolina State University	Analytics
North Carolina State University	Electric Power Systems Engineering
North Carolina State University	Geospatial Information Science and Technology
North Carolina State University	Climate Change and Society
North Carolina State University	Environmental Assessment
North Carolina State University	Financial Mathematics
Northeastern University	Biopharmaceutical Regulatory Science
Northeastern University	Marine Biology
Northeastern University	Biotechnology
Northeastern University	Bioinformatics
Northern Arizona University	Climate Science and Solutions
Northern Arizona University	Applied Geospatial Sciences
Open University (UK)	Master of Science
Oregon State University	Applied Biotechnology
Oregon State University	Applied Systematics (Botany)
Oregon State University	Environmental Science
Oregon State University	Applied Physics
Pennsylvania State University	Biotechnology
Pennsylvania State University	Forensic Science
Pennsylvania State University	Applied Statistics
Rice University	Bioscience Research and Health Policy
Rice University	Environmental Analysis and Decision Making
Rice University	Subsurface Geoscience

Rice University	Nanoscale Physics
Richard Stockton College of New Jersey	Environmental Science
Rochester Institute of Technology	Bioinformatics
Rochester Institute of Technology	Computer Science
Rochester Institute of Technology	Environmental Science
Rochester Institute of Technology	Imaging Science
Rutgers, The State University of New Jersey-Inter Campus*	Biotechnology and Genomics
Rutgers, The State University of New Jersey-Inter Campus*	Chemistry
Rutgers, The State University of New Jersey-Inter Campus*	Sustainability
Rutgers, The State University of New Jersey-Inter Campus*	Food Science
Rutgers, The State University of New Jersey-Inter Campus*	Statistics and Biostatistics
Rutgers, The State University of New Jersey-Inter Campus*	Industrial Mathematics
Sacred Heart University	Environmental Systems Analysis and Management
San Diego State University	Bioinformatics and Medical Informatics
San Diego State University	Computational Science
San Diego State University	Medical Physics
San Francisco State University	Biomedical Science
San Jose State University	Biotechnology
San Jose State University	Statistics
Sonoma State University	Bioengineering
Sonoma State University	Computer Hardware and Software Systems
Sonoma State University	Communications and Photonics
Southeastern Louisiana University	Integrated Science and Technology
Southern Illinois University Carbondale	Advanced Energy and Fuels Management
Southern Illinois University Edwardsville	Biotechnology Management
Southern Illinois University Edwardsville	Environmental Science Management
Southern Oregon University	Applied Computer Science
St. John’s University	Biotechnology
Stanford University	Biomedical Informatics
State University of New York at Buffalo	Computational Chemistry
State University of New York at Buffalo	Molecular Chemical Biology
State University of New York at Buffalo	Natural and Biomedical Sciences

State University of New York at Buffalo	Environmental Geographical Information Systems
State University of New York at Buffalo	Biophysics
State University of New York at Oswego	Chemistry
State University of New York College of Environmental Science and Forestry	Paper Engineering
State University of New York College of Environmental Science and Forestry	Bioprocess Engineering
Stony Brook University	Master of Science in Instrumentation
Temple University	Chemical Informatics
Temple University	Forensic Chemistry
Temple University	Drug Analysis
Texas A & M University	Biotechnology
Thomas Jefferson University	Cell and Developmental Biology
Thomas Jefferson University	Microbiology
Thomas Jefferson University	Biomedical Sciences
Thomas Jefferson University	Pharmacology
Towson University	Forensic Science
Towson University	Applied Physics
Truman State University	Bioscience Informatics
University at Albany, State University of New York	Forensic Biology
University of Arizona	Applied Biosciences
University of Arizona	Medical Physics
University of British Columbia	Bioinformatics
University of California, Santa Cruz	Computational Molecular Biology/ Bioinformatics
University of Central Florida	Conservation Biology
University of Central Florida	Biotechnology
University of Central Florida	Modeling and Simulation
University of Central Florida	Health Care Informatics
University of Connecticut	Microbial Systems Analysis
University of Connecticut	Applied Genomics
University of Connecticut	Applied Financial Mathematics
University of Dayton	Financial Mathematics
University of Delaware	Biotechnology
University of Delaware	Bioinformatics
University of Florida	Pharmaceutical Chemistry
University of Florida	Forensic Science

University of Houston-Clear Lake	Physics, Technical Management Sub-plan
University of Idaho	Sustainability Science
University of Idaho	Grassland and Shrubland Ecosystem Science
University of Idaho	Water Resources Management
University of Idaho	Management of Regulated River Systems
University of Idaho	Environmental Contamination
University of Idaho	Climate Change Science
University of Idaho	Wildland Fire Ecology and Management
University of Idaho	Restoration Ecology
University of Idaho	Ecohydrology Science and Management
University of Illinois at Urbana-Champaign	Bioenergy
University of Illinois at Urbana-Champaign	Agricultural Production
University of Illinois at Urbana-Champaign	Food Science and Human Nutrition
University of Illinois at Urbana-Champaign	Plant Biology
University of Maryland Eastern Shore	Quantitative Fisheries
University of Maryland, Baltimore County	Biotechnology
University of Maryland, University College	Biotechnology Management
University of Maryland, University College	Bioinformatics
University of Maryland, University College	Software Engineering
University of Maryland, University College	Information Assurance
University of Maryland, University College	Telecommunications Management
University of Maryland, University College	Environmental Management
University of Maryland, University College	Biosecurity and Biodefense
University of Massachusetts-Inter Campus*	Biomedical Engineering and Biotechnology
University of Massachusetts-Inter Campus*	Coastal and Ocean Administration, Science and Technology
University of Massachusetts Boston	Environmental Sciences
University of Massachusetts Lowell	Ergonomics and Safety
University of Massachusetts Lowell	Project Management in Life Sciences
University of Massachusetts Lowell	Applied Biotechnology
University of Massachusetts Lowell	Biosafety
University of Massachusetts Lowell	Environmental Biotechnology
University of Massachusetts Lowell	Clinical Lab Sciences
University of Massachusetts Lowell	Occupational, Environmental Hygiene
University of Massachusetts Lowell	Pharmaceutical Biochemistry
University of Massachusetts Lowell	Chemistry and Polymer Science
University of Massachusetts Lowell	Cleaner Production/Pollution Prevention

University of Massachusetts Lowell	Industrial Mathematics
University of Massachusetts Lowell	Radiological Sciences and Protection
University of Massachusetts Lowell	Epidemiology
University of Miami	Oceans and Human Health
University of Miami	Weather Forecasting
University of Miami	Tropical Marine Ecosystem Management
University of Miami	Fisheries Management
University of Miami	Aquaculture
University of Miami	Integrated Coastal Zone Management
University of Miami	Broadcast Meteorology
University of Miami	Marine Mammal Science
University of Miami	Weather, Climate and Society
University of Minnesota	Financial Mathematics
University of North Carolina at Charlotte	Bioinformatics
University of North Carolina at Wilmington	Computer Science & Information Systems
University of North Texas	Biotechnology
University of North Texas	Industrial Chemistry
University of North Texas	Environmental Science
University of Northern Iowa	Biotechnology
University of Northern Iowa	Applied Chemistry and Biochemistry
University of Northern Iowa	Ecosystem Management
University of Northern Iowa	Industrial Mathematics
University of Northern Iowa	Applied Physics
University of Pittsburgh	Geographical Information Systems (GIS) and Remote Sensing
University of Queensland	Biotechnology
University of South Carolina	Biotechnology
University of South Carolina	Bioinformatics
University of South Florida	Biotechnology
University of South Florida	Bioinformatics and Computational Biology
University of Southern Maine	Biostatistics
University of Texas at El Paso	Computational Molecular Biology/ Bioinformatics
University of Texas at San Antonio	Industrial Mathematics
University of the District of Columbia	Water Resources Management
University of the District of Columbia	Applied Statistics
University of Utah	Biotechnology
University of Utah	Computational Science

University of Utah	Environmental Science
University of Utah	Science Instrumentation
Virginia Commonwealth University	Bioinformatics
Washington State University	Molecular Biosciences
Worcester Polytechnic Institute	Industrial Mathematics
Worcester Polytechnic Institute	Financial Mathematics

*State system-wide initiatives/Inter Campus programs/Joint programs/Joint collaborations: California State University has a joint Applied Biotechnology Studies program at the Fullerton, Los Angeles, and Pomona campuses; North Carolina A&T State University and the University of North Carolina at Greensboro have a joint collaboration program in Nanoscience; Rutgers, The State University of New Jerseys has five programs at the Camden, Newark, and New Brunswick campuses; the University of Massachusetts has two programs at the Amherst, Boston, Dartmouth, and Lowell campuses

Appendix B: List of NSF Science Master's Program Awardees

Institution	Program
Clemson University	Sustainable and Resilient Infrastructure
Cornell University	Medical and Industrial Biotechnology
Grand Valley State University	Biomedical Engineering
Humboldt State University Foundation	Professional Training for an Environmental Work Force
North Carolina State University	Biomanufacturing
Northern Arizona University	Climate Science and Solutions for Nothern Arizona University
Northwestern University	Engineering and Global Health Technologies
Purdue University	Concentration in Wireless Technology and Systems Engineering
Rochester Institute of Technology	Decision Support Technologies for Environmental Forecasting and Disaster Response
Rutgers, The State University of New Jersey-New Brunswick	Fueling Innovation in New Jersey Through Graduate Education
San Diego State University Foundation	Integrating Regulatory Affairs in Bioscience and Biomedical Physics: A Scalable, Replicable Model Addressing Current and Emerging Workforce Needs
San Francisco State University	Concentrations in Biotechnology and Stem Cell Science
State University of New York at Buffalo	Professional Applied and Computational Mathematics
University of Alaska Fairbanks Campus	Ecosystem Approaches to Fishery Management
University of Florida	Translational Biotechnology
University of Georgia	From Science to Business in Biomanufacturing: The Missing Link for the US Biotechnology Industry
University of Idaho	Environmental and Natural Resource Sciences at the University of Idaho
University of Maryland Eastern Shore	Quantitative Fisheries and Resources Economics
University of New Mexico	Connecting NanoScience to MicroSystems

Appendix C: Annotated List of System-wide and State-wide PSM Programs

State- or system-wide PSM initiatives were developed to target individual programs and institutions, respond to geographical needs, partner with local employers ensuring they remain responsive and adaptive to current and future workforce needs, and to foster collaboration between multiple departments and schools within colleges and universities, serving as a catalyst for innovative research and discovery.

The Arizona PSM Initiative. Arizona was among the five states chosen to participate in the 2008 NGA Policy Academy, *State Strategies to Meet Emerging Workforce Needs through the PSM*. Arizona's three public universities: Arizona State University, Northern Arizona University, and the University of Arizona, offer six PSM degrees (as of the publication of this monograph). Northern Arizona University received funding ($698,733, Award Abstract #1011706) in the 2009 NSF Science Masters Program competition to develop a degree in Climate Science and Solutions, which was approved as an official PSM program in July 2010.

URL: http://arizonapsm.wordpress.com/

The California State University PSM Initiative. The California State University system is the largest state-wide higher education system in the United States to launch PSM programs on multiple campuses. Grant support of $1.365 million from the Alfred P. Sloan Foundation has helped support PSM program development on 14 campuses, with programs projected to expand to include all or most of the university's 23 campuses. Specifically, 21 PSM programs on 17 campuses between 2001 and 2010 have received PSM affiliation approval.

In considering the feasibility of a system-wide initiative, CSU conducted a student interest survey (http://www.sciencemasters.com/portals/0/Proceedings/PROCEEDINGS_Qayoumi_presentation.pdf retrieved 11/24/2010) finding that:

- 46.3% of students planned to enter graduate school immediately;
- 45.9% interested in a Master's degree program;
- 52.5% would seriously consider a PSM program; and
- 78.5% would pursue a PSM degree over a non-science master's degree.

A professional survey of business and industry representatives revealed that the CSU PSM initiative must be able to establish credibility among prospective employers and have a targeted focus that leverages CSU strengths. All programs are designed as rigorous two-year master's degree programs preparing professionals with

the science and management skills needed by the state's science and technology industries. CSU programs include biotechnology and biosciences, with additional programs focusing on bioinformatics, medical product development management, biostatistics, computational science, environmental science, forensic science, and genetic counseling.

URL: http://www.calstate.edu/psm/

The HBCU Mid-Atlantic Professional Science Master's Alliance. The HBCU is a group of predominantly Historically Black Colleges and Universities in Delaware, the District of Columbia, Maryland, Pennsylvania, and Virginia, which have partnered to develop and offer new PSM programs.

The year-long planning phase for this project was supported by the Alfred P. Sloan Foundation, which approved a three-year implementation grant to the University of the District of Columbia in October 2009. Consistent with the goal of expanding PSM programs at HBCUs and addressing current workforce needs, the Alliance is conducting an extensive market survey—as found on www.sciencemasters.com, among other locations—of regional employers and prospective students. The HBCU has committed to develop and launch 16 new PSM programs over the next three years. At least six of these programs will admit students starting in Fall 2010.

Three programs at two institutions have already received PSM affiliation (as of the publication of this monograph): the Applied Statistics and Water Resources Management at the University of the District of Columbia, and Quantitative Fisheries at the University of Maryland, Eastern Shore.

URL: http://www.hbcu-psm-alliance.org/

The Massachusetts PSM Initiative. The University of Massachusetts system-wide PSM initiative is focused primarily on the life and environmental sciences. A major rationale for scaling up to the system-wide level was to increase flexibility for students by providing "…more options than would ordinarily be available on a single campus…," by offering professional courses through UMass Online, and to enhance the financial sustainability of these programs (http://www.nash-psm.org/wp-content/uploads/2010/02/npsma-news-umass-1st-anniversary.pdf retrieved 1/6/2011).

URL: http://www.nash-psm.org/wp-content/uploads/2009/11/umass-fast-start.pdf

Minnesota State Colleges and Universities. This system, the largest single provider of higher education in the state of Minnesota, contains 32 institutions, including 25 two-year colleges and seven state universities. The colleges and universities operate 54 campuses in 47 Minnesota communities and serve about 277,000 students in credit-based courses. Overall, the system produces about 34,700 graduates each year. The system also serves 157,000 students in non-credit courses. In addition to credit-based courses, the system offers customized training programs

that serve about 179,500 employees from 6,000 Minnesota businesses each year. The law creating the system was passed by the Minnesota Legislature in 1991 and went into effect July 1, 1995. The law merged the state's community colleges, technical colleges and state universities into one system. Instead of three separate governing boards and three chancellors, there is now one board and one chancellor for the entire system.

In August 2010, the system was awarded an eight-month, $99,802 planning grant by the Alfred P. Sloan Foundation to study the market demand for and feasibility of developing professional science master's degree programs. The intent of developing these degree programs is to prepare graduates to serve as technical managers in industry. The new project, launched Sept. 1, is led by the Office of the Chancellor Strategic Partnerships, Career and Workforce Development Unit, and the project work group will be chaired by President Judith Ramaley of Winona State University. Participants include six system universities: Bemidji State University; Metropolitan State University; Minnesota State University, Mankato; Minnesota State University Moorhead; St. Cloud State University; and Winona State University. Also participating are North Dakota State University, University of Wisconsin-La Crosse and University of Wisconsin-Stout. In addition, numerous industry groups have been engaged as partners in the project.

(Information from the Minnesota State Colleges and Universities website and *The Chronicle: An Internal Newsletter for the Office of the Chancellor*: http://www.mnscu.edu/index.php and http://www.chancellor.mnscu.edu /chronicle/2010/sept10.html retrieved 1/6/2011).

URL: http://www.mnscu.edu/index.php

National Association of System Heads. Established to "inspire and facilitate the rapid development of system-wide and state-wide PSM initiatives," this project seeks to communicate with approximately a dozen university systems, in an effort to engage and develop additional systems across the United States. The NASH website provides resources focusing on systems, state-wides, and regional PSMs programs, as well as funding recommendations and resources, PSM presentations and promotional materials, reports, and other information focusing on partner websites, including the California State University PSM Initiative and the Veterans Initiative. This project is funded by the Alfred P. Sloan Foundation.

URL: http://www.nash-psm.org/

The Oregon PSM Initiative. "Oregon was chosen as one of five states to participate in the National Governors Association *Policy Academy on State Strategies to Meet Emerging Workforce Needs through the PSM* in 2008. The following year, the Oregon University System launched a state-wide PSM program development initiative with support from the Alfred P. Sloan Foundation.

Seven campuses (Eastern Oregon University, Oregon Health Sciences University, Oregon Institute of Technology, Oregon State University, Portland State University, Southern Oregon University, and Western Oregon University) are currently involved in developing new PSM programs in collaboration with regional businesses and industries.

Oregon's PSM initiative strives to foster collaborative innovations in education by facilitating discussions among universities, businesses, government agencies, non-profit organizations and other affiliated associations to better meet the state's economic and workforce development needs."

(Information from the Oregon PSM Initiative website: http://oregonpsm.org/home retrieved 1/6/2011).

URL: http://oregonpsm.org/home

Rutgers, The State University of New Jersey PSM Initiative. The Master of Business and Science degree at Rutgers, The State University of New Jersey combines master's level study in science or engineering with "plus" courses in business and policy. There are currently more than 20 concentrations, with additional areas of study being developed.

According to the Initiative's main website, the degree is "a combination of an MS and MBA degree with 43 credits: 24 credits in the sciences and/or engineering and 19 credits in business. The science courses are taken in concentrations in areas such life science, engineering management, mathematics, information technology and sustainability. The business and policy component of the degree consists of core courses in finance and accounting, marketing, communication and leadership, management of science and technology electives, ethics and a capstone course, teaching entrepreneurship and intrapreneurship. Full time students are expected to perform an internship (up to six credits which can come from the Science or Business electives)."

The Rutgers PSM Initiative also features an Industrial Advisory and Affiliates Program who work with the program in creating curriculum "relevant to industry, providing internship and networking opportunities for our students, and presenting lectures and seminars on relevant topics." Each curriculum area has an advisory board particular to that scientific area.

Information Sessions, Lecture Series, Workshops, and other events are offered to students interested in pursuing the degree.

(Information from the Rutgers, The State University of New Jersey PSM Initiative website: http://psm.rutgers.edu/ retrieved 1/6/2011).

URL: http://psm.rutgers.edu/

The State University of New York PSM Initiative. "Regional industry partnerships between SUNY campuses, industry and regional development agencies are an integral component of the strategy to promote economic growth in New York State. Additionally, these partnerships are critical to the success of PSM programs. Regional industry partners serve on PSM program advisory councils that provide guidance on emerging skill sets and workforce needs, facilitate degree development and promote feedback on program performance. Most importantly, industry partners help provide internship and employment opportunities for program graduates."

In New York, both the State University (SUNY) and City University (CUNY) systems are involved in PSM initiatives. Nancy Zimpher, Chancellor of the SUNY system, envisions several ways in which PSM programs can help SUNY and the state of New York: reversing the brain drain; enhancing the academic portfolio offered to attract students; helping to attract external funding; leveraging new partnerships with business and industry; using PSM graduates to mentor undergraduates; and providing another vehicle for promoting living and working in the state of New York. (http://www.sciencemasters.com/portals/0/Proceedings/PROCEEDINGS_Zimpher_presentation.pdf retrieved 11/24/2010).

URL: http://www.psm.suny.edu/

The State University System of Florida PSM Initiative. The Florida PSM Initiative offers a two-year degree focusing on four key elements: industry advisory board; in-depth study in a science driven field; industry internship; and professional development courses intended to emphasize written and oral communication, leadership, business, and team-building skills. There are currently 22 programs (as of the publication of this monograph) at seven institutions that have received official PSM affiliation approval.

URL: http://www.flpsm.org/

The Illinois PSM Initiative. Development of the Illinois PSM was funded by a grant from the Alfred P. Sloan Foundation. At the time of the publication of this monograph, institutions receiving official PSM affiliation approval for one or more of their programs include: Elmhurst College; Illinois Institute of Technology; University of Illinois at Urbana-Champaign; Southern Illinois University Carbondale; and Southern Illinois University Edwardsville.

Course of study at each of these institutions addresses multiple business and industry needs, with disciplinary interest focusing on the environmental sciences, specifically in programs such as Advanced Energy and Fuels Management, Agricultural Production, Environmental Science Management, and many others.

URL: http://psm.illinois.edu/

The University of North Carolina PSM Initiative. As part of "UNC Tomorrow," the strategic plan of the University of North Carolina, many of the 16 UNC campuses are in the process of developing and implementing PSM programs.

North Carolina State University currently serves as a resource center, providing multiple serves and consultation to the other UNC campuses with PSM programs. There are currently 14 programs (as of the publication of this monograph) at six institutions that have received official PSM affiliation approval.

URL: http://www.ncsu.edu/grad/psm/index.php

The University of North Texas PSM Initiative. Comprised of three programs: Biotechnology, Environmental Science, Industrial Chemistry, the University of North Texas "requires 36 semester credit hours with 24 graduate semester credit hours in the science discipline and 12 graduate semester credit hours of professional skills or "plus" courses."

A thesis is not required, but a three or six semester credit hour internship is included within the 24 semester credit hours of science. In addition, students must satisfactorily pass a final comprehensive examination given by the student's advisory committee during the final semester of enrollment.

(Information from the University of North Texas website: http://www.psm.unt.edu/ retrieved 1/6/2011).

URL: http://www.psm.unt.edu/

Washington Higher Education Coordinating Board. "The Higher Education Coordinating Board (HECB) provides strategic planning, coordination, monitoring, and policy analysis for higher education in Washington, and administers state and federal financial aid and other educational services. Governed by a 10-member citizen board, which is appointed by the Governor, the HECB is charged by state law with representing the "broad public interest above the interests of the individual colleges and universities."

Major functions of the HECB include: developing a statewide strategic master plan for higher education; recommending policies to enhance the availability, quality, efficiency, and accountability of public higher education in Washington; administering student financial assistance programs; serving as an advocate on behalf of students and the overall system of higher education; coordinating with other governing boards and institutions to create a seamless system of public education for the citizens of Washington; and helping families save for college.

In addition, The HECB distributes more than $231 million in state financial assistance to about 76,000 Washington students annually."

At the time of publication, the Molecular Biosciences at Western Washington University has received official PSM affiliation approval.

(Information from the Washington Higher Education Coordinating Board website: http://www.hecb.wa.gov/ retrieved 1/6/2011).

URL: http://www.hecb.wa.gov/

Appendix D: Sources of Employer and Student Surveys

Institution	Program Contact
Grand Valley State University	Mark Staves
Oregon State University	Ursula Bechert
Southern Oregon University	Dan Harvey
Towson University	Mark Profili
University of Connecticut	Linda Strausbaugh
University of Illinois	Kevin Sightler
University of the District of Columbia	Beverly Karplus-Hartline

Appendix E: Employer Focus Group Protocol

Script for MnSCU PSM Focus Groups
January 25th & 26th, 2011

Preliminaries (Gail & Shannon)
Step 1: Introductions. Identify which attendees represent "hiring managers/recruiters" and which represent "potential students" or some other perspective so comments can be classified based on type of participant.
Step 2: 10-minute description of PSMs by Gail/Shannon.
Step 3: Discussion

Introduction (Focus Group Facilitator)

- Thanks for coming
- Appreciate your time
- Introduce ourselves. OERG. Grad students here will be taking notes for us.
- Here to listen to you.
- We want to get feedback from you about how we can be stronger partners moving forward in fostering new ways of learning.

Ground Rules

- My job is to make sure that the conversation keeps moving so I may have to interrupt you to keep things moving or to clarify a point. I apologize in advance if I cut you off, but we want to hear from as many people as we can on a variety of topics in the short time that we have today.
- If you have specific concerns or important issues arise, we will make a note of that and Gail or Shannon will follow up with you on that.

Does anybody have any questions before we start?

Focus Group Questions (Focus Group Facilitator)

1) **General Impressions of PSM**

    - Most of you are fairly new to the PSM concept. Now that you're heard a little bit more about the PSM concept, what are your general impressions?

2) **Determination of Disciplines** – this is by far the most important question

    - We'd like to know which disciplines you feel have greatest promise for PSMs. To that end, could you identify the top three PSM-related occupations in your organization or industry and the number of workers employed in those occupations?
    - To what extent do you believe industry would be receptive to PSMs as preparation for those types of jobs? In other words, would PSM grads be considered/hired/desired for these types of jobs?

3) **Determination of roles students would fill at end of program.**

- Where are the jobs (now and in the future) for students who would complete a Professional Science Master's program?
- Currently what degrees do individuals in these jobs have?

4) **Determination of who students for such a program would be**

- What kinds of students would this program attract? (prompts: full vs. part time, straight out of undergrad vs. currently working)
- Who in your places of work would become our students? (prompts: job titles, experience level, high (mgmt) potential)

5) **Program feasibility**

- What would be the main barriers, if any, to hiring PSM candidates where you work?
    - Prompt: Policies of hiring PhDs
    - Prompt: Limitation of recruitment to elite universities
    - Prompt: Lack of a research thesis

6) **Low priority question – Internships/Co-ops/Practicum**

- If you were to hire graduates from (or enroll in) a PSM, what role should things like internships or practica play in the program?
- Would employers in the industry be receptive to hiring interns or providing practicum opportunities from PSM programs?

7) **Low priority question (this is more a question for program development phase)**

- What are the critical competencies that _(INSERT SPECIFIC FOCUS GROUP DISCIPLINE HERE)_ in your organization need to have? (OR: What are the skill sets required for success and advancement in your organization that should be included in a PSM program?)

End of session

8) **Plus courses**

- Here we have a list of some of the possible "plus courses" that were mentioned earlier. These are courses outside the discipline of _(INSERT SPECIFIC FOCUS GROUP DISCIPLINE HERE)_ that students in a PSM program might take. Please complete this survey and indicate which 8 of these courses you think would be most useful and which 3 you think would be most critical.

    - If there are any courses that you feel are missing please add those to the list.
    - There is also an online version of this survey that we can send the link for if you prefer to complete it that way.

- We're out of time. Thanks again for your time. We've gotten a lot of really good information that I'm sure will help with the planning and implementation of new PSM programs. If you raised specific programs, Gail or Shannon will follow up with you on those at a later date.

- Social time. (for morning participants) Please feel free to join us for lunch.

Appendix F: Employer Workforce Survey Instrument

City University of New York (CUNY) Survey Instrument

PSM 2011 - Master - Copy

Professional Science Master's (PSM) degree programs are designed to respond to the needs of industry and government employers. They produce graduates with cross-disciplinary scientific expertise and the business and social skills to manage complex projects. This survey should only take a few minutes to complete. Thanks for your participation.
[CLICK on >> Next >> BUTTON below to continue]

1. Have you heard of the Professional Science Master's (PSM) degree?
- ❍ Yes
- ❍ No
- ❍ Not Sure

2. In which degree fields do you hire Master's graduates? (Check all that apply)
- ❑ Biology
- ❑ Business
- ❑ Chemistry
- ❑ Computer Science
- ❑ Earth and Environmental Science
- ❑ Engineering
- ❑ Geography
- ❑ Mathematics
- ❑ Pharmacology
- ❑ Physics
- ❑ Statistics
- ❑ Other (Please specify) _____

3. Please list up to 3 technical/scientific skills you look for in potential employees.

4. When hiring, what non-scientific types of expertise do you look for? (Check all that apply)

- ❑ Business
- ❑ Finance
- ❑ Fundraising
- ❑ Legal
- ❑ Policy Analysis
- ❑ Project Management
- ❑ Public Relations
- ❑ Sales
- ❑ Technical Writing
- ❑ Web Development
- ❑ Other (please specify) _____

5. When hiring, what professional workplace skills do you look for in an employee? (Check the most important)

- ❍ Communication
- ❍ Interpersonal
- ❍ Multitasking
- ❍ Presentation/Public Speaking
- ❍ Self-motivation
- ❍ Teamwork
- ❍ Writing

6. When interviewing candidates for employment, which has more weight in your organization:

- ❍ Academic credentials
- ❍ Industry experience
- ❍ Neither
- ❍ Not sure

7. How important is holding a Master's degree to advancement in your organization?

- ❍ Very important
- ❍ Somewhat important
- ❍ Not very important
- ❍ Not important at all
- ❍ Not sure

8. What types of positions within your organization are the hardest to fill? (Check all that apply)

- ❑ Analysis/Technical writing
- ❑ Development/Product Development
- ❑ Marketing
- ❑ Regulatory/Legal
- ❑ Research
- ❑ Strategic Planning
- ❑ Other (Please specify) _____

9. How important is it for your trained scientific staff to also have business skills?

- ❍ Very important
- ❍ Somewhat important
- ❍ Not very important
- ❍ Not important at all
- ❍ Not sure

10. What would influence your organization's decision to encourage current staff to participate in a program like the Professional Science Master's? (Check the most important)

- ❍ Availability of scholarships
- ❍ Availability of tuition assistance
- ❍ Course offerings
- ❍ Duration of program
- ❍ Government endorsement
- ❍ Relevance of subject matter
- ❍ Reputation of the university
- ❍ Support from major foundation
- ❍ Tax benefits
- ❍ Type of training
- ❍ Other (Please specify) _____

11. Does your organization offer educational benefits/tuition assistance to employees?

- ❍ Yes
- ❍ No
- ❍ Not sure

12. Would your organization offer time release to your employees who pursue a PSM degree?

- ❍ Yes
- ❍ No
- ❍ Not sure

13. Which category best describes your organization's industry?

- ❍ Aerospace
- ❍ Agriculture
- ❍ Architecture
- ❍ Automobiles
- ❍ Chemical
- ❍ Computer
- ❍ Construction
- ❍ Consulting
- ❍ Defense
- ❍ Drug Development
- ❍ Energy/Clean Energy
- ❍ Engineering
- ❍ Entertainment
- ❍ Environmental
- ❍ Food
- ❍ Government (excluding Defense)
- ❍ Green Technology / Sustainability
- ❍ Healthcare
- ❍ Hospitality
- ❍ Information Technology
- ❍ Insurance
- ❍ Manufacturing
- ❍ Mass Media
- ❍ Medical Research
- ❍ Telecommunications
- ❍ Water
- ❍ Other (Please specify) _____

14. How many employees in your organization?

- ❍ 1-100
- ❍ 101-500
- ❍ 501-1000
- ❍ 1000+

15. Would you be interested in being involved with the program in any of the following capacities? (Check all that apply)

- ❑ Offering summer and/or academic year internships to students
- ❑ Offering scholarship to students
- ❑ Having student teams develop business plans for any of your technologies
- ❑ Providing input on curriculumn
- ❑ Participating in a job fair with program graduates
- ❑ Teaching a course
- ❑ Other (Please specify) _____

16. Which category best describes your position in the Organization?

- ❍ President, CEO, CFO, CIO
- ❍ Vice President
- ❍ Manager, Supervisor, Leader
- ❍ Professional
- ❍ Human Resources
- ❍ Science officer
- ❍ Other (Please specify) _____

17. Please let us know any comments or questions you may have about this survey or PSMs programs at CUNY.

Appendix G: Student Survey Instrument

University of Massachusetts-Lowell Survey Instrument[24]

Professional Science Master's Survey: Spring 2010

1. intro

The University of Massachusetts offers several Professional Science Master's (PSM) degree programs. The purpose of this survey is to gauge undergraduate interest in, and opinions about, PSM degrees. Your answers will remain anonymous. Completing the survey will give you a chance to win a gift certificate to your UMass Book Store for $100, $50, or $25.

Professional Science Master's (PSM) Degrees:

- Are a new type of master's degree increasingly valued by business, government, and non-profit sectors engaged in the application of science and technology
- Are typically earned in the equivalent of two full-time years
- Are available in science, mathematics, and interdisciplinary science/math-based areas
- Consist of a core of advanced work in one discipline or an interdisciplinary area and also include courses that expose students to business basics, intellectual property law, teamwork, communication/presentation skills, and project management, preparing graduates for work outside academia
- Are designed to produce well-rounded and highly employable graduates prepared for positions as analysts, project leaders, and mid-level managers in life sciences, environmental sciences, medical, pharmaceutical, and software industries, among others
- Require a significant internship in a relevant business/industrial/governmental environment in place of a conventional thesis; this offers students close contact with those in the industry in which they may be employed.

PSM programs that UMass currently offers are the following: Biology: Applied Biotechnology; Biology: Biosafety; Biology: Environmental Biotechnology; Biology: Project Management for Life Sciences; Biomedical Engineering and Biotechnology; Clinical or Medical Laboratory Sciences; Environmental Science; Industrial Mathematics; Marine Sciences; Radiological Protection; Work Environment: Cleaner Production and Pollution Prevention; Work Environment: Environmental Epidemiology; Work Environment: Ergonomics and Safety; Work Environment: Occupational, Environmental Hygiene. Programs that UMass is considering offering include the following: Applied Chemistry: Analytic Chemistry; Applied Chemistry: Biochemistry; Applied Physics; Atmospheric Sciences; Bioinformatics; Computer Science; Food Science; Health Informatics; Marine Biology; Materials Engineering; Science in a Changing World; and Wind Energy.

Thanks in advance for your help!

Professional Science Master's Survey: Spring 2010

2. plans after Bach

Which of the following best describes your plans after obtaining your bachelor's degree?

- ◯ I plan to enter graduate school immediately after obtaining my BA or BS.
- ◯ I plan to work for about one year and then attend graduate school.
- ◯ I plan to work for more than one year and then attend graduate school.
- ◯ I plan to work and NOT attend graduate school.
- ◯ Undecided
- ◯ Other (please specify)

24 Several items were adopted with permission from the 2009 HBCU survey available at http://www.surveymk.com/s.aspx?sm=RWrae07EGYuXNEyLmjJ_2bQ_3d_3d.

Professional Science Master's Survey: Spring 2010

3. grad study plans

What field and what area of specialization are you most likely to enter when you pursue graduate education? Please be as specific as possible.

What is the highest degree you intend to achieve?

- ◯ Master's Degree
- ◯ Doctorate
- ◯ Other (please specify)

Professional Science Master's Survey: Spring 2010

4. for those pursuing doc: Masters first?

Do you intend to obtain a master's degree before entering a doctoral program?

- ◯ Yes
- ◯ No

Professional Science Master's Survey: Spring 2010

5. for those pursuing master's: which kind?

For each of the master's degrees listed below, indicate the likelihood you would pursue each.

	Not at all Likely	Somewhat Unlikely	Somewhat Likely	Very Likely
Master's in Business Administration	◯	◯	◯	◯
Master's in Public Administration	◯	◯	◯	◯
Science Master's degree	◯	◯	◯	◯
Other non-science Master's degree	◯	◯	◯	◯

Are there any other master's degree programs you would be likely to pursue?

- ◯ No
- ◯ Yes (Please specify.)

Professional Science Master's Survey: Spring 2010

6. how likely to enroll in PSM?

Based on what you know now about the Professional Science Master's degree,* how likely is it that you would enroll in such a program if it were offered by one of the UMass Campuses?

- ◯ Not at all Likely
- ◯ Somewhat Unlikely
- ◯ Somewhat Likely
- ◯ Very Likely

*As a reminder, Professional Science Master's degrees: • Are a new type of master's degree increasingly valued by business, government, and non-profit sectors engaged in the application of science and technology • Are typically earned in the equivalent of two full-time years • Are available in science, mathematics, and interdisciplinary science/math-based areas • Consist of a core of advanced work in one discipline, or an interdisciplinary area, and also include courses that expose students to business basics, intellectual property law, teamwork, communication/presentation skills, and project management, preparing graduates for work outside academia • Are designed to produce well-rounded and highly employable graduates prepared for positions as analysts, project leaders, and mid-level managers in life sciences, environmental sciences, medical, pharmaceutical, and software industries, among others • Require a significant internship in a relevant business/industrial/governmental environment in place of a conventional thesis. This offers students close contact with those in the industry in which they may be employed.

Professional Science Master's Survey: Spring 2010

7. thesis? masters at UMass?

Please indicate your opinion for each of the following statements.

	Strongly Disagree	Disagree Somewhat	Agree Somewhat	Strongly Agree
If I enroll in a master's level program, I would prefer to do a thesis rather than an internship.	◯	◯	◯	◯
I plan to do graduate work at an institution other than one of the UMass campuses.	◯	◯	◯	◯

Professional Science Master's Survey: Spring 2010

8. rank current PSM offerings

Of the following current PSM program offerings, in which would you be most likely to enroll? Please rank your top three choices 1= First Choice; 2=Second Choice; 3=Third Choice. Leave blank those options that are not among your top three choices.

	Top Three Choices
Biology: Applied Biotechnology	
Biology: Biosafety	
Biology: Environmental Biotechnology	
Biology: Project Management for Life Sciences	
Biomedical Engineering and Biotechnology	
Clinical or Medical Laboratory Sciences	
Environmental Science	
Industrial Mathematics	
Marine Sciences	
Radiological Protection	
Work Environment: Cleaner Production and Pollution Prevention	
Work Environment: Environmental Epidemiology	
Work Environment: Ergonomics and Safety	
Work Environment: Occupational, Environmental Hygiene	

Professional Science Master's Survey: Spring 2010

9. want to take biomed/biotech PSM?

Was "Biomedical Engineering and Biotechnology" among your top three choices?

- ◯ Yes
- ◯ No

Professional Science Master's Survey: Spring 2010

10. for those wanting biomed/biotech PSM: rank options

Of the following Biomedical Engineering/Biotechnology PSM specializations, which would you be most likely to pursue? Please rank your top three choices 1= First Choice; 2=Second Choice; 3=Third Choice. Leave blank those options that are not among your top three choices.

	Top Three Choices
Agricultural Biotechnology: Therapeutics, Pharmacology, Nutritional Biochemistry, Food Science Technology	
Biomaterials: Tissue Engineering, Polymers/Plastics, Fibers/Textiles, Nanotechnology	
Biomedical Information Systems: Bioinformatics, Genomics, Proteomics	
Biomedical Instrumentation: Clinical Sciences, Signal Processing, Sensors, Microprocessing, Manufacturing/Quality Control	
Biomechanics: Biotransport, Cell Mechanics, Tissue/Organ Mechanics, Joint/Muscle Mechanics	
Bioprocessing/Applied Microbiology: Bioremediation, Fermentation, Biocatalysis, Applied Genetic Engineering	
Medical Imaging: Optics, NMR, MRI, Acoustics, Cell Imaging	
Medical Physics/Radiological Sciences: Dosimetry, Shielding/Protection, Nuclear Instrumentation	
Molecular Biotechnology: Clinical Sciences, Biochemical Applications, Diagnostics	

Professional Science Master's Survey: Spring 2010

11. rank proposed PSM offerings

Of the following proposed PSM programs, in which would you be most likely to enroll? Please rank your top three choices 1= First Choice; 2=Second Choice; 3=Third Choice. Leave blank those options that are not among your top three choices.

	Top Three Choices
Applied Chemistry: Analytical Chemistry	
Applied Chemistry: Biochemistry	
Applied Physics	
Atmospheric Sciences	
Bioinformatics	
Computer Science	
Food Science	
Health Informatics	
Marine Biology	
Materials Engineering	
Science in a Changing World	
Wind Energy	

Professional Science Master's Survey: Spring 2010

12. attractiveness of PSM components

For each of the following potential components of a Professional Science Master's degree program, indicate the extent to which you find it attractive.

	Very Unattractive	Somewhat Unattractive	Somewhat Attractive	Very Attractive
Coursework in business and management	◯	◯	◯	◯
Coursework in ethics	◯	◯	◯	◯
Coursework in innovative technology and entrepreneurship	◯	◯	◯	◯
Coursework in leadership and team building	◯	◯	◯	◯
Coursework in public policy	◯	◯	◯	◯
Coursework in regulatory affairs	◯	◯	◯	◯
Multidisciplinary training	◯	◯	◯	◯
Academic training with a strong real-world component	◯	◯	◯	◯
Work on real-world problems directly relevant to current product development in industry	◯	◯	◯	◯
Preparation for the work force rather than preparation for academia	◯	◯	◯	◯
Doing an internship in industry	◯	◯	◯	◯
Working with other students on business-oriented projects in the classroom	◯	◯	◯	◯

Professional Science Master's Survey: Spring 2010

13. online willingness

If it were necessary to take some classes online to complete a PSM, how willing would you be to do that?

- ◯ Not at all Willing
- ◯ Somewhat Unwilling
- ◯ Somewhat Willing
- ◯ Very Willing

How willing would you be to take courses in a blended format (combination of online and in person) where the class would meet once a month in a centralized location?

- ◯ Not at all Willing
- ◯ Somewhat Unwilling
- ◯ Somewhat Willing
- ◯ Very Willing

Professional Science Master's Survey: Spring 2010

14. importance of various components

For each of the following potential components of a PSM program, indicate the importance of each to you.

	Not at all Important	Somewhat Unimportant	Somewhat Important	Very Important
Having a faculty mentor throughout my graduate education.	◯	◯	◯	◯
Having a professional mentor - someone outside my academic institution - that can provide me with career advice, networking opportunities, etc.	◯	◯	◯	◯
Having an internship placement during my enrollment.	◯	◯	◯	◯
Having career placement after graduation.	◯	◯	◯	◯

Professional Science Master's Survey: Spring 2010

15. FT/PT, which campus

Would you anticipate attending the PSM program as a full- or part-time student?

- ◯ Full-Time
- ◯ Part-Time
- ◯ Not Sure

If you were to pursue a UMass PSM graduate degree, please indicate the campus you are most lik attend:

- ◯ UMass Amherst
- ◯ UMass Boston
- ◯ UMass Dartmouth
- ◯ UMass Lowell

Professional Science Master's Survey: Spring 2010

16. financing of PSM

What level of financial aid in the form of grants, fellowships, scholarships, stipends, etc. that do not need to be repaid would you expect from a PSM program?

- ◯ 0% Coverage
- ◯ 25% Coverage
- ◯ 50% Coverage
- ◯ 75% Coverage
- ◯ 100% Coverage

What level of financial aid in the form of loans, etc. that need to be repaid would you expect from the PSM program?

- ◯ 0% Coverage
- ◯ 25% Coverage
- ◯ 50% Coverage
- ◯ 75% Coverage
- ◯ 100% Coverage

Professional Science Master's Survey: Spring 2010

17. why PSM is appealing

What elements of the PSM program do you find appealing? (Please be as specific as possible.)

Professional Science Master's Survey: Spring 2010

18. why PSM is unappealing

What elements of the PSM program do you find unappealing? (Please be as specific as possible.)

Professional Science Master's Survey: Spring 2010

19. Want more info?

Would you like additional information on PSM programs at UMass?

- ◯ Yes
- ◯ No

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20. request e-mail for follow-up on PSM

Below, please provide your e-mail address so someone can follow up with you regarding your interest in PSM programs at UMass.

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21. future work

Please choose all areas below in which you see yourself working.

- ☐ In private industry (e.g., with science-intensive companies such as Genzyme, Raytheon, Pfizer)
- ☐ In government (e.g., the Environmental Protection Agency or Department of Homeland Security)
- ☐ In academia (e.g., as a university professor)
- ☐ Not sure at this time
- ☐ Other (please specify)

Thinking ahead to about ten years from now, what type of work would you like to be doing? Please select all that apply.

- ☐ Research in industry
- ☐ Scholarly research and teaching (academic work)
- ☐ Scholarly research and teaching that intersects with industry
- ☐ Managerial work (middle or upper management in an organization)
- ☐ Development/Production (write code, develop products, etc.)
- ☐ Sales
- ☐ Self-employed/Consulting
- ☐ Other (please specify)

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22. demographic basics

Demographic information is requested for statistical purposes only.

Gender

- ◯ Male
- ◯ Female

Age

How do you describe your race/ethnicity?

- ☐ Asian or Pacific Islander
- ☐ Black or African American
- ☐ Hispanic/Latino
- ☐ Caucasian or White
- ☐ Other (please specify)

At which campus are you currently enrolled?

- ◯ UMass Amherst
- ◯ UMass Boston
- ◯ UMass Dartmouth
- ◯ UMass Lowell

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Class Level

- ◯ Sophomore
- ◯ Junior
- ◯ Senior

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23. GPA

Please estimate what you think your cumulative GPA is.

Please estimate what you think your major GPA is.

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24. major ID

What is your major? (Please check all that apply.)

- ☐ Animal Science
- ☐ Astronomy
- ☐ Atmospheric Science
- ☐ Biochemistry
- ☐ Biochemistry & Molecular Biology
- ☐ Bioinformatics
- ☐ Biological Engineering
- ☐ Biology: General
- ☐ Biology: Marine
- ☐ Biotechnology
- ☐ Building & Construction Technology
- ☐ Chemistry
- ☐ Civil Engineering Technology
- ☐ Clinical Laboratory Science
- ☐ Community Health Education
- ☐ Computer Science
- ☐ Cytotechnology
- ☐ Earth Systems
- ☐ Ecology
- ☐ Engineering: Computer
- ☐ Engineering: Electrical
- ☐ Engineering: Industrial
- ☐ Engineering: Mechanical
- ☐ Engineering: Nanomaterials
- ☐ Engineering: Nuclear
- ☐ Engineering: Paper
- ☐ Engineering: Plastics
- ☐ Engineering: Software
- ☐ Engineering: Undeclared
- ☐ Environmental Health
- ☐ Environmental Science
- ☐ Environmental Studies
- ☐ Environmental, Earth, and Ocean Sciences
- ☐ Exercise Physiology
- ☐ Food Science
- ☐ Geography
- ☐ Geology
- ☐ Geoscience
- ☐ Materials Science
- ☐ Mathematics: Applied
- ☐ Mathematics: Computational
- ☐ Mathematics: General
- ☐ Mechanical Engineering Technology
- ☐ Medical Laboratory Science
- ☐ Medical Technology
- ☐ Microbiology
- ☐ Natural Resources Conservation: Environmental Conservation
- ☐ Natural Resources Conservation: Fisheries Ecology & Conservation
- ☐ Natural Resources Conservation: Forest Ecology & Conservation
- ☐ Natural Resources Conservation: Urban Forestry & Arboriculture
- ☐ Natural Resources Conservation: Water Resources
- ☐ Natural Resources Conservation: Wildlife Ecology & Conservation
- ☐ Nutritional Sciences
- ☐ Physics

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- ☐ Electronic Engineering Technology
- ☐ Engineering Physics
- ☐ Engineering: Chemical
- ☐ Engineering: Civil
- ☐ Industrial Engineering Technology
- ☐ Information Technology
- ☐ Management Information Systems
- ☐ Manufacturing
- ☐ Plant, Soil, and Insect Sciences: Applied Biology & Biotechnology
- ☐ Plant, Soil, and Insect Sciences: Horticulture
- ☐ Plant, Soil, and Insect Sciences: Sustainable Food & Farming
- ☐ Plant, Soil, and Insect Sciences: Turfgrass Science & Management
- ☐ Pre-Veterinary
- ☐ Science (Interdepartmental)
- ☐ Statistics
- ☐ Other (please specify)

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25. took business courses, internship?

How many business courses did you take as an undergraduate?

- ◯ None
- ◯ One
- ◯ More than one
- ◯ I minored in business.

Did you participate in an internship as part of your undergraduate experience?

- ◯ Yes
- ◯ No

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26. internship beneficial?

To what extent was the internship beneficial to you?

- ◯ Not at all beneficial
- ◯ A little beneficial
- ◯ Beneficial
- ◯ Very beneficial

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27. year will graduate; work outside home?

In what year do you expect to graduate?

- ◯ 2010
- ◯ 2011
- ◯ 2012
- ◯ 2013
- ◯ 2014

Do you work outside of the home for wages?

- ◯ Yes
- ◯ No

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28. for those who work outside the home

On average, how many hours do you work each week?

To what extent would you expect your employer to fund your graduate studies?

- ◯ Not at all
- ◯ One or two courses
- ◯ Half of the courses required for the degree
- ◯ More than half of the courses required for the degree
- ◯ The complete degree

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29. request e-mail for payment

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