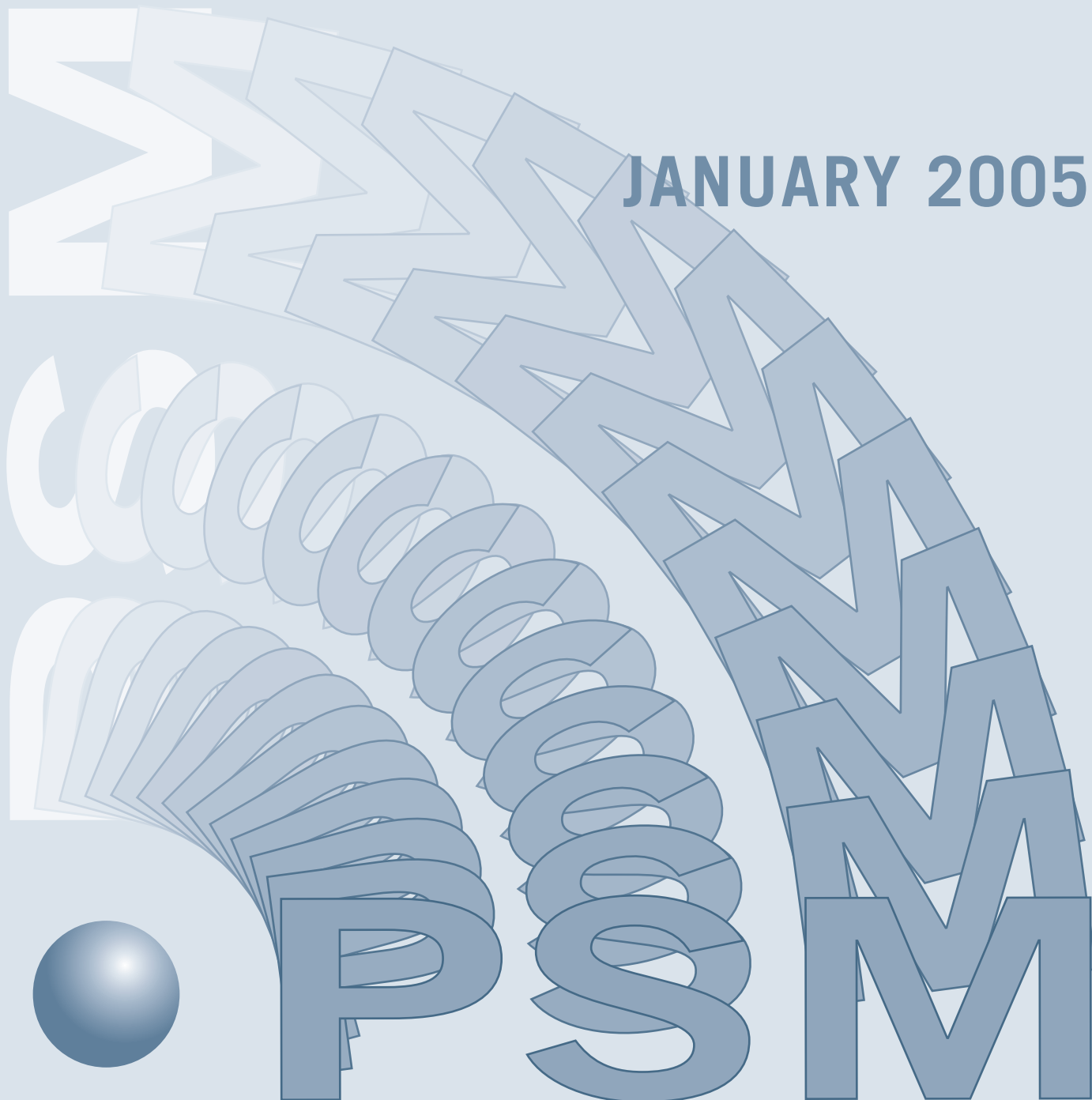


An Industry Perspective of the Professional Science Master's Degree in California

Prepared for the California State University System

JANUARY 2005



CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY

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CCST is a nonprofit organization established in 1988 at the request of the California State Government and sponsored by the major post-secondary institutions of California, in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending policies and initiatives that will maintain California's technological leadership and a vigorous economy.

The California Council on Science and Technology gratefully acknowledges support from the California State University System Professional Science Master's campus coalition and the California State University Chancellor's Office.

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City of Downey
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San Diego Telecom Council
San Gabriel Valley Economic Partnership
Semiconductor Industry Association
Time Structures

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Sally DiDomenico, Vice President, Bay Area Economic Forum
Sean Randolph, President, Bay Area Economic Forum
Sheila Tobias, Sloan Science Master's Outreach Initiative
Tyler Orion, Executive Director, San Diego Regional Technology Alliance

LETTER OF REQUEST

THE CALIFORNIA STATE UNIVERSITY
OFFICE OF THE CHANCELLOR

May 10, 2004

BAKERSFIELD

CHANNEL ISLANDS

CHICO

DOMINGUEZ HILLS

FRESNO

FULLERTON

HAYWARD

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LONG BEACH

LOS ANGELES

MARITIME ACADEMY

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NORTHBRIDGE

POMONA

SACRAMENTO

SAN BERNARDINO

SAN DIEGO

SAN FRANCISCO

SAN JOSE

SAN LUIS OBISPO

SAN MARCOS

SONOMA

STANISLAUS

Dr. Susan Hackwood
Executive Director
California Council on Science and Technology
5005 La Mart Drive, Suite 105
Riverside, California 92507

Dear Dr. Hackwood,

SUSAN,

The purpose of this letter is to request the assistance of the California Council on Science and Technology in helping the California State University plan new Professional Science Master's degree programs.

California's shortage of qualified science and technology graduates has been well documented by CCST and is an ongoing concern for the California State University system. As your 2002 report "A Critical Path Analysis of California's Science and Technology Education System" showed, all the components of California's higher education system need to take steps to enhance the quality and quantity of the science and technology graduates we contribute to California's workforce. As the state's largest four-year university system, we take this responsibility seriously.

One of the suggestions made in the report was to examine the possibility of instituting Professional Science Master's degree programs to produce a new class of science and technology experts. Instituting new programs such as this on a widespread basis would constitute a major new effort for the CSU, and such a change would need to be evaluated carefully before initiated.

There is now an opportunity to examine the demand for Professional Science Master's degrees via a planning grant from the Sloan foundation awarded to a CSU team led by Faramarz Valafar, professor of Computer Science at San Diego State University. This grant is designed to allow Professor Valafar and a consortium of interested CSU campuses to establish the need for such degree programs, and if successful, the CSU will be applying to the Sloan Foundation for a more comprehensive grant.

Both the funding and schedule for this planning grant are limited, but I am confident that CCST is the right organization to provide a valid "snapshot" of industry need for such degree programs. The CSU is a sustaining institution

Dr. Susan Hackwood
May 10, 2004
Page Two

of CCST; our faculty and administrators are represented on both the CCST Board and Council. Consequently, I know the value that CCST has demonstrated for all of California's higher education systems, and that CCST is capable of producing an analysis that the CSU can stand behind.

I therefore request that the California Council on Science and Technology work with Professor Valafar and the California State University planning team to assess whether and to what extent there is a high-tech industry demand for the Professional Science Master's degree.

With kind regards,

Sincerely,

A handwritten signature in cursive script that reads "Charlie".

Charles B. Reed
Chancellor

CBR/slw

Enclosure

PREFACE FROM CCST MEMBERS

Science and technology industries remain a vital part of California's economic strength, and are key components in any projection of the state's future prosperity. For some time, however, it has been apparent that our educational system is not producing the science and engineering graduates needed to meet industry's growing requirement for skilled workers.

For many years CCST has recognized the essential need for strengthening California's science and technology education system. New ideas for improving the education infrastructure are emerging from many sources. One such idea has been to develop master's degree programs that combine theoretical knowledge with practical applications and business acumen. Known as Professional Science Master's degrees, several are in place in California institutions and others are being considered.

In this report, requested by the Chancellor of the California State University System, CCST has conducted a qualitative study of interest in the PSM with a select group of California's high-tech business leaders. The results show widespread interest in the skill sets of PSM graduates, and interest in fostering significantly closer relationships with universities. But it is apparent that degrees such as the PSM must be carefully targeted and systematically supported in order to become effective professional credentials.

This report has been prepared under the direction of the CCST Education Committee, composed of Alice Huang, Tina Nova, James Rosser, and Cornelius Sullivan, with Lawrence T. Papay serving as committee chair. Each and every one of them has contributed substantially to the methodology and composition of the report and worked to maintain the inclusive perspective and integrated focus of the study.

Many individuals and groups have assisted in the production and review of this report, and we express our gratitude to those who contributed their time and expertise, and in particular to the 36 study participants who gave generously of their valuable time to take part in the study.

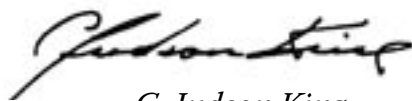
We would like to thank the California State University Professional Science Master's campus coalition and the California State University Chancellor's Office for their generous underwriting of this project, and extend our sincere appreciation to the Alfred P. Sloan Foundation for its guidance and support.



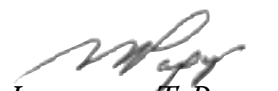
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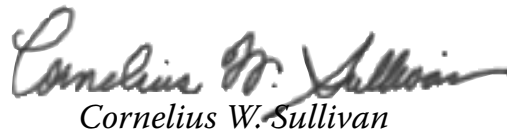
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James M. Rosser
Council Member, 1999-2004



Cornelius W. Sullivan
Council Vice-Chair

EXECUTIVE SUMMARY

BACKGROUND

The master's degree in most scientific disciplines has not traditionally been considered a primary goal of graduate education. Science, technology, engineering and mathematics (STEM) master's degree production in the past 10 years has been largely flat, resembling that of comparable majors at the baccalaureate level.¹ Engineering remains the most attractive STEM master's degree and produces the most master's degrees; however, as a percentage of overall master's degree production, even this declined from 1990 through 2001.² By discipline, slightly more than 20% of scientists and engineers employed in engineering and computer sciences hold master's degrees as their highest qualification; the percentage is lower in other disciplines, and lowest in the life sciences.

In a recent report on California's science and technology education system, it was pointed out that California compensates for insufficient technical workforce production by importing skilled people from other states and countries. This is particularly true for master's degree level employees. With changes in H-1B visa quotas and difficulties in hiring foreign labor, this is now more difficult and an often undesirable alternative for many companies.³

The concept of a "professional" master's degree in science results from recognition that science and technology workers may need new kinds or combinations of skills to perform well in the corporations, institutions and agencies of the 21st century. Science and technology have advanced at the fastest rates in history but ways of working for technical employees has changed even more. Teamwork, often multidisciplinary and inter-functional, is now the norm. Individual contributors with a very narrow focus, while still important, are increasingly compelled to work on teams, especially in organizations that develop cutting edge products or engage in multi-faceted applied research.

¹ National Science Board, *Science and Engineering Indicators – 2002*. Arlington, VA: National Science Foundation, 2002 (NSB-02-1) p. 2-27.

² Judith Glazer-Raymo, "Trajectories for Professional Master's Education," *Council of Graduate Schools Communicator*, Vol. XXXVII No. 2, (March 2004), pp.1-5.

³ California Council on Science and Technology, *Critical Path Analysis*, pp. 99-102.

The professional science master's (PSM) is a two-year master's level degree that is designed to prepare professionals for work outside academia. The concept was developed in cooperation with industry leaders from new and emerging fields such as applied, industrial and financial mathematics; bioinformatics; computational science; geographical information systems; and industrial microbiology.

There are several successful variations of professional science masters programs already in place in California, such as the Keck Graduate Institute, the Professional MS in Regulatory Affairs at the University of Southern California, and the Professional MS in Biomedical Quality Systems degrees at San Diego State University. The PSM degree programs as defined in this report specifically are those that fall under the Alfred P. Sloan Foundation definition.

The California State University (CSU) wished to investigate the benefits of and level of interest in making the Sloan model of PSM degree programs more widely available on the part of industry. To date, PSM programs have been created in conjunction with local industries/industry clusters and assessments of student interest. There has not been any significant attempt to assess the potential interest of science and technology companies on a wide scale in any region or state, or how effective they are either at placing students or at meeting industry's needs. The California Council on Science and Technology (CCST) was requested to provide a qualitative study of industry need.

METHODOLOGY

In order to establish which companies should be targeted for the present study, it was necessary to prepare an overview of California's current high-tech industry clusters and to establish which offer the greatest likelihood to remain, or are projected to become, key high-tech employment sectors in the state. Industry cluster data were organized according to California's nine economic regions as established by the California Economic Strategy Panel.

Appropriate industry groups were suggested based on an approximate alignment between various CSU campuses – based on proposed offerings in each professional science master's (PSM) degree program – and the closest industry cluster that might serve as a source of employment for students. It is assumed that internships will play an important role in the programs, and hence companies must be reasonably close to programs. In some cases, such as government, forensics, and speech pathology related services, growth opportunities were identified in several regions.

Using this methodology, the following nine areas were seen as promising sectors to focus on, incorporating a range of disciplines and geographic distribution throughout the state's principal areas of high-tech growth.

- Greater Sacramento:
 - (1) Agricultural Biotechnology and Environment
 - (2) Government
- San Francisco Bay Area:
 - (3) Bio/Nano/Information Sciences
 - (4) Computer Sciences and Software
 - (5) Environmental Technologies
- Southern California/Los Angeles:
 - (6) Nanotechnology-Materials Sciences
 - (7) Specialty Manufacturing (Pharmaceuticals, MIMS, aerospace, military, etc)
- San Diego:
 - (8) Biotechnology
 - (9) Telecommunications and Computing

Note: This selection of high-tech clusters and geographic area does not imply that similar high-tech clusters are not growing in different regions. It is also not complete; project constraints precluded such an examination. It is simply intended to provide a distribution for data gathering. We would strongly propose extending future analyses to other areas not specifically covered here, such as the biomedical industry in the Los Angeles area.

Using recommendations provided by regional technology associations, economic, and business organizations, CCST contacted 144 companies and government agencies by letter, email and telephone over a two-month period. Prospective participants were invited to participate via regular mail (Section 10) and email, with follow-up phone calls made by CCST staff. Depending on the company, the following level of employee was initially contacted (in descending order):

- President/Chief Executive Officer (CEO)/Center Director
- Chief Operating Officer (COO)
- Vice President of Business Development or Research
- Vice President of Human Resources

The goal was to target high-level executives, scientists, and managers with the ability to constructively evaluate a set of qualifications that may not fit current employment niches at their respective companies. Thirty-six participated in

an in-depth analysis of the PSM degree, including 11 CEOs and presidents. A majority of the remaining participants were at the senior vice president or director level. Fifteen of the executives participated in 90-minute focus group meetings; 21 participated in phone interviews averaging 20 minutes. Prior to the meetings and interviews, participants were asked to read a one-page background description of the PSM program (Section 8).

RESULTS

Respondents provided a wide range of feedback on the PSM programs, with some unanticipated differences among the sectors represented in the study. While the total sample size is neither random nor sufficient to count as a comprehensive and statistically accurate assessment of potential need throughout California, the thoughtful contribution of many senior executives from California's high-tech sectors does provide valuable insight into strengths and pitfalls of expanding the PSM degree programs.

Principal perceived strengths of developing and expanding PSM degree programs:

- Any program increasing overall number of STEM graduate degrees is seen as positive
- Addition of business-related coursework is valuable
- Inclusion of internships is attractive, though dependent on program
- Companies welcome increased university-industry interaction (via advisory boards)
- PSM is one of several logical and needed evolutionary steps in the development of interdisciplinary graduate degrees

Principal concerns expressed about developing and expanding PSM degree programs:

- Other ways to instill business skills in graduates may be preferable
- Degree may not be valuable to recipients
- Degree may not be portable
- Lack of research thesis a detriment for some companies
- PSM programs may not increase overall master's recipients, but siphon students from existing programs

It should be noted that many participants learned of the PSM for the first time through this study, and that those familiar with the program ahead of time were more easily able to provide constructive feedback. It is likely that more time spent on educating the public about the PSM would help future studies obtain useful information from participants.

The essential goal of the PSM program concept, to increase the quantity and quality of graduate degree recipients entering the STEM workforce, was strongly supported by most of the participants. Nearly all were well aware of the inability of California's degree production to keep up with workforce demand. Many companies are conscious that they rely heavily on foreign graduates or graduates from California institutions who are not U.S. citizens, and expressed a desire to change this trend. Being able to hire California-native graduates offers several advantages: for companies in the Bay Area and San Diego, the high cost of living is a significant and growing obstacle to recruitment from elsewhere. For companies involved in defense-related research, particularly in San Diego, hiring non-citizens is not an option due to security clearance issues.

Most participants also acknowledged that the combination of skills produced by PSM programs is desirable. However, lack of business experience and, more specifically, an understanding of what jobs in STEM are actually like is a significant issue. Companies involved in interdisciplinary or emerging fields were particularly interested in fostering this combination of skills.

Many study participants expressed concerns as to whether or not a PSM program would be the best means of producing graduates with this combination of business acumen and technical skills. Some companies (mostly large, but also some small and medium companies as well) stated outright that they would prefer to teach these skills themselves, and that they would prefer a stronger technical skill base to start with. Many participants suggested that modifications could be made to existing degree programs, both at the graduate and undergraduate level, to provide some of the business and teamwork skills.

Questions were raised about whether or not PSM degree programs would result in a net increase in graduate degree recipients, or siphon off students from existing programs such as MBA programs or various STEM graduate programs.

There was a strong interest on the part of many companies in providing input into the curriculum of either a PSM program or an existing graduate or undergraduate degree program. The connection between industry and university was universally described as wanting, and companies are eager to provide input if they have the connections to do so. Many participants complained that such connections depend too much on personal relationships, and that there is no “clearinghouse” way of effectively connecting with the local universities. This was true even for those participants who actively participate in advisory boards at one or more local schools.

In addition, several participants across multiple sectors stated that effective university-industry collaboration would need to be ongoing and highly responsive, and require better communication on the part of the universities in the establishment of such relationships. Companies are interested in giving genuine feedback, but many feel that too often they are only approached by universities when the universities are seeking tangible resources.

Government seems to have a different view and may require a different set of relationships because of how people are hired and what their responsibilities are. These conditions could vary by department.

We recognize that the limited response rate and overall number of study participants is too limited to draw definitive conclusions on the marketability of the PSM program beyond the actual participants; it was not possible to expand the study given the time and resource restraints of the project. A larger study would be highly advisable for institutions considering establishment or expansion of Sloan model PSM programs.

RECOMMENDATIONS

There are a few key messages underlying much of the feedback we received from study participants. The most significant finding is that most companies want a better relationship with universities, but feel that current connections are inefficient and do not permit meaningful interaction on issues such as curriculum development. Even those companies which currently participate in advisory boards for one or more universities cite a lack of effective interaction beyond the individual departmental level. It is not just a question of putting more industry representatives on committees; it is a question of developing new kinds of partnerships that allow strategic planning on a higher level.

Based on our results, we offer the following conclusions for the CSU:

1. The PSM program must establish credibility in order to be accepted on a widespread basis.

Despite recent publicity in a variety of articles (Section 11) many had never heard of the PSM, and those who had did not have a clear perception of what the degree entailed. Many felt that the degree may not be portable beyond the region where the PSM degrees are produced, and even among companies within the region which are not part of the developing program partnership.

The two elements that companies identified as vital for establishing widespread credibility of PSM programs are making sure the programs are truly high-quality programs, and effectively branding the degree. To this end, the CSU would benefit most by the following:

- Supporting (at least initially) a smaller number of programs that are able to maintain a higher level of quality, in areas where the PSM has demonstrated success
- Offering statewide promotion of the degree at high-level venues where CSU interfaces with industry and the public

2. In order to succeed, the PSM must be targeted to industries where it is best suited.

The sectors targeted by this study were intended to provide a snapshot across a range of high technology business areas. A core motivation behind the promotion of PSM programs has been the fact that terminal master's degrees in areas such as the life sciences are not as respected or widely sought as master's degrees in engineering. However, not all life sciences companies were receptive to the idea of the PSM. Conversely, some sectors which are not considered ideal for PSM degrees expressed a great deal of interest.

It is true that any PSM program being launched must establish a successful relationship with one or more companies. However, in order to be successful and credible, PSM programs must produce graduates that are considered employable by a range of companies in a given discipline. The results of the current study suggest the following:

Most likely to support PSM programs

- Large companies with multidisciplinary interests
- Companies with an interdisciplinary focus (e.g. environmental technology and nanotechnology)
- Government agencies

Least receptive to PSM program idea

- Biotech companies
- Highly specialized companies
- Specialty manufacturers

We recognize that there are many examples of successful life sciences PSM programs and of biotechnology companies that support them (e.g. Amgen and the Keck Graduate Institute). However, additional education and/or “missionary work” may be needed to establish these relationships and the credibility of the PSM in the biotechnology community.

3. Industry and universities need to develop better working relationships.

While many participants serve or have served in some advisory capacity for one or more local universities, all stated that there was room for improvement. Most connections presently are on a personal basis between faculty members and local companies; there is no way to connect at a higher level with institutions. Collaboration via advisory boards is a key component of PSM programs, but many companies indicated that this model needed to be expanded upon.

The difficulty that CCST experienced in gaining the cooperation of companies to participate in the study, 25% of companies contacted, indicates that a great deal of work will be necessary to gain the involvement and trust of industry in these programs.

Several suggestions were raised as to how companies and universities should improve working relationships, and the quality of programs such as the PSM:

- Inviting guest speakers from industry on a regular basis
- CSU program heads attending industry association meetings
- Regional technology alliances serving as intermediaries

4. Statewide partnerships which best leverage the resources of the CSU should be explored.

The interviews raised the possibility of several partnerships between local CSU programs and interested companies. While several CSU programs would obviously benefit from such associations, we find that there is also room for higher-level collaboration with key companies.

Several participants mentioned the possible construction of statewide networks or contact points to facilitate the placement of interns and publicizing of the PSM degree. One of the most effective ways for the CSU to do this might be to assemble a statewide university-industry advisory board with companies that have the interest and the capability to bring substantial workforce needs analyses to the table. IBM and SAIC would be possible candidates for such a board.

Implementing a high-level advisory board between the Chancellor's office and high-tech companies would offer several advantages:

- The ability to leverage substantial independent workforce needs analyses being conducted in the private sector
- The ability to offer a higher-level conduit for companies to offer feedback into the university systems, in a context where they do not feel pressured for resources
- The ability to provide meaningful high-level input into curriculum development, both in the PSM and in undergraduate programs
- An opportunity to leverage high-powered meetings into PR events which can be used to promote the PSM at minimal cost to the CSU

1. INTRODUCTION

This report was initiated at the request of the California State University (CSU) Chancellor's office, requesting that CCST assist a coalition of 15 CSU campuses seeking to establish and/or enhance Professional Science Master's programs with the assistance of the Alfred P. Sloan Foundation. The Professional Science Master's (PSM) is a new professional MS degree in science or mathematics for students interested in a wider variety of career options than provided by current graduate programs in these two areas. The programs are open to bachelor's degree holders in the sciences, mathematics, or engineering. These programs consist of two years of training in an emerging or interdisciplinary area. Many include internships and "cross-training" in business and communications.

The CSU wished to investigate the benefits of and industry's level of interest in making the Sloan model of PSM degree programs more widely available. To date, PSM programs have been created in conjunction with local industries/industry clusters and assessments of student interest. There has not been any significant attempt to assess the potential interest of science and technology companies on a wide scale in any region or state, or how effective they are either at placing students or at meeting industry's needs.

There are several successful variations of professional science masters programs already in place in California, such as the Keck Graduate Institute, the Professional MS in Regulatory Affairs at the University of Southern California, and the Professional MS in Biomedical Quality Systems degrees at San Diego State University. The PSM degree programs as defined in this report specifically are those that fall under the Alfred P. Sloan Foundation definition.

In a recent report on California's science and technology education system,⁴ it was pointed out that California compensates for insufficient technical workforce production by importing skilled people from other states and countries. This is particularly true for master's degree level employees. With changes in H-1B visa quotas and difficulties in hiring foreign labor, this is now more difficult and an often undesirable alternative for many companies.

⁴ California Council on Science and Technology, *Critical Path Analysis*, pp. 99-102.

CCST is a nonpartisan, impartial, not-for-profit corporation created in 1988 by Assembly Concurrent Resolution 162, designed to offer expert advice to the state and provide solutions to science and technology-related public policy issues. CCST has a proven record of accomplishment in providing timely, impartial analyses of complex issues for the legislative and executive branches of government. It was considered an appropriate body to explore industry interest because of its strong connections with the business community and record of impartiality and expertise.

There are several challenges inherent in assessing industry interest in a new class of graduate degree. It was felt that the most appropriate people to constructively evaluate the potential of such a degree program would be the executives and business leaders shaping the companies' long-term development and workforce strategies. In addition, the qualities and ramifications of the PSM degree often require extensive explanation before respondents are able to respond effectively to inquiries about potential roles for the degree. Consequently, rather than a large mail survey, CCST opted to speak directly with respondents at some length, in extensive phone interviews and meetings bringing together representatives from selected high-tech sectors throughout the state. Wherever possible, companies were contacted at the president, CEO, or senior VP level.

The result is a collection of detailed feedback from 36 of California's high-tech business leaders, which we have sorted and analyzed by sector. This feedback is presented in the context of an overview of the history and development of the PSM degree, as well as current and projected high-tech business sectors in California.

This is not a comprehensive survey of the high-tech business community in California. We strongly recommend such a survey as the next step in determining whether and how to support PSM programs in California. It is, however, a qualitative study of reactions and feedback from a group of California's top science and technology executives. The scope of the study was limited to consideration of the PSM degree programs proposed in conjunction with the Sloan Foundation, and hence did not focus on other professional MS programs currently offered or in development throughout the state, such as those supported by the California State University Program for Education and Research in Biotechnology (CSUPERB). However, we believe that the data presented here should be instructive for any professional MS program. We hope that this study provides a valuable starting point for understanding what California's

business leadership is looking for in science and technology related degree qualifications, and how the PSM degree programs underway and proposed may address some of those needs.

Section 2 provides a brief background of the PSM, including the development of the degree and current Sloan-funded programs. Section 3 contains a macro analysis of the state's high-tech industry clusters, used to identify high-tech industry sectors with the most growth potential in each region of the state. These data are used to help determine what kinds of companies to target for the study in each region of the state. Section 4 describes the study methodology and an overview of results from meetings and interviews with representatives from each industry sector. Section 5 contains an overall analysis of our findings, and Section 6 contains recommendations for the CSU. Sections 7 through 15 contain the primary data gathered in the study, including lists of companies contacted and participating companies, the instruments used in contacting and interviewing participants, meeting and interview minutes, and information gathered on current PSM programs.

We have included these data, particularly the meeting and interview transcripts, as a resource for those seeking more information. Our study participants provided considerable input which is summarized and analyzed in the body of the report. However, we recognize that there may well be further information of value in the extensive feedback gathered and invite those who may be interested to consult the data directly. Again, we thank our study participants for their valuable time.

2. THE PROFESSIONAL SCIENCE MASTER'S DEGREE

2.1 Background

The master's degree in most scientific disciplines has not traditionally been considered a primary goal of graduate education. However, while it has historically not enjoyed as much prestige in academia as the doctorate, the master's degree has overall been evolving from an intermediate academic degree to an entrepreneurial credential. "Professional" master's degrees in specialized fields ranging from pharmaceuticals to accounting have grown, providing programs that, instead of being research-oriented, are multidisciplinary, problem-oriented, and attuned to the marketplace.⁵

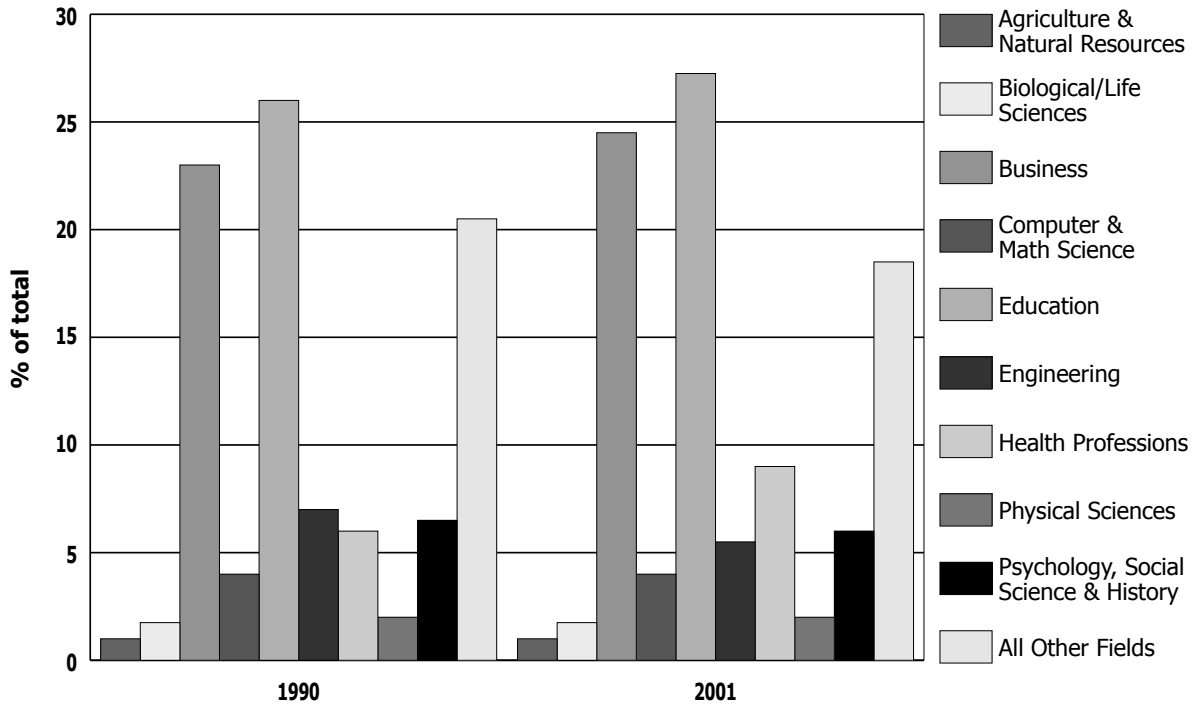
This evolution has been most visible in the fields of business and the health professions, which together with education make up most of the master's degrees awarded (Figure 1). However, while there has been growth in these three areas, science, technology, engineering and mathematics (STEM) degree production in the past 10 years has been largely flat, resembling that of comparable majors at the baccalaureate level.⁶ Engineering remains the most attractive STEM master's degree and produces the most master's degrees; however, as a percentage of overall master's degree production, even this declined from 1990 through 2001 (Figure 1).⁷

Yet there has been increasing recognition that science and technology workers as well may need new kinds or combinations of skills to perform well in the corporations, institutions and agencies of the 21st century. Science and technology have advanced at the fastest rates in history but ways of working for technical employees has changed even more. Teamwork, often multidisciplinary and inter-functional, is now the norm. Individual contributors with a very narrow focus, while still important, are increasingly compelled to work on teams, especially in organizations that develop cutting edge products or engage in multi-faceted applied research.

⁵ Judith Glazer-Raymo, "Trajectories for Professional Master's Education," *Council of Graduate Schools Communicator* Vol. XXXVII, No. 2 (March 2004) p. 5.

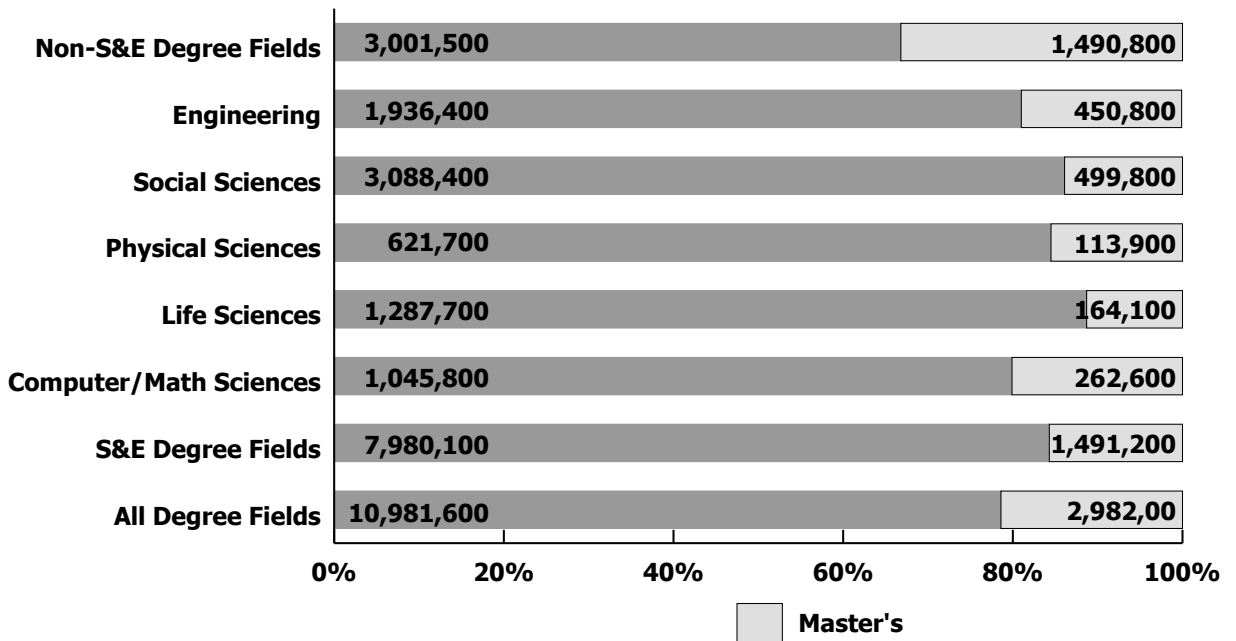
⁶ National Science Board, *Science and Engineering Indicators – 2002*. Arlington, VA: National Science Foundation, 2002 (NSB-02-1) p. 2-27.

⁷ Glazer-Raymo, p. 5.



**Figure 1. U. S. Distribution of Master's Degrees by Field, 1990 and 2001
(Glazer-Raymo)**

Companies, particularly small ones, spend less on training than they used to, meaning that employees must arrive with the necessary skills. There

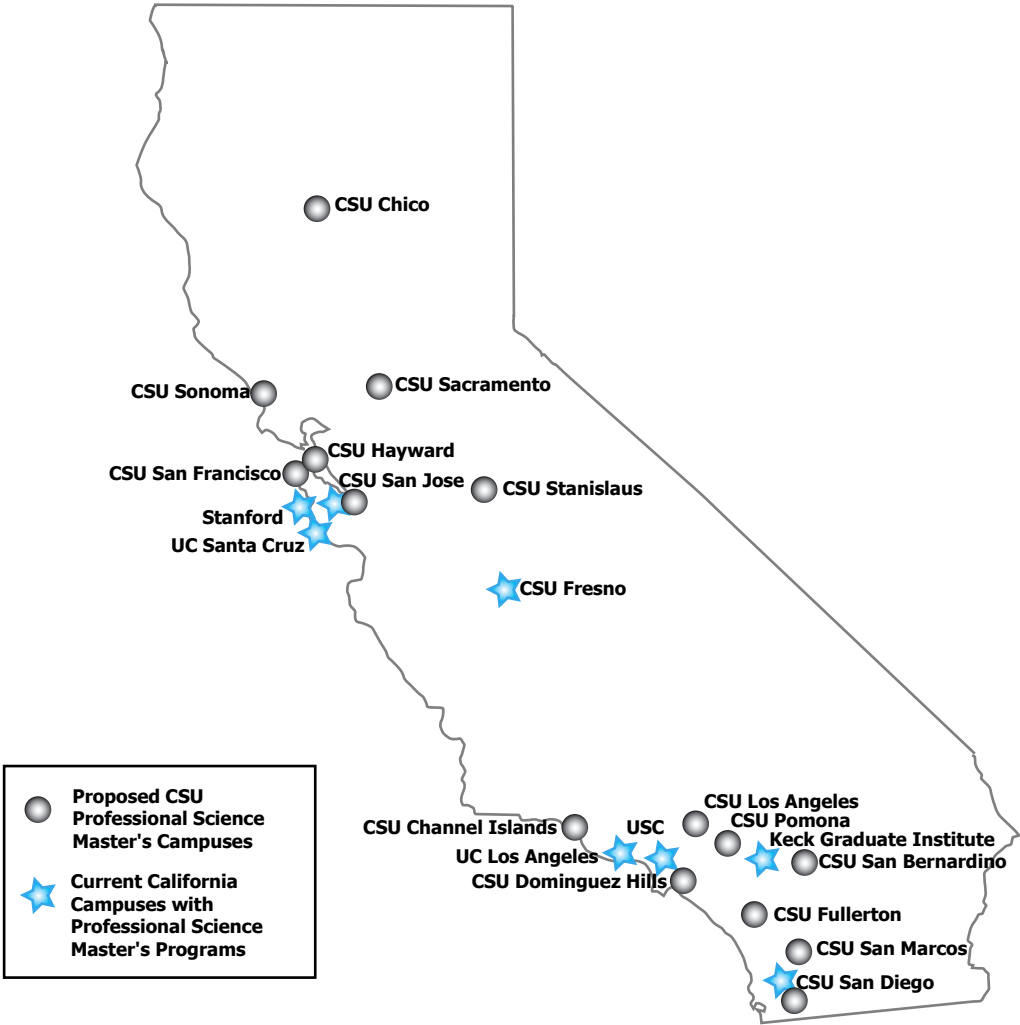


may be a market, in other words, for a professional science master's degree, an entrepreneurial credential combining technical expertise with business acumen.

Some master's degree programs have been developed independently which encompass this skill set. In particular, the California State University Program for Education and Research in Biotechnology (CSUPERB) has been active in discussing the role of professional M.S. degrees in the CSU and has supported development of several programs throughout the CSU system. However, the Alfred P. Sloan Foundation decided that developing such degree programs systematically, and devising a distinctive label for them, would be an effective way to improve high-tech workforce production, and in 1997 began providing resources to seed professional science master's programs in institutions throughout the country.

Expanding the employment niche for STEM master's degree recipients has been no easy task, however. By discipline, slightly more than 20% of scientists and engineers employed in engineering and computer sciences hold master's degrees as their highest qualification; the percentage is lower in other disciplines, and lowest in the life sciences. (Figure 2).

Figure 2. U.S. Employed Total and Master's Level Scientists and Engineers, 1999 (Glazer-Raymo)



The professional science master's (PSM) is a two-year master's level degree that is designed to prepare professionals for work outside academia. The concept was developed in cooperation with the Council of

Graduate Schools and with industry leaders from new and emerging fields such as applied, industrial and financial mathematics; bioinformatics; computational science; geographical information systems; and industrial microbiology.

Open to bachelor's degree holders in the sciences, mathematics, or engineering, the PSM degree programs prepare students for work in fields such as consulting, banking, finance and shareholder relations, management of IP resources, insurance, research management technology transfer, marketing of technical products, and more. These programs consist of two years of training in an emerging or interdisciplinary area. The programs are for the most part a mixture of a science-based curriculum with business coursework and experience added in place of a research-oriented thesis. Most PSM programs require an internship or project that combines a practical application of studies in an actual industry environment. A few campuses have initiated on-line coursework that has a more flexible schedule and can cater more towards those students who are also fully employed.

Figure 3. Distribution of Proposed & Current PSM Programs in California

2.2 Currently established PSM programs

The Sloan Foundation has led the expansion of PSM programs by providing startup funding for programs in the sciences and mathematics at universities throughout the United States.

According to the Sloan definition there are three types of science master's degree programs:

1. Those that deepen a student's knowledge beyond what can be learned in a four-year undergraduate program, but stay within a discipline.
2. Those that fuse scientific fields at a level of depth and complexity hard for undergraduates to achieve. In many cases, the fusion may be with computer or information sciences.

⁸ Jesse H. Ausubel and Sheila Tobias, "Mastering Science: Graduate Schools Invigorate the MS in Science and Math," http://www.sciencemasters.com/articles_mastering_science.html].

3. Those that combine study in natural sciences and mathematics with knowledge and training in management, law, or other professional areas.

Nationwide, 95 Alfred P. Sloan Foundation professional science master's programs have been developed at 45 campuses. The programs all have a similar foundation but each program has been individualized to respond to student interest and the surrounding area's industry requirements. As graduates complete the programs they are able to fulfill a specific niche in the employment market that up to this point has been vacant.

Most of these programs were created to a large extent by combining existing science and business coursework offered by the institution. A few institutions, such as the Keck Graduate Institute of Life Sciences, have relied primarily on coursework designed specifically for the PSM program. By making use of existing resources and faculty, the Sloan approach is designed to be less expensive to initiate, requiring an initial investment of no more than \$75,000 to \$300,000 to seed a program.⁸

As of 2004, approximately 400 PSM graduates have been produced nationwide. There are as of yet no overall data on the employment or placement of these graduates.

There are currently 12 PSM programs held at 8 campuses throughout California:

- California State University, Fresno
Biotechnology (Ag.)
Forensic Science
- Keck Graduate Institute of Applied Life Sciences
Computational Molecular Biology/Bioinformatics
Biosciences Management
- San Diego State University
Computational Science
- San Jose State University
Biotechnology
- Stanford University
Biomedical Informatics
- University of Southern California
Computational Molecular Biology/Bioinformatics
Computational Linguistics
Physics for Business Applications
- University of California, Los Angeles
Computational Molecular Biology/Bioinformatics
- University of California, Santa Cruz
Computational Molecular Biology/Bioinformatics

The total number of PSM degrees received each year is relatively small in relation to the number of masters degrees awarded in the STEM areas. For example, in 2002 U.S. institutions granted 56,854 master's degrees in the areas of biological sciences, computer and information systems, engineering, mathematics and physical sciences. California's institutions granted 6,540 of those degrees. The number of PSM degrees awarded each year by the 12 California programs is between 10 to 15. The Keck Graduate Institute granted an additional 34 masters degrees in the biosciences management area. The total number of PSM degrees received each year is relatively small in relation to the number of masters degrees awarded in these areas.

⁹ <http://www.professionalsciencemasters.com>

¹⁰ See Section 6.

2.3 Industry needs assessments conducted for extant programs

CCST contacted 31 PSM programs by email and phone throughout the country, selected on availability of contact information in the program listings provided by the Sloan Foundation.⁹ Nineteen programs responded to our inquiries. Responding programs were asked:

- How long has the program been in place?
- What factors led to the establishment of the program?
- Were local industries surveyed to assess potential interest in PSM graduate placement?

Results of these inquiries are summarized by program in Section 14. While all respondents indicated that they had made some contact with one or more local companies prior to establishing the PSM program, these contacts were largely oriented towards setting up appropriate internship opportunities for PSM program students. None of the 19 programs had conducted an industry needs survey, nor did they have formal data on industry feedback which they were able to share.

2.4 PSM programs in the media

A variety of mainstream publications have printed articles about the PSM degree in the past few years; major articles in 2004 include features in *The Wall Street Journal*, *USA Today*, and *The Scientist*. Most of these are cautiously optimistic about the potential of the PSM programs, and some advocate the PSM as a logical degree choice for high-tech industries; “PSM employees attract industry enthusiasts because of clear bottom-line benefits,” said Joanna Krotz in *The Scientist*.¹⁰ Others, though, have sounded a more cautionary note: the *Wall Street Journal* notes that top schools such as Harvard, Princeton and Cornell have been resistant to implementing PSM programs. The *Journal* reports Harvard faculty member L.J. Wei as saying “Harvard tries to create leadership in industry, academics, and government... We don’t think that with a master’s degree people can fill that role very easily.”

All the articles published to date rely on case studies; most note that there are no comprehensive data as of yet to indicate whether or not the PSM programs are successful or not. So far, they are typically small, niche programs.

3. CALIFORNIA'S HIGH-TECH INDUSTRY CLUSTERS: REGIONAL ECONOMY ANALYSIS

3.1 Background

California has over 16.5% of total STEM employment in the United States (compared to just over 11% of total employment).¹¹ In order to establish which companies should be targeted for the present study, it was necessary to prepare an overview of California's current high-tech industry clusters and to establish which offer the greatest likelihood to remain or are projected to become key high-tech employment sectors in the state.

A macro approach was used, organizing industry cluster data according to California's nine economic regions as established by the California Economic Strategy Panel (Figure 4).¹² Various sources of industry clusters and occupational data identified in the footnotes were used to identify California's regional high technology related industry clusters based in part on cluster studies¹³ and distribution of occupational categories. North American Industry Classification System (NAICS) data were used where available; where not available Standard Industrial Classification (SIC) data were used. Table 1 provides information on the state of California. None of the projections go beyond 2006, nor do they anticipate if or how new clusters will form and develop.

In some cases recent detailed industry cluster analyses were available but in others, such as Los Angeles, they were not. In every region the most recent data, special purpose studies, or special projections were used to identify likely high technology growth sectors.

Some occupations that the Labor Market Information Division (LMID) expects to exhibit relatively high growth are identified by industry sector. They serve as examples but the list is not exhaustive since the employment patterns for the new sectors have not been fully analyzed, are not published by LMID, or are too voluminous to list here.¹⁴ It must be remembered that

¹¹ U.S. Dept. of Labor, 2002.

¹² Time Structures, a research consulting company, assisted with the cluster analysis.

¹³ Employment Development Department industry cluster studies, Technology, Trade and Commerce industry studies ("Matrix of Selected California Industry Cluster Studies"), and other materials were drawn together for this analysis.

¹⁴ <http://www.calmis.cahwnet.gov/htmlfile/subject/occproj.htm>

this economic analysis is at a macro level, while the current and proposed PSM programs will be producing relatively small numbers of graduates that could be absorbed by local companies that do not show up at the scale used here. Consequently, the identification of a particular high-tech cluster in the present analysis does not suggest that employment opportunities for PSM graduates do not exist elsewhere in the state.

Further, it should be noted that this approach was primarily intended as a starting point for providing an acceptable range of geographic and industrial areas and should not be construed as a comprehensive assessment of California's high-tech industries.

Following are overviews of California's principal economic regions and the most promising high-tech sectors in each.

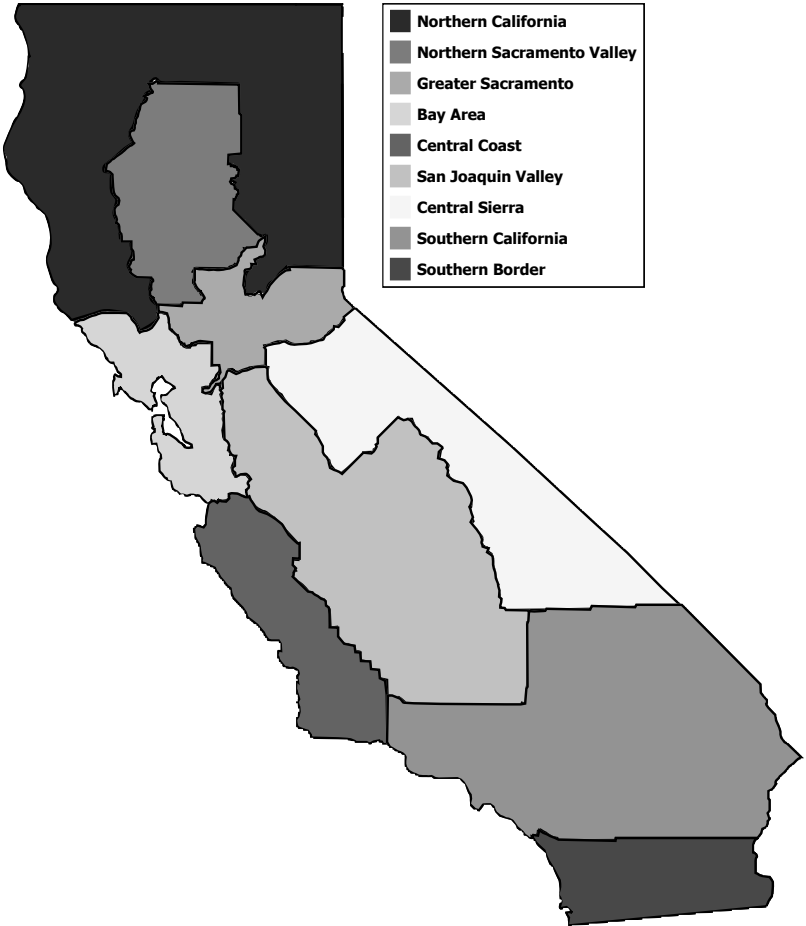


Figure 4. Economic regions in California as defined by the California Economic Strategy Panel

ECONOMIC REGION: NORTHERN CALIFORNIA



High Technology Sectors Expected to Grow:

- Computer related activities

Major Industry Clusters:¹⁵

- Agriculture
- Arts and Crafts
- Entertainment/Multimedia
- Hospitality/Recreation
- Tourism
- Information Technology/Communication Services
- Manufacturing/Other
- Metals/Materials
- Transportation and Wood Products

High Technology Industries with Greatest Job Growth:

- Education: Special Ed Teachers, Preschool, Kindergarten, and Elementary School (BA/BS+), and Vocational and School Counselors (MA);
- Environmental: Foresters (BA/BS);
- Computer and Information Services: Network & Computer Systems Administrators (BA/BS), Computer Software Engineers, Systems Software (BA/BS+); Computer Systems Analysts (BA/BS); Computer Software Engineers, Systems Software (BA/BS); Computer & Information Systems Managers (BA/BS); Computer Software Engineers, Applications (BA/BS);

¹⁵ Sources of data: Employment Development Department, Labor Market Information, Northern Rural Training and Employment Consortium (NORTEC), California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; and Regional Economies Project.

- Health and Social Services: Pharmacists (Professional Degree); and
- Government: Legislators (BA/BS+).

Economic Base Industry Changes:

- Computer and health related industry growth

ECONOMIC REGION: NORTHERN SACRAMENTO VALLEY



High Technology Sectors Expected to Grow:

- Health Care and Social Assistance: Nursing Home, Residential Care, Hospital, and Individual Family Services Personnel including Pharmacists (Professional Degree)
- Government: First-Line Supervisors/Managers of Office & Admin Support Workers

Major Industry Clusters:¹⁶

- Agriculture
- Waste Services
- Construction
- Manufacturing
- Accommodations and Food Services
- Retail Trade
- Health Care and Social Assistance
- Government
- Professional and Technical Services
- Finance and Insurance
- Information Services

High Technology Industries with Greatest Job Growth (2000-2002):

- Health Care and Social Assistance
- Government

¹⁶ Sources of data: Employment Development Department, Labor Market Information, Northern Rural Training and Employment Consortium (NORTEC), California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; City of Chico Community Profile and Site Selection Handbook (2000).

Economic Base Industry Changes:

- Administrative and Waste Services
- Health Care and Social Services
- Government

ECONOMIC REGION: GREATER SACRAMENTO

High Technology Sectors Expected to Grow:

- Biomedical: Life Science Researchers and related technicians
- Specialized agricultural products; Industrial Engineers (BA/BS); Life Scientists (Ph.D.); and Chemists (BA/BS)
- Electronics: Electronic Engineers (BA/BS); Electrical Engineers (BA/BS); and Computer Hardware Engineers(BA/BS)



- Health care: Pharmacists (Professional Degree); Dentists (Professional Degree), Registered Nurses and other professional support including Audiologists (MA/MS), Speech-Language Pathologists (MA/MS); and Physical Therapists (MA/MS)
- Software and related areas: Computer and Information Systems Managers; Computer and Mathematical Science Occupations (BA/BS, MA/MS); Data Base Managers (BA/BS); and Operations Research Analyst (MA/MS).

Note that government, while a large industry cluster, is not expected to grow much; however, replacement of retiring scientifically and technically skilled workers should be substantial over the coming years. Consequently while growth is expected to be low, the number of jobs needing to be filled could be significant.

*Major Industry Clusters:*¹⁷

- Agriculture
- Biotechnology

¹⁷ Sources of data: Employment Development Department, Labor Market Information, California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; Sacramento Area Council of Governments, <http://www.sacog.org/>; the Sacramento Regional Technology Alliance, <http://www.sarta.org/>; New Valley Connexions (2001) The Economic Future of the Sacramento Valley; and California Healthcare Institute (2002), Biomedicine: The Next Wave for California's Economy.

- Computers/Electronics/High Technology
- Entertainment/Multimedia
- Finance/Insurance/Real Estate
- Government
- Health Care Services
- Hospitality/Recreation Tourism
- Information Technology/Communications Services
- Manufacturing, Metals/Materials
- Transportation
- Wood Products

High Technology Industries with Greatest Job Growth (2000-2008):

- Communications and Public Utilities
- Durable Goods
- Services

ECONOMIC REGION: SAN FRANCISCO BAY AREA

High Technology Sectors Expected to Grow:

- Biomedical: Life Science Researchers and related technicians; Medical Scientists (BA/BS, MS/MA, Ph.D., MD); Biochemists and Biophysicists (Ph.D.); Microbiologists (Ph.D.); and Natural Sciences Managers (BA/BS)
- Nano/Materials/Bio: Materials scientists and various cross trained researchers
- Computer: various computer engineers, and systems operators
- Electronics: Electronic Engineers (BA/BS); Electrical Engineers (BA/BS); and Computer Hardware Engineers(BA/BS)



- Environmental Technology
- Manufacturing: computer and peripheral equipment, communications equipment, semiconductors, magnetic media, aerospace, and pharmaceuticals
- Software and related areas: Computer Software Engineers
- Information Systems Managers: Computer and Mathematical Science Occupations (BA/BS, MA/MS); Data Base Managers (BA/BS); Operations Research Analyst (MA/MS); and Computer Programs (BA/BS)

*Major Industry Clusters:*¹⁸

- Bioscience
- Computer
- Telecommunications

¹⁸ Sources of data: Employment Development Department, Labor Market Information, California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; Regional Economies Project; California Healthcare Institute (2002) Biomedicine: The Next Wave for California's Economy; Joint Venture Silicon Valley (1998), Silicon Valley 2010: A Regional Framework for Growing Together; Joint Venture Silicon Valley, "Regional Convergence Companies: Nano, Info, and Bio"; Joint Venture Silicon

- Education and Health Services
- Electronics
- Defense/Aerospace
- Contract Manufacturing
- Multi-media
- Professional and Business Services
- Semiconductors
- Banking and Finance
- Tourism
- Software

Economic Base:

- Professional
- Technical
- Scientific and Management Services
- Wholesale Trade and Transportation
- High Technology Manufacturing
- Diversified Manufacturing
- Basic Government
- Basic Information Services
- Entertainment and Tourism

High Technology Industries with Greatest Job Growth (2000-2002):

- Leisure and Hospitality
- Government
- Education and Health Services

Valley (2001), "The Next Silicon Valley: Riding the Waves of Innovation"; Milken Institute (2004), "America's Biotech and Life Sciences Clusters"; Bay Area Economic Forum, Bay Area Council, Association of Bay Area Governments (2002), *After the Bubble: Sustaining Economic Prosperity*; Bay Area Economic Forum and Bay Area Council (1999), *The Bay Area: Winning in the New Global Economy*; Bay Area Bioscience Center, et al. (2002), *A Critical Analysis of the Local Biotechnology Industry Cluster in Alameda, Contra Costa, and Solano Counties*; and California Council on Science and Technology (2004), *Nanoscience and Nanotechnology: Opportunities and Challenges in California*.

ECONOMIC REGION: SAN JOAQUIN VALLEY

High Technology Sectors Expected to Grow:

(Note: it is not possible to identify workers for these emerging sectors with the existing SIC codes.)

- Flexible food manufacturing
- Precision irrigation technology
- Agriculture technology
- Agile industrial manufacturing
- Advanced logistics
- Smart commerce and customer service
- Computer Systems Support: Computer and Information System Managers (BA/BS)



Major Industry Clusters:¹⁹

- Agriculture
- Government
- Forestry and Fishing
- Retail Trade
- Manufacturing
- Health Care and Social Services

¹⁹ Sources of data: Employment Development Department, Labor Market Information, California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; Regional Economies Project; New Valley Connexions (Great Valley Center and CA Technology, Trade and Commerce Agency partnership) (2002), The Economic Future of the San Joaquin Valley; and New Valley Connexions (Great Valley Center and CA Technology, Trade and Commerce Agency partnership) (2002), Producing a Competitive Advantage: Agri-tech in the San Joaquin Valley.

- Hospitality and Social Services
- Administrative and Waste Services
- Transportation and Warehousing
- Wholesale Trade
- Finance and Insurance
- Professional and Technical Services

Economic Base:

- Government
- Retail Trade
- Manufacturing
- Health Care and Social Assistance
- Accommodations and Food Services
- Administrative and Waste Management
- Other Services

High Technology Industries with Greatest Job Growth (2000-2002):

- Education and Health Services

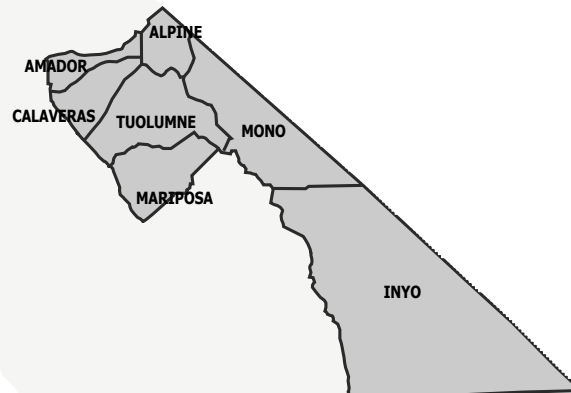
ECONOMIC REGION: CENTRAL SIERRA

High Technology Sectors Expected to Grow:

- Professional and Technical Services: Architectural and Engineering Services (BA/BS), Management and Technical Consulting Services (BA/BS), Computer Systems design and related services (BA/BS), and Computer Support Services (BA/MA)
- Health Care and Social Services: Pharmacists (Professional Degree)

Major Industry Clusters:²⁰

- Government
- Accommodations and Food Service



- Retail Trade
- Health Care and Social Assistance
- Construction
- Manufacturing
- Administrative and Waste Services
- Professional and Technical Services
- Arts and Entertainment

Economic Base:

- Same above

High Technology Industries with Greatest Job Growth (2000-2002):

- Health Care and Social Assistance
- Professional and Technical Services
- Administrative and Waste Services

²⁰ Sources of data: Employment Development Department, Labor Market Information, California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; and California Economic Strategy Panel, (2004), Regional Economies Project.

ECONOMIC REGION: CENTRAL COAST

High Technology Sectors Expected to Grow (2006):

- Professional and Business Services
- Various computer, computer network and systems support (BA/BS)
- Computer Software Engineers (BA/BS)

Major Industry Clusters:²¹

- Government
- Accommodations and Food Service
- Retail Trade
- Leisure and Hospitality
- Trade, Transportation and Utilities
- Education and Health Services
- Professional and Business Services

Economic Base:

Same above



High Technology Industries with Greatest Job Growth (2000-2002):

- Health Care and Social Assistance
- Professional and Business Services

²¹ Sources of data: Employment Development Department, Labor Market Information, California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; LMID, County Business Profiles.

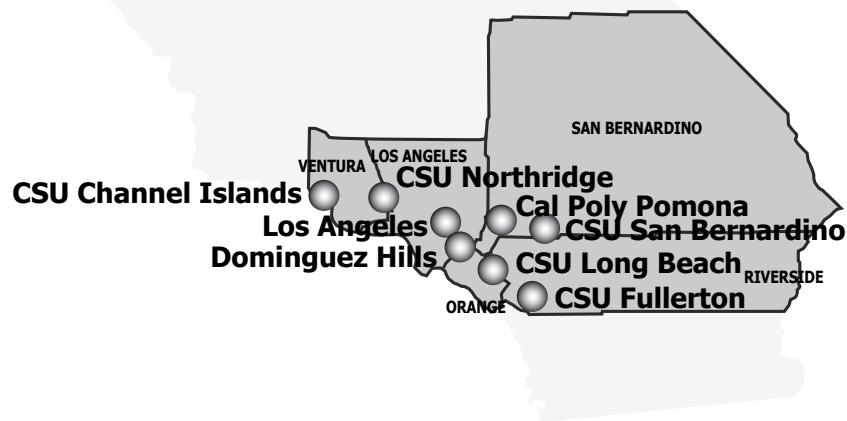
ECONOMIC REGION: SOUTHERN CALIFORNIA

High Technology Sectors Expected to Grow:

- Aerospace (Commercial Space)
- Nanotechnology and MIMS and other Microsystems Technologies
- Professional and Business Services: Various computer, computer network and systems support (BA/BS); and Computer Software Engineers (BA/BS)
- Biosciences/Medical Devices
- Pharmaceuticals
- Computer Systems and Related Systems Design

Major Industry Clusters:¹²

- Tourism
- Computer and Electronics Manufacturing
- Aerospace Manufacturing
- Software
- Internet Services
- Computer Systems Design
- Professional Business Services



²² Sources of data: Employment Development Department, Labor Market Information, California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; LMID, County Business Profiles; Los Angeles County Economic Development Corporation, "LA County's 16 Top Industries"; Larta, LAEDC (1998), Beyond Consolidation: A study of the Continuing Transformation of Aerospace and Defense in Southern California; Milken Institute (2002), Blueprint for a High-Tech Cluster: The Case of the Microsystems Industry in the Southwest; Los Angeles County Workforce Preparation and Economic Development Collaborative (2002), Fashion Forward: the Future of Apparel

- Motion Picture and TV Production
- Health Services/Bio-Medical
- Apparel/Textile Design and Manufacturing
- Fabricated Metals
- Furniture
- Auto Parts Manufacturing

High Technology Industries with Greatest Predicted Job Growth (2001-2008):

- Computer design, services, networks, software, and database

Manufacturing in Los Angeles; Los Angeles Regional Technology Alliance (2000), Heart of Gold: The Bioscience Industry in Southern California; Los Angeles County Workforce Preparation and Economic Development Collaborative (2002), Metal Manufacturing in Los Angeles; Orange County Workforce Investment Board (2002), Orange County Cluster Project; and California Council on Science and Technology (2004), *Nanoscience and Nanotechnology: Opportunities and Challenges in California*.

ECONOMIC REGION: SAN DIEGO BORDER REGION

High Technology Sectors Expected to Grow:

- Diversified and High Technology Manufacturing: Computer, Electronic Engineers; Telecommunications and Communications Equipment Engineers; Audio and Video Equipment Engineers.
- Nanotechnology and MIMS and other Microsystems Technologies: Materials Engineers, Physicists, and Specialized Nano and MIMS Engineers.
- Professional and Business Services: Various Computer, Computer Network and Systems Support (BA/BS); Computer Software Engineers (BA/BS), and Scientific R&D Services.
- Biosciences: Pharmaceuticals, Medical Devices, Biotechnology, Bio-agriculture, and Environmental Biotechnology: Biochemists, Biophysicists, and Pharmaceutical Production Engineers.
- Digital Media: Desktop Publishing and Software Programmers.

Major Industry Clusters:²³

- Bioscience
- Communications
- Environmental Technology
- Biomedical and Biotech Products
- Pharmaceuticals
- Computer & Electronics Manufacturing
- Defense & Transportation Manufacturing
- Software & Computer Services
- Professional and Business Services
- Agriculture
- Hospitality and Tourism
- Financial Services



²³ Sources of data: Employment Development Department, Labor Market Information, California Economic Strategy Panel, Collaborating to Succeed in the New Economy, and associated appendices, 1993-98; Regional Economies Project; LMID, Milken Institute (2002), Blueprint for a High-Tech Cluster: The Case of the Microsystems Industry in the Southwest; California Council on Science and Technology (2004), *Nanoscience and Nanotechnology: Opportunities and Challenges in California*; Council on Competitiveness (2001), Clusters of Innovation Initiative: San Diego; San Diego Regional Technology Alliance (2000), E-Tech:

Economic Base:

- Professional, Technical and Management Services
- Government
- Diversified Manufacturing, Wholesale Trade and Transportation
- Entertainment and Tourism
- High Technology Manufacturing
- Basic Information Services
- Resources (agriculture)

High Technology Industries with Greatest Job Growth (2000-2002):

- Health Care and Social Assistance
- Professional and Business Services

Recommended Regional Analyses

Appropriate industry groups were suggested based on an approximate alignment between various CSU campuses – based on proposed offerings in each professional science master’s (PSM) degree program – and the closest industry cluster that might serve as a source of employment for students. It is assumed that internships will play an important role in the programs, and hence companies must be reasonably close to programs. In some cases, such as government, forensics, and speech pathology related services, growth opportunities were identified in several regions. Since this approach cannot detect brand new clusters with only a few companies, nor the potential to develop new industry clusters, a literature review of economic development studies of each of the state’s nine regions was also completed.

Using this methodology, the following nine areas were seen as promising sectors to focus on, incorporating a range of disciplines and geographic distribution throughout the state’s principal areas of high-tech growth.

Missing the Green, Reassessing San Diego’s Environmental Technology Cluster; Center on Policy Initiatives (2000), Planning for Shared Prosperity or Growing Inequality? An In depth Look at San Diego’s Leading Industry Clusters; SANDAG / SourcePoint (1998), San Diego Regional Employment Clusters: Engines of the Modern Economy; SANDAG (2000), San Diego Surf meets Silicon Sand, An examination of Industry Growth, Employment Trends, and Training Opportunities for San Diego’s Digital Media Industry; San Diego Workforce Partnership Inc. (2000), San Diego’s Biosciences Industry Cluster, A Regional Employment Study; San Diego Workforce Partnership Inc. (2000), San Diego’s Medical Services Industry Cluster: A Regional Employment Study; and San Diego Regional Technology Alliance (2000), Wireless Wonders: Assessing San Diego’s Wireless Industry.

- Greater Sacramento:
 - (1) Agricultural Biotechnology and Environment
 - (2) Government
- San Francisco Bay Area:
 - (3) Bio/Nano/Information Sciences
 - (4) Computer Sciences and Software
 - (5) Environmental Technologies
- Southern California/Los Angeles:
 - (6) Nanotechnology-Materials Sciences
 - (7) Specialty Manufacturing (Pharmaceuticals, MIMS, aerospace, military, etc)
- San Diego:
 - (8) Biotechnology
 - (9) Telecommunications and Computing

Note: This selection of high-tech clusters and geographic areas does not imply that similar high-tech clusters are not growing in different regions. It is simply intended to provide a distribution for data gathering. It should also be recognized that this approach provides a highly simplified overview of clusters throughout the state. There are, for example, significant clusters in biotechnology in the Bay Area and biomedical industries in the Los Angeles area which were not singled out for meetings. Again, this was primarily a result of the constraints of the study and an effort to ensure a wide range of both geographic and industrial areas. Further study will be needed to obtain comprehensive data on any individual cluster identified here.

Table 1: High Technology Related Occupations Requiring a Master's Degree or Higher with Fastest Expected Job Growth from 2000-2010 in California

CA SIC Code	Occupation	Number of Jobs: 2000	Number of Jobs: 2010	Percent Change	Education Required
29-1127	Speech-Language Pathologists	5,800	8,600	48.3%	MA/MS
15-1011	Computer & Information Scientist	5,000	7,200	44%	Ph.D.
21-1013	Marriage and Family Therapists	6,000	8,500	41.7%	MA/MS
21-1011	Substance and Abuse Counselor	6,400	9,000	40.6%	MA/MS
25-9031	Instructional Coordinator	9,200	12,800	39.1%	MA/MS
25-1071	Health Specialists	5,000	6,900	38%	Ph.D.
21-1012	Educational, Vocational Counselors	19,500	26,800	37.4%	MA/MS

Source: LMID, Table 5, 2004.

4. PSM SURVEY

4.1 Survey goals

The overall goal was to conduct a qualitative study on whether respondents were interested in seeing the development and expansion of the proposed PSM programs in the CSU system. The four primary specific goals were:

- 1) Evaluate local and state-wide industry demand for PSM degree-holding employees or, determine whether the proposed PSM programs align with high technology industry clusters developing the area and if there be a demand for master's level employees within the next few years? Determine if follow-up continuing education courses in the discipline and across disciplines are an attractive option?
- 2) Investigate willingness to support (including making equipment donations, identifying required skills sets, etc), advise and recruit students from academic and work skills oriented graduate programs
- 3) Assess what an appropriate CSU PSM coordination system might look like to:
 - a. Place students in regional high technology jobs and in other locations statewide; and
 - b. Combine and evolve course content so that programs can work together across disciplines (biotech and nanotech is an example).
- 4) Investigate what kind(s) of PSMs would be most in demand over the next five years including:
 - a. Time frames necessary for PSM programs to evolve their course content to meet the emerging needs of industry; and
 - b. Evaluate current courses effectiveness in placing students, meeting skill requirements, and improving the skills and income of the current workforce relative to the expenditure of Sloan Foundation and public funds.

4.2 Methodology

Once the economic macro-analysis identified regions and high-tech industry sectors to look for, it was possible to focus on identifying companies to take part in the study. CCST contacted the following

regional technology alliances, economic development corporations, and industry groups to assist in locating appropriate companies and contacts within those companies:

American Electronics Association
Bay Area Science and Innovation Consortium
Bay Area Nanotech Forum
Bay Area Regional Environmental Business Resource Assistance Center (REBRAC)
BIOCOM
California Manufacturing Technology Center
City of Anaheim Office of Economic Development
City of Carson Office of Economic Development
City of Downey Office of Economic Development
City of Orange Office of Economic Development
Economic Alliance of the San Fernando Valley
Greater Antelope Valley Economic Alliance
Nanotechnology Investment and Commercialization Forum
Northern California Nanotech Initiative
Riverside County Economic Development Agency
San Diego Economic Development Corporation
San Diego Regional Technology Association
San Diego Telecom Council
San Gabriel Valley Economic Partnership
Semiconductor Industry Association
Silicon Valley Association of Start-up Entrepreneurs
Silicon Valley Manufacturers Association
Software Industry Council
The Larta Institute
Telecom Council
Valley Economic Development Center

Companies were to contact chosen first based on their prominence in their respective sectors, according to the recommendations of responding organizations, and second based on the availability of known contacts within those companies. For non-governmental sectors, a list of 15-20 companies was drawn up (Section 8). In all, 144 companies and government agencies were contacted.

Prospective participants were invited to participate via regular mail (Section 10) and email, with follow-up phone calls made by CCST staff. Depending on the company, the following level of employee was initially contacted (in descending order):

- President/Chief Executive Officer (CEO)/Center Director
- Chief Operating Officer (COO)
- Vice President of Business Development or Research
- Vice President of Human Resources

Each company was contacted an average of 4 times. Twenty-one respondents agreed to participate in the focus groups, of whom 15 attended the meetings. Those who could not attend were subsequently contacted via phone interviews. The same basic list of questions was used for both the phone interviews and for the focus groups, developed in conjunction with the CSU committee. (A copy of the moderator's guide is included in Section 10.) Prior to the meetings and interviews, participants were asked to read a one-page background description of the PSM program (Section 9). The questions asked in both settings were as follows:

1. Have you heard of the PSM prior to our contacting you? What has been your experience?
2. How can CSU align PSM programs with industry and structure course content?
3. Do you currently provide input to local university programs? How? Who initiated this contact?
4. How should CSU be connecting with industry? Is it doing this?
5. How do you recruit currently?
6. How can recruitment be improved?
7. What can we do to ensure the success of existing and new PSM programs?
8. Would you hire a PSM graduate today if available?
9. Do you currently use internships? Paid or unpaid?
10. Would you offer an internship to a PSM student?
11. Would you sit on an advisory board to a PSM program?

The focus group meetings lasted 90 minutes and were hosted at the Bay Area Science and Innovation Consortium (San Francisco), The Larta Institute (Los Angeles), and the San Diego Economic Development Corporation (San Diego). Six meetings were held in all, involving a total of 15 companies. Each meeting was attended by a CCST moderator, a CCST support staff member, and an observer from the CSU coalition.

In all, 36 respondents participated in the study. Eleven respondents were CEOs or presidents, and a majority of the remainder were senior executives at the vice president or program director level.

While the total number of companies participating in the meetings represented only half of the total companies participating in the study, the longer meetings allowed for shared perspectives and valuable interchanges among participants, and enabled us to explore the PSM in greater depth than the phone interviews. In turn, the phone interviews allowed us to reach a wider range of companies than would otherwise have been possible, particularly given the senior level of executive which CCST targeted for the study.

3.3 Respondents by sector

Although an average of fifteen companies was contacted for each of the ten sectors, the response rate was not uniform and the distribution of respondents varied by discipline:

- Bio/Nano/Info Technology: 8
- Nanotechnology: 6
- Biotechnology: 6
- Telecom/Computing Science: 3
- Computer Science/Software: 5
- Environmental Technology: 2
- Agricultural Biotechnology: 0
- Specialty Manufacturing: 0
- Government: 6

Bio/Nano/Info Technology (Bay Area)

- Respondents:
 - Lawrence Livermore National Laboratory
 - NASA Ames Research Center
 - NanoGram
 - NanoSIG
 - Palo Alto Research Center

Some respondents had heard of the PSM program prior to being contacted by CCST.

There was general support for the idea of providing expanded interdisciplinary training to graduates and incorporating business skills into technical graduates. “An interdisciplinary background and teamwork are very important,” said James McGraw (Lawrence Livermore). “Program content and general curriculum must be flexible and must have depth.” “This [PSM program] is what industry really needs,” said Pauksta (Palo Alto Research Center). “Project management, business basics, intellectual property... now these are important for everyone to know about.” Companies were also in favor of expanding the base of California talent, as opposed to utilizing students from other states and countries.

“It is very common for scientists to not know business and businesses to not know science,” said Bo Varga (NanoSIG). “We want students who have access to current science technology with an understanding of business practices.”

“The problem we have is how to develop people who know the applications or design areas and also have management savvy,” said Scott Hubbard (NASA Ames). “There is a gap. We try to grow these people ourselves.” Similar sentiments were expressed by participants from Lawrence Livermore.

However, while the PSM degree skill set was seen as attractive, some participants had concerns about maintaining the relevance of the program. “The biggest problem will be staying current,” said Hubbard (NASA Ames). “Do not train for yesterday.”

There were also concerns about establishing credibility for the degree program. “This type of degree can be well positioned,” said Hubbard (NASA Ames). “[But] the most important thing is to establish it as a high quality program.” All participants observed that the PSM programs address a different niche than other CSU graduate degree programs, and that CSU might face particular obstacles in marketing the PSM as a program that produces top-quality people.

Nanotechnology

Respondents:

First Nano
HRL Laboratories
Gene Fluidics
Tanner Laboratories
IJ Research Inc.
Unisun, Crucible Partners
Nanosolar

Only one of the participating companies had heard of the PSM prior to being contacted by CCST.

Nanotechnology is an interdisciplinary area and consequently there was general interest among participants in the prospect of a new graduate degree offering a different combination of skills. One of the participants (GeneFluidics) serves on a board at UCLA exploring the creation of a similar degree program in engineering at UCLA.

Most companies currently recruit by word of mouth and by specific contacts with programs producing relevant degree holders. Most use interns, though the process for acquiring them is highly idiosyncratic. Recruitment methods vary, although one participant in the focus group mentioned the lists of available graduates and intern students provided by the University of Southern California (USC) to regional companies. Other meeting participants expressed significant interest in being on this distribution list and in seeing similar lists from other universities in the area.

Nearly all participants agreed that a combination of business skills and technical acumen would make an employee more desirable. “My school did not teach me how to communicate,” said Yoon (IJ Research). “Communication is an art and it is a good tool to have.” Some stated they would probably send an engineer back to school for an MBA in order to acquire an employee with this combination of skills, but most stated they would consider hiring a PSM graduate if they were available. “The program looks good,” said Eberspach (Nanosolar). This was true both of the small and large companies.

Participants did question, however, whether it was necessary to create a new class of degrees in order to acquire the PSM skill set. “Training can be provided in other areas such as business skills,” said Vincent Gau (GeneFluidics). “Graduates need skills in the technical areas.” It was

suggested that a stronger undergraduate curriculum, providing a “more realistic preparation” for careers in respective degrees (e.g. EE) would be a potentially preferable alternative.

Most participants in both the focus group and in phone interviews said they would be willing to serve on advisory boards and/or provide input into a PSM curriculum. However, they tended to frame the question in terms of a broader university-industry relationship.

“There needs to be better integration between universities and industry, an alignment of goals,” said Stephen Jaffe (Material Methods).

Most felt that it was difficult to connect with universities on any level. This was even true for the GeneFluidics participant, who noted that while his company is the first nanotechnology spinoff from UCLA and that he serves on several advisory boards at UCLA, his company gets better information on interns and graduates from USC. There was a strong desire to provide feedback into the development and updating of related programs, both for PSM and existing degrees. “I’d welcome the opportunity to offer input on the curriculum,” added Jeffers.

Intellectual property concerns played a significant part in this discussion for the focus group.

Specialty Manufacturing

None of the 20 companies contacted agreed to participate. Thirteen stated specifically that they felt that the PSM degree program would not be relevant to them.

Biotechnology

Respondents:

- Genentech
- Alta Gen
- Bayer
- Invitrogen
- Apovia
- Diversa
- Althea Tech

The San Diego companies interviewed by phone had heard of the PSM program prior to being contacted, due to interactions with SDSU. Biotech companies elsewhere in the state had not heard of the program and only one of the companies participating in the focus group meeting had heard of the PSM.

In general, respondents favored the idea of acquiring and developing employees with greater business acumen. However, there were several concerns expressed about whether the PSM degree program was the best way to accomplish this goal. Several companies felt that some features of the PSM were not advantageous to graduates or to employers. “We would rather take an MBA or a scientist and train them ourselves,” said Arathoon (Genentech).

A principal concern for many was the substitution of business training for a research thesis. Nearly all the biotech respondents said they felt the research thesis was a crucial part of a master’s degree and that the other skills incorporated into PSM programs would not compensate for the lack of the thesis. They felt the research thesis developed demonstrable critical thinking skills which could not be acquired on the job, and that the business skills could be learned later. “I’m not sure the PSM is a good fit for us,” said Monforte (Althea). “We might advance someone internally instead by sending a scientist to school to get management skills.”

“You do not want a jack-of-all-trades,” said Paul Zorner (Diversa). “The PSM sounds like a good program, but maybe at the baccalaureate level.”

All participants indicated they use internships, and some noted that they would consider offering internships to PSM program students and possibly hiring PSM graduates.

“We’d hire them if they were good,” said Thomas Malott (Bayer). “Just be sure students have a strong background in the fundamentals.”

Several companies however asserted they would rather hire postdoctoral fellows for the kinds of positions that a PSM graduate might hold. Critical thinking skills and experience were judged by many to be more important than the actual degree. Some participants said they were concerned that the PSM would not be advantageous to graduates because it wouldn’t make them eligible for higher pay or more senior positions at their companies. Apovia and Diversa compared the PSM to the MBA, which they characterize as a degree intended solely to make the recipient more money in the same position that a baccalaureate recipient might hold.

“The challenge is that post docs and Ph.D.s are relatively inexpensive,” said Alan Honeycutt (Invitrogen). “Why would you choose to hire a lower degree [such as the PSM]?”

Telecom/Computer Science

Respondents:

Science Applications International Corporation (SAIC)

Cubic Inc.

Entropic Communications Inc.,

HRL Laboratories

Participants had heard of the PSM degree before being contacted by CCST. Cubic and SAIC are also actively involved with regional associations including the San Diego Science Alliance and the San Diego Science and Technology Association. While both companies are large national corporations, they are both headquartered in San Diego and hence have strong California connections.

Participants were supportive of the PSM concept, and of broadening the capabilities of students in general. “Universities need to produce life-long learners; those that can teach themselves and are always learning,” said Stephen Rockwood (SAIC). “Organizational skills and project managers who have the bigger picture in mind are necessary.” “It would interest me to have people like this on our staff,” said Pappas (Entropic). “We would want this.”

They also indicated that the needs of the San Diego high-tech employment sector differ from those elsewhere in the state and the country. “The needs in the Bay Area are probably different from what San Diego needs,” said Barbara Abelin (Cubic). “The localized advisory boards should work on discovering what is important for the area.”

“Universities should have industry representation on their advisory boards,” added Rockwood. “The curriculum should not be developed solely by the university. It needs to be developed together from the beginning.”

Internships are provided by all companies and participants stated they would be willing to offer them to PSM students. “Ninety percent of interns will convert to employees,” added Abelin (Cubic). “Productivity is very high for these people.” “Internships are a great way to screen potential employees,” said Ganz (HRL).

Computer Science/IT

Respondents:

IBM Almaden
Pixar
Per Medics

Participants were interested in the development of the PSM program, although the larger two companies (IBM and Pixar) placed it in the context of a broader evolution of disciplines.

The combination of business skills with technical expertise was seen as very positive by all the participants. However, it was stressed that the technical expertise component needs to be sound in order for the program to work. “General competency must not leave out specific mastery,” said Randy Nelson (Pixar). “The student must be good at something... I would hire them only if they had a deep mastery, with breadth, communication skills, and collaboration.”

IBM has been systematically analyzing the evolution of selected relevant academic disciplines and degree programs for the past two years, and situated the PSM degree as one of several logical developments in the creation of degree programs seeking to adapt to changing business environments.

“The PSM degree is a band-aid step in the right direction,” said James Spohrer (IBM). “The real issue is the paradigm shift to service science.”

All companies said that university-industry collaboration was vital to the relevancy of curricula in general, and for the PSM program in particular. All said they would be interested in developing stronger relationships with local CSU campuses to accomplish this. However, it was stressed that the nature of the collaboration had to be a genuine partnership.

“I’d like to have a better relationship with CSU, but the way we connect is through networking, word of mouth. I wish I could get some kind of announcement of candidates, students graduating,” said Robert Anglea (PerMedics).

“To be sustainable you must have reciprocity with industry,” said Nelson (Pixar). “Reciprocity in a fundamental sense, not as an abstraction. Partnerships with industry will be expensive to the university; it will be their job to build relationships.”

All expressed some concerns about whether PSM programs would be adequately able to communicate what the degree is about with prospective industry partners and with prospective employers for their graduates.

“You need to be able to tell the story in an elevator,” said Nelson (Pixar). “Universities are really bad at this skill. They want to drag out the PowerPoint presentation and so on.”

Environmental Technology

Respondents:

Technology Forecasters Inc.

Tetra Tech Inc.

Neither participant had heard of the PSM program prior to being contacted by CCST.

Participants were very interested in the PSM program, as environmental technology is highly interdisciplinary and participants felt that few if any programs effectively trained environmental technology specialists for the business world. Internships are used frequently and high value was placed upon this feature of the PSM. (Note that the respondent from the Environmental Protection Agency, in the Government group, echoed these sentiments.)

Respondents felt that individual skills of an applicant would weigh more heavily than specific degree qualifications in terms of most hiring (other than Ph.D. level research positions). While PSM degrees would not automatically confer an advantage upon applicants, participants stated that the combination of skills would probably produce an attractive applicant.

It was noted that successful programs would have to be highly flexible and remain in contact with companies in order to remain relevant. There are regular meetings held by environmental technology associations and by a program at UC Berkeley where participants felt PSM programs could efficiently touch base with a variety of environmental technology companies. This would need to be an ongoing component of the PSM programs, according to participants.

It was also felt that a successful PSM program would need a custom-designed curriculum and new courses. Pam Gordon (Technology Forecasters) observed that despite several high-quality programs in California, including the one at the Donald Bren School of Environmental Science and Management at UCSB, none truly provides the breadth of background and experience necessary. Participants were not aware that there are several environmental science PSM programs in development around the state.

Overall, interest in the program was high, and respondents expressed a desire to participate.

Government

Respondents:

- CALTRANS Research and Innovation
- CALTRANS Economics
- Department of General Services (DGS)
- State Personnel Board
- California State Employees Association
- The Environmental Protection Agency

None of the participants had heard of the PSM program prior to being contacted by CCST.

Interest in the PSM was high among participants. “I liked the part about teamwork, communication and presentation skills,” said Scott Matthews (CEC). “We highly value those skills.” All respondents mentioned teamwork as a critical skill for working in government. One suggested that the PSM was designed more for industry than for government, but all indicated interest in hiring PSM degree recipients.

“In our agency I find that master’s level people with an applied orientation are often better than Ph.D.s,” said Richard Bode (EPA).

There are already channels of communication between the state government and the CSU, including the Hornet Foundation at the CSU (which assists in recruitment). The notion of aligning a PSM degree program curriculum with government needs did not seem challenging to respondents, provided that it “focuses on the basic tools”, said Don Dean (CALTRANS Research & Innovation). However, the ability of government departments to participate effectively in advisory boards was questioned by some.

The current hiring system, which depends on competitive examinations and is much less flexible than that of a typical private company, might pose an obstacle to introducing people with a new class of qualifications. However, two factors may mitigate these obstacles. The first is the use of internships, that can offer an edge: “Civil Service wants the testing but as soon as we start to know people [who are interns], preferences come to the top... Just being on the inside increases your chances,” said Shelly Langdon (State Personnel Board).

In addition, it was suggested that the PSM program would be ideal for senior staff. “In government, staff can take time off to go back to school – this is a great opportunity for professional development”, said Robert Wiswell (CALTRANS).

The other factor is the aging of the state’s workforce and difficulties in recruitment. This has been recognized by Governor Schwarzenegger’s California Performance Review (CPR) Taskforce, which includes a subcommittee assigned to take an extensive look at human resources.

5. OVERALL ANALYSIS

Respondents provided a wide range of feedback on the PSM programs, with some unanticipated differences among the sectors represented in the study. While the total sample size is neither random nor sufficient to count as a comprehensive and scientifically accurate assessment of potential need throughout California, the thoughtful contribution of many senior executives from California's high-tech sector does provide valuable insight into strengths and pitfalls of expanding the degree programs.

Principal perceived strengths of developing and expanding PSM degree programs:

- Any program increasing the overall number of STEM graduate degrees is perceived as positive
- Addition of business-related coursework is valuable
- Inclusion of internships is attractive, though dependent on program
- Companies welcome increased university-industry interaction (via advisory boards)
- PSM degrees are one of several logical and needed evolutionary steps in the development of interdisciplinary graduate degrees

Principal concerns expressed about developing and expanding PSM degree programs:

- Other ways to instill business skills in graduates may be preferable
- Degree may not be valuable to recipients
- Degree may not be portable
- Lack of the research thesis is a detriment for some companies
- PSM programs may not increase overall master's recipients, but siphon students from existing programs

The essential goal of the PSM program concept, to increase the quantity and quality of graduate degree recipients entering the STEM workforce, was strongly supported by most of the participants. Nearly all were well

aware of the inability of California's degree production to keep up with workforce demand. Many companies are conscious that they rely heavily on foreign graduates or graduates from California institutions who are not citizens, and express a desire to change this trend. Being able to hire California-native graduates offers several advantages: for companies in the Bay Area and San Diego, the high cost of living is a significant and growing obstacle to recruitment from elsewhere. For companies involved in defense-related research, particularly in San Diego, hiring non-citizens is not an option due to security clearance issues.

Most participants also acknowledged that the combination of skills produced by PSM programs is desirable. However, lack of business experience and, more specifically, an understanding of what jobs in STEM are actually like is a significant issue. Companies involved in interdisciplinary or emerging fields were particularly interested in fostering this combination of skills.

Many study participants expressed concerns as to whether or not a PSM program would be the best means of producing graduates with this combination of business acumen and technical skills. Some companies (mostly large, but also some small and medium companies) stated outright that they would prefer to teach these skills themselves, and that they would prefer a stronger technical skill base to start with. Many participants suggested that modifications could be made to existing degree programs, both at the graduate and undergraduate level, to provide some of the business and teamwork skills.

Questions were raised about whether or not PSM degree programs would result in a net increase in graduate degree recipients, or siphon off students from existing programs such as MBA programs or various STEM graduate programs.

There was a strong interest on the part of many companies in providing input into the curriculum of either a PSM program or an existing graduate or undergraduate degree program. The connection between industry and university was universally described as wanting, and companies are eager to provide input if they have the connections to do so. Many participants complained that such connections depend too much on personal relationships, and that there is no "clearinghouse" way of effectively connecting with the local universities. This was true even for those participants who actively participate in advisory boards at one or more local schools.

One of the most fundamental concerns raised was that of university-industry collaboration in general. Several participants across multiple sectors stated that effective university-industry collaboration would need to be ongoing and highly responsive, and requires better communication on the part of the universities in the establishment of such relationships. Companies are interested in giving genuine feedback, but many feel that too often they are only approached by universities when the universities are seeking tangible resources. More than one company stated they felt feedback provided to universities in the past has been ignored.

Government seems to have a different view and may require a different set of relationships because of how people are hired and what their responsibilities are. These conditions could vary by department.

Aside from the merits of the PSM degree program concept, several participants questioned whether the CSU was the right organization to implement and promote the degree program on a wide scale. This arose from concerns about CSU's limited budget and, in some cases, its limited reputation at the graduate level. While many companies enjoy a good relationship with one or more CSU campuses and highly value the graduates from some CSU programs, particularly in the Bay Area and San Diego, several people noted that a principal issue for the success of the PSM program would be a public relations issue. Since the PSM program is not widely known, many participants expressed a concern that PSM degrees would not be very "portable," offering limited value to PSM graduates seeking jobs elsewhere. In order for the degree to be successful, it would need a substantial boost in credibility. Some suggested that the University of California (UC) might be able to accomplish this more easily.

By economic sector, the most supportive of the PSM concept were the largest companies and those involved in interdisciplinary or emerging fields, including nanotechnology and environmental technology. While it is not surprising that large companies would generally be more favorably inclined to the PSM, it is noteworthy that several small companies (ten to twenty employees) also expressed interest. The environmental technology companies were strongly supportive of the concept, but asserted that entirely new curricula would be needed, rather than an amalgamation of existing coursework. Nanotechnology participants were supportive of the PSM concept and the skill set it encompasses. In short, the PSM's flexibility and adaptability is attractive to companies involved with emerging and/or interdisciplinary work.

It is worth noting that the largest three companies surveyed (IBM Almaden, SAIC, and Cubic) were all very supportive of the idea. IBM and SAIC have in fact been actively researching the evolution of academic disciplines and degree programs for some time and see the PSM degree as one component of a larger trend towards interdisciplinary degrees. These companies have the resources and the interest in examining the creation and implementation of degree programs such as the PSM and should be actively sought out as partners in the development of the programs.

Surprisingly, however, the biotechnology participants, both in the San Diego meeting and in phone interviews elsewhere throughout the state, were much less receptive to the concept. This is likely to be an area of significant concern for the CSU coalition as the programs being proposed are largely life sciences programs. It is noteworthy that there were many currently successful PSM programs in the life sciences, including the program at the Keck Graduate Institute of Applied Life Sciences (KGI). “Virtually all of our graduates are employed in that industry,” said former KGI President Henry Riggs. “On the other hand, we have had to do a great deal of missionary work to get potential employers to understand the nature of KGI’s education and the kinds of positions for which our graduates are qualified.”²⁴

While productive relationships may be feasible with biotechnology companies, our interviews did find their first reaction to the programs was significantly less positive than the first reactions of companies in other sectors we interviewed. Given this fact and the testimony of KGI, the message to take away from our interviews may be that more intensive efforts may be required to build support for PSM degree programs among biotechnology companies, a factor that should be taken into consideration by programs in this area. We recommend further research in this area; while the indications we have are of interest, there is clearly a need for a larger study to understand the potential need for Sloan model PSM programs in the state’s biotechnology sector.

²⁴ Henry Riggs, personal correspondence via email, 12/14/04

6. RECOMMENDATIONS

There are a few key messages underlying much of the feedback we received from study participants. The most significant finding is that most companies want a better relationship with universities, but feel that current connections are inefficient and do not permit meaningful interaction on issues such as curriculum development. Even those companies which currently participate in advisory boards for one or more universities cite a lack of effective interaction beyond the individual departmental level. We did find several examples of good university-industry interfaces, mostly in the Bay Area. However, there was clearly widespread interest in developing new kinds of partnerships that allow strategic planning on a higher level.

1. The PSM program must establish credibility in order to be accepted on a widespread basis.

Based on our results, we offer the following conclusions for the CSU:

Despite recent publicity in a variety of articles (Section 11) many had never heard of the PSM, and those who had did not have a clear perception of what the degree entailed. It was felt by many that the degree might not be portable beyond the region where the PSM degrees are produced, and even among companies within the region which are not part of the partnership developing the program.

“There will need to be a branding of the individual,” said Abelin (Cubic).

“The degree needs to be seen as a real addition to the STEM community.”

“Relevancy is important,” said Rockwood (SAIC). “Do these students have skills and relevant knowledge? If I don’t know these graduates exist, how will I find them?”

“The CSU PSM program will have to graduate high-quality students capable of competing with well established and reputable MS programs at other universities, including the UC system. Employers, particularly in the science and technology sector, will have to be convinced of the greater value of including more business training at the expense of some technical training,” said McGraw (Lawrence Livermore).

“Be persistent. Be in it for the long haul. Make a 5-year investment, maybe 10 years. It has to be funded... You must be clear on targeting and objectives,” said Srigley (AltaGen Biosciences).

“You must make sure the course work and faculty are up to speed. Train for today. Do not train for yesterday,” said Hubbard (NASA Ames).

“Be selective in your early candidate choices,” said Ganz (HRL Laboratories).

The two elements that companies identified as vital for establishing widespread credibility of PSM programs are making sure the programs are truly high-quality programs, and effectively branding the degree. To this end, the CSU would benefit most by the following:

- Supporting (at least initially) a smaller number of programs able to maintain a higher level of quality, in areas where the PSM has demonstrated success
- Offering statewide promotion of the degree at high-level venues where CSU interfaces with industry and the public

2. In order to succeed, the PSM must be targeted to industries where it is best suited.

The sectors targeted by this study were intended to provide a snapshot across a range of high technology business areas. A core motivation behind the promotion of PSM programs has been the fact that terminal master’s degrees in areas such as the life sciences are not as respected or widely sought as master’s degrees in engineering. However, not all life sciences companies were receptive to the idea of the PSM. Conversely, some sectors which are not considered ideal for PSM degrees saw a great deal of interest.

“This is a great opportunity for students to learn not only technology but also business collaboration... You can tell I’m enthusiastic about it,” said Pauksta (Palo Alto Research Center).

“In my experience, the PSM is not really an advantage to a graduate,” said Zorner (Diversa Corp.)

“The PSM program is very exciting. It could be done,” said Dean (CALTRANS Research & Innovation Division).

“The challenge is that post docs and Ph.D.s are relatively inexpensive. Why would you choose to hire a lower degree?” said Honeycutt (Invitrogen Life Technologies).

“I’d say if I was looking for an administrative person in a technical company, I’d rather have someone with a PSM degree,” said Anglea (PerMedics).

“Sure I’d hire a PSM graduate, especially from California,” said Chee (First Nano).

It is true that any PSM program being launched must establish a successful relationship with one or more companies. However, in order to be successful and credible, PSM programs must produce graduates that are considered employable by a range of companies in a given discipline. The results of the current study suggest the following:

Most likely to support PSM programs

- Large companies with multidisciplinary interests
- Companies with an interdisciplinary focus (e.g. environmental technology and nanotechnology)
- Government agencies

Least receptive to PSM program idea

- Biotech companies
- Highly specialized companies
- Specialty manufacturers

As noted previously, we recognize that there are many examples of successful life sciences PSM programs and of biotechnology companies that support them (e.g. Amgen and KGI). However, additional education and/or “missionary work” may be needed to establish these relationships and the credibility of the PSM in the biotechnology community.

3. Industry and universities need to develop better working relationships.

While many participants serve or have served in some advisory capacity for one or more local universities, all stated that there was room for improvement. Most connections presently are on a personal basis between faculty members and local companies; there is no way to connect at a higher level with institutions. Collaboration via advisory boards is a key component of PSM programs, but many companies indicated that this model needed to be expanded.

“I am serving on several advisory boards at UCLA, but I get more information on prospective interns from USC,” said Gau (GeneFluidics).

“As you filter for partners, you must look for those who see themselves as life-long learners,” said Nelson (Pixar). “Steer clear of those that aren’t in favor of innovation.”

“You can talk to faculty members, but when you get higher up... Deans and so forth usually only want to talk to me when they want something,” said Spohrer (IBM).

“As past treasurer of the Small Manufacturing Institute, I experienced CSU as an institution that would say ‘thanks,’ but then ignore all input. Put industry leaders on front end committees regarding both curriculum and assessment techniques,” said Ward (Crucible Partners).

In addition, the difficulty that CCST experienced in gaining the cooperation of companies to participate in the study, 25% of companies contacted, indicates that a great deal of work will be necessary to gain the involvement and trust of industry in these programs.

Several suggestions were raised as to how companies and universities should improve working relationships, and the quality of programs such as the PSM:

- Inviting guest speakers from industry on a regular basis
- Program heads attending industry association meetings
- Regional technology alliances serving as intermediaries

4. Statewide partnerships should be explored which best leverage the resources of the CSU.

The interviews raised the possibility of several partnerships between local CSU programs and interested companies. While several CSU programs would obviously benefit from such associations, we find that there is also room for higher-level collaboration with key companies.

“This system is not well organized [to find potential interns],” said Rockwood (SAIC).

“There are existing industry groups that could be leveraged. CSU could tap into these groups as a resource to fill in the gaps,” said Gordon (Technology Forecasters).

“A very active internship outreach will help the success of recruitment and placing graduates... I get more information now from the University of Singapore placement network than I do from the CSU,” said Nobi Kambe (NanoGram).

“There are problems for universities in placing students... The state of California needs to look at what it is providing overall, not just on a campus level,” said Gau (GeneFluidics).

Several participants mentioned the possible construction of statewide networks or contact points to facilitate placement of interns and publicizing the PSM degree. One of the most effective ways for the CSU to do this might be to assemble a statewide university-industry advisory board with companies that have the interest and the capability to bring substantial workforce needs analyses to the table. IBM and SAIC would be possible candidates for such a board.

Implementing a high-level advisory board between the Chancellor’s office and high-tech companies would offer several advantages:

- The ability to leverage substantial independent workforce needs analyses being conducted in the private sector
- The ability to offer a higher-level conduit for companies to offer feedback into the university systems, in a context where they do not feel pressured for resources
- The ability to provide meaningful high-level input into curriculum development, both in the PSM and in undergraduate programs

- An opportunity to leverage high-powered meetings into PR events which can be used to promote the PSM at minimal cost to the CSU

7. STUDY PARTICIPANTS

Company Contact/Title	Company	Location	Focus Group
Rick Srigley, President and CEO	AltaGen Bioscience Inc.	Morgan Hill	Bio/Nano/Info
Joe Monforte, VP and Chief Scientific Officer	Althea Technologies Inc.	San Diego	Biotech
G. B. Thornton, Managing Director & Exec VP of R&D	Apovia Inc.	San Diego	Biotech
Thomas Malott, Project Portfolio Manager	Bayer Corporation	Berkeley	Bio/Nano/Info
Kathleen O'Connor	California State Employees Association	Sacramento	Government
Robert Wiswell, Chief	CALTRANS Division of Aeronautics	Sacramento	Government
Don Dean	CALTRANS Research & Innovation Division	Sacramento	Government
Brad Ward	Crucible Partners	Burbank	Nanotech
Barbara Abelin, Director of HR	Cubic	San Diego	Telecom/Computer Science
Scott Matthews, Chief Deputy Director	California Energy Commission	Sacramento	Government
Paul Zorner, Senior Director of Business Corp.	Diversa Corporation	San Diego	Biotech
Tim Pappas	Entropic Communications, Inc.	San Diego	Telecom/Computer Science
Richard Bode, Chief	Environmental Protection Agency, Air Resources Board	Sacramento	Government
Cary Chee, CEO	First Nano, Inc.	Santa Barbara	Nanotech
Vincent Gau, CEO	GeneFluidics Inc.	Monterey Park	Nanotech
Arthur Levinson, CEO	Genentech	San Francisco	Bio/Nano/Info
Tina Nova, CEO	Genoptix, Inc.	San Diego	Biotech
Matthew Ganz, CEO	HRL Laboratories	Malibu	Computer Science
James Spohrer, Director Almaden Services Research	IBM Almaden	San Jose	Computer Science
Alan Honeycutt	Invitrogen Corp.	Carlsbad	Biotech

STUDY PARTICIPANTS CONTINUED

Company Contact/Title	Company	Location	Focus Group
Charles Castellano	NASA Ames Research Center	Moffett Field	Bio/Nano/Info
Kevin Gorman, Senior VP Business Development	Neurocrine Biosciences Inc.	San Diego	Biotech
Marc Bernstein, President and Center Director	Palo Alto Research Center	Palo Alto	Computer Science
Robert Anglea, President	PerMedics Inc.	Loma Linda	Computer Science
Randy Nelson	Pixar Animation Studios	Emeryville	Computer Science
Stephen Rockwood, Exec. VP and Chief Technology Officer	Science Applications International Corporation (SAIC)	San Diego	Telecom/Computer Science
Shelly Langdon, Manager	State Personnel Board, Test Validation & Construction and Technical Training	Sacramento	Government
Lee Fisher, Director	Tanner Labs	Pasadena	Nanotech
Pam Gordon, President	Technology Forecasters Inc.	Alameda	Environmental Tech
Gary Floyd, Principal Scientist	Tetra Tech Inc.	San Francisco	Environmental Tech



Figure 5. Geographic Distribution of Participating Companies

8. COMPANIES CONTACTED

Company	Location	Focus Group
3Com Corporation	Santa Clara	Computer Science
Abgenix Inc.	Fremont	Nanotech
Adobe Systems	San Jose	Computer Science
Affymax	Palo Alto	Biotech
Affymetrix, Inc.	Santa Clara	Biotech
Aguila Technologies	San Marcos	Specialty Manufacturing
Alameda Center for Environmental Technologies	Alameda	Environmental Tech
Alliance Pharmaceuticals	San Diego	Biotech
Allied Environmental Technologies Inc.	Huntington Beach	Environmental Tech
AltaGen Bioscience Inc.	Morgan Hill	Bio/Nano/Info
Althea Technologies Inc.	San Diego	Biotech
ALZA Corporation	Mountain View	Biotech
Ambit Biosciences Corp.	San Diego	Biotech
Amgen San Francisco	South San Francisco	Bio/Nano/Info
Apovia Inc.	San Diego	Biotech
Apple Computer	Cupertino	Computer Science
Applied Biosystems	Foster City	Bio/Nano/Info
Applied Micro Circuits Corporation	San Diego	Telecom/Computer Science
Applied Molecular Evolution	San Diego	Biotech
Asylum Research Inc.	Santa Barbara	Nanotech
Avanir Pharmaceuticals	San Diego	Biotech
Aventis Crop Science		Agricultural Biotech
Avigen, Inc.	Alameda	Bio/Nano/Info
Bayer Corporation	Berkeley	Bio/Nano/Info
Bayview Environmental Services	Oakland	Environmental Tech
Bechtel, Inc.	San Francisco	Environmental Tech
Berlex Inc.	Richmond	Bio/Nano/Info
Bio-Rad	Hercules	Bio/Nano/Info
Biodot Inc.	Irvine	Specialty Manufacturing

Company	Location	Focus Group
Biogen Idec	San Diego	Biotech
Biosource International, Inc.	Camarillo	Nanotech
Broadley-James Corporation	Irvine	Biotech
Calgene Inc.	Davis	Agricultural Biotech
California Pacific Medical Care Research Institute	San Francisco	Bio/Nano/Info
California State Employees Association	Sacramento	Government
Calmont Wire and Cable Inc.	Santa Ana	Specialty Manufacturing
CALTRANS Division of Aeronautics	Sacramento	Government
CALTRANS Research & Innovation Division	Sacramento	Government
Celera AgGen	Davis	Agricultural Biotech
Cell Genesys, Inc.	South San Francisco	Bio/Nano/Info
ChevronTexaco Corp.	San Ramon	Environmental Tech
Chiron Corporation	Emeryville	Bio/Nano/Info
Ciphergen Biosystems, Inc.	Fremont	Bio/Nano/Info
Cisco Systems Inc.	San Jose	Computer Science
Clean Cut Technologies, LLC	Fullerton	Specialty Manufacturing
CNET Networks Inc.	San Francisco	Computer Science
Crucible Partners	Burbank	Nanotech
Cubic	San Diego	Telecom/Computer Science
Department of General Services, Telecommunications Division	Sacramento	Government
Diversa Corporation	San Diego	Biotech
Dow Agrosciences		Agricultural Biotech
Elan Pharmaceuticals	San Diego	Biotech
Elan Pharmaceuticals	San Francisco	Bio/Nano/Info
Electrolizing, Inc.	Los Angeles	Specialty Manufacturing
Entropic Communications, Inc.	San Diego	Telecom/Computer Science

Company	Location	Focus Group
Entropic Communications, Inc.	San Diego	Telecom/Computer Science
Environ	Mountain View	Environmental Tech
Environmental Protection Agency, Air Resources Board	Sacramento	Government
First Nano, Inc.	Santa Barbara	Nanotech
GeneFluidics Inc.	Monterey Park	Nanotech
Genencor International Inc.	Palo Alto	Environmental Tech
Genentech	San Francisco	Bio/Nano/Info
General Atomics	San Diego	Telecom/Computer Science
Genoptix, Inc.	San Diego	Biotech
Gen-Probe	San Diego	Biotech
Gilead Sciences	Foster City	Bio/Nano/Info
Google	Mountain View	Computer Science
Guidant	Temecula	Specialty Manufacturing
Hewlett Packard	Palo Alto	Computer Science
HRL Laboratories	Malibu	Computer Science
IBM Almaden	San Jose	Computer Science
Icoria, Inc.	Research Triangle Park, NC	Agricultural Biotech
Idun Pharmaceuticals	San Diego	Biotech
Insert Therapeutics, Inc.	Pasadena	Nanotech
International Rectifier Corporation	El Segundo	Specialty Manufacturing
Invitrogen Corp.	Carlsbad	Biotech
Isis Pharmaceuticals	Carlsbad	Biotech
Johnson Laminating	Carson	Specialty Manufacturing
Kyocera Wireless Corp.	San Diego	Telecom/Computer Science
Lawrence Livermore National Laboratory (LLNL)	Livermore	Bio/Nano/Info
LifeMed of California	Anaheim	Specialty Manufacturing
Ligand Pharmaceuticals	San Diego	Biotech

Company	Location	Focus Group
Lockheed-Martin	Sunnyvale	Bio/Nano/Info
Lucasfilm	San Rafael	Computer Science
Macromedia	San Francisco	Computer Science
Magtek	Carson	Specialty Manufacturing
MATERIA	Pasadena	Nanotech
Material Methods, LLC	Newport Beach	Nanotech
Maxygen Inc.	Redwood City	Environmental Tech
Microfabrica Inc.	Burbank	Nanotech
Microsoft's Telepresence Research Group	San Francisco	Computer Science
Mil-Ram Technology, Inc.	Fremont	Environmental Tech
Monsanto Company	Martinez	Agricultural Biotech
Motorola, Inc.	San Diego	Telecom/Computer Science
NanoGram Corporation	San Jose	Bio/Nano/Info
Nanomix Inc.	Emeryville	Bio/Nano/Info
NanoSIG	Palo Alto	Bio/Nano/Info
NanoSolar	Newbury Park	Nanotech
NANOSTREAM INC.	Pasadena	Nanotech
NASA Ames Research Center	Moffett Field	Bio/Nano/Info
NASSCO	San Diego	Telecom/Computer Science
National Wire & Cable Corporation	Los Angeles	Specialty Manufacturing
Neurocrine Biosciences Inc.	San Diego	Biotech
Nokia Inc.	San Diego	Telecom/Computer Science
NOVA	Sunnyvale	Bio/Nano/Info
Opto Diode Corporation	Newbury Park	Specialty Manufacturing
Oracle	Redwood Shores	Computer Science
Orchid BioSciences	Princeton, NJ	Agricultural Biotech
Pacific Gas & Electric	San Francisco	Environmental Tech
Palo Alto Research Center	Palo Alto	Computer Science

Company	Location	Focus Group
PeopleSoft Inc.	Pleasanton	Computer Science
Peregrine Semiconductor Corp.	San Diego	Telecom/Computer Science
PerMedics Inc.	Loma Linda	Computer Science
Pfizer La Jolla	San Diego	Biotech
Pixar Animation Studios	Emeryville	Computer Science
Plastic & Metal Center, Inc.	Laguna Hills	Specialty Manufacturing
Precision Sampling, Inc.	Richmond	Environmental Tech
Pulse LINK	Carlsbad	Telecom/Computer Science
Qual-Pro rop.	Carson	Specialty Manufacturing
QUALCOMM, Inc.	San Diego	Telecom/Computer Science
Roche Molecular Systems	Pleasanton	Bio/Nano/Info
Sanyo	Carson	Specialty Manufacturing
Science Applications International Corporation (SAIC)	San Diego	Telecom/Computer Science
Semiconductor Industry Association (SIA)	San Jose	Specialty Manufacturing
SGX (Structural Genomix)	San Diego	Biotech
Sierra Environmental Technologies	Watsonville	Environmental Tech
Silicon Graphics	Mountain View	Computer Science
Sony Electronics Inc.	San Diego	Telecom/Computer Science
SRI International	Menlo Park	Environmental Tech
Staccato Communications	San Diego	Telecom/Computer Science
State Personnel Board, Test Validation & Construction and Technical Training	Sacramento	Government
SubTerra LLC	White Pine, MI	Agricultural Biotech
Sun Microsystems Inc.	Santa Clara	Computer Science
Symantec Corporation	Cupertino	Computer Science

Company	Location	Focus Group
Syngenta Crop Protection USA	Greenboro, NC	Agricultural Biotech
Tanner Labs	Pasadena	Nanotech
Technical Safety Services Inc.	Berkeley	Environmental Tech
Technology Forecasters Inc.	Alameda	Environmental Tech
Tetra Tech Inc.	San Francisco	Environmental Tech
Thin Film Technology, Inc.	Buelleton	Specialty Manufacturing
Tridus Manufacturing Inc.	Rancho Dominguez	Specialty Manufacturing
ViaSat	Carlsbad	Telecom/Computer Science
Viking Rubber Products Inc.	Brea	Specialty Manufacturing
Watson Pharmaceuticals	Corona	Specialty Manufacturing
Women's Technology Center	San Francisco	Environmental Tech
Yahoo!	Sunnyvale	Computer Science

9. BACKGROUND INFORMATION SHARED WITH PARTICIPANTS

The following was shared with all study participants prior to the meetings and interviews via fax, email attachment, and a temporary webpage added to the CCST website. The description was developed in conjunction with the CSU campus coalition.

A brief description of the PSM

Professional science master's (PSM) programs are designed to prepare graduates for entry-level professional positions in business, government, and non-profit employment sectors which are engaged in the application of science and technology. PSM programs are available in science, mathematics and interdisciplinary science/math-based areas. They generally consist of a core of advanced work in the discipline or an interdisciplinary area, augmented by work in information technology and related disciplines. They also include short courses or modules that expose students to fundamental elements such as business basics, intellectual property law, teamwork, communication/presentation skills, and project management. In addition, PSM programs require a significant internship in a relevant environment. PSM programs aim at providing an intense, discipline-specific education coupled with the management skills necessary in today's environment.

The concept of a "professional" master's degree in science results from recognition that science and technology workers may need new kinds or combinations of skills to perform well in the corporations, institutions and agencies of the 21st century. Science and technology have advanced at the fastest rates in history, but ways of working for technical employees has changed even more. Teamwork, often multidisciplinary and inter-functional, is now the norm. Individual contributors with a very narrow focus, while still important, are increasingly compelled to work on teams, especially in organizations that develop cutting edge products or engage in multi-faceted applied research.

Professional science master's (PSM) degree programs are intended to prepare scientists for work in the corporate/institutional environment, work that has a technological basis but which may not be research oriented per se. The PSM is not intended as a replacement for the Ph.D. nor is it a "Ph.D.-lite". The traditional Master of Science degree

programs, whether a terminal degree program or a consolation prize for those who couldn't complete a Ph.D., were designed to give the Bachelor of Science additional concentrated study in a sub-discipline of the field and some exposure to laboratory (or field) research. A PSM program, however, broadens rather than narrows the study of technical disciplines to include other areas and/or add the disciplines of management science and interpersonal/teamwork skills.

Nor is a PSM program a substitute for a MBA since it is grounded in science and technology and prepares the graduate for a career in a technology based endeavor not general management *per se*. The graduate of an effective PSM program will have a) more depth in the scientific area of sub-specialty beyond the typical BS, b) exposure to or knowledge of other technical disciplines, and c) familiarity with the elements of management, business issues and teamwork that are vital to the success of today's institutions.

10. FOCUS GROUP MODERATOR GUIDE

A. Introduction

1. *Who we are*

Let's begin by introducing ourselves to each other. I'll begin with myself... please tell us your name, what industry you are from, and whether your company hires, or is likely to hire, employees with master's degrees.

2. *Who is CCST?*

The California Council on Science and Technology (CCST) is a nonpartisan, impartial, not-for-profit corporation created in 1988 by Assembly Concurrent Resolution 162. CCST is designed to offer expert advice to the state and provide solutions to science and technology-related public policy issues. The strength of CCST lies in its representation, both by its sustaining institutions, the University of California, the California State University, California Institute of Technology, Stanford University, University of Southern California, and the California Community Colleges and by having strong connections to industry through its membership.

CCST has a proven record of accomplishment in providing timely, impartial analyses of complex issues for the legislative and executive branches of government. Key projects include the 2002 "Critical Path Analysis of California's Science and Technology Education System," as well as a variety of education-related projects currently underway.

3. *What we are doing here?*

California's shortage of qualified science and technology graduates was well documented by the "Critical Path Analysis." One of the many suggestions made in that report was to consider instituting a new type of master's degree program to produce a different class of science and technology experts. The "professional science master's" (PSM) degree suggested by CCST in that report is strongly supported by the Alfred P. Sloan Foundation. Over 95 PSM degree programs have been implemented at over 45 institutions in 20 states. Now, CCST is responding to a request from California State University Chancellor Charles Reed to explore the feasibility of implementing such degree programs over 15 CSU campuses, making this a potentially major initiative for the CSU.

A group of 15 CSU campuses has obtained a planning grant from the Sloan Foundation to establish whether and how PSM programs could be established in participating campuses throughout the state. The CSU proposal would mark the first time that the PSM degree would be introduced on a system-wide basis throughout a state.

This meeting is one of several being conducted by CCST throughout the state to evaluate industry need and interest in PSM programs.

4. Expectations

B. Background of PSM

Handouts:

- PSM background and overview (Sloan Foundation)
- Articles on PSM from USA Today, The Scientist, and the Wall Street Journal
- Map showing participating campuses in the PSM project in California

PSM programs are designed to prepare graduates for entry-level professional positions in business, government, and non-profit employment sectors. PSM programs generally consist of a core of advanced work in the discipline or an interdisciplinary area, augmented by work in information technology and related disciplines. They also include short courses or modules that expose students to fundamental elements of business environments, such as business basics, intellectual property law, teamwork, communication/presentation skills, and project management.

1. What is a PSM Program?

- (a) How does it differ from a Masters of Engineering (ME)?

Unlike ME degrees, PSM programs also include short courses or modules that expose students to fundamental elements of business environments, such as business basics, intellectual property law, teamwork, communication/presentation skills, and project management.

- (b) Include references to student internships, practitioner instructors and advisory boards

Student internships in a business environment are a required part of PSM programs.

2. *History*

(a) Skills concentrated upon

Many PSM programs have been designed to respond to workforce needs in the life sciences, where the master's degree alone is not a widely sought qualification. However, there have been PSM programs in disciplines ranging from nanotechnology to information sciences to industrial mathematics. A list of current programs is provided.

(b) Where and by whom

In California, see enclosed map. In the Bay Area, programs include bioinformatics, biotechnology, applied physics, applied ecology, pharmacogenomics, molecular diagnostics, industrial mathematics, and clinical research management.

(c) Participation of industry in identifying skills needed and course content

(d) Graduates produced (number and placement)

To date, approximately 400 PSM graduates have entered the workforce nationwide. Comprehensive data on placement are not available, although results from individual programs such as the Keck Graduate Institute of Life Science have been positive.

Are you familiar with the PSM program concept? Experience? What has been your experience?

(e) Historic reactions / outcomes (whatever is known so far)

- (1) Workplace
- (2) Government
- (3) Universities

C. Description of the Proposed Program

The programs will vary from campus to campus and be developed in conjunction with the results of the current study. Each prospective program will identify members for an advisory board composed of representatives from local industry and the campus' faculty. The function of this board will be to advise the program on all its affairs (e.g. financing, student recruitment, establishing points of contact within the industry,

securing internship positions for the students, and advertising. The board will also address important issues such as the financial health of the program, its long-term sustainability, long-term maintenance of industry interest in the program, and adaptation of the program to changes in the business environment.

D. Idea Generation for Future Programs

1. How can CSU align PSM programs with industry?

At this point I would like to throw out a few questions about how CSU can align PSM curricula with industry. A professional science master's program must answer the needs of local industry, so let's talk about whom should talk with whom...

- (a) Regarding the coordination of **program content**... How can the program be structured so that course content always keeps up with industry needs?
 - (1) How do we identify 'best practices' that can be brought into curriculum content?
- (b) In developing program content, should CSU align with the high-tech **industry clusters** that are developing in your area?
 - (1) Which ones?
 - (2) What about a new industry that might not show up ... cross-overs between clusters or supply chains, for example?
 - (3) Should these connections be made via business associations or unions? Who is the best collaborator for this?
- (c) Before we leave the topic of program content, are there any potential problems that you foresee that we haven't talked about yet?

2. What would a CSU / PSM employment coordination system look like?

A CSU / PSM system that is fully coordinated with industry is able to place students in regional high technology jobs statewide. Let's talk about existing connections for **recruiting**.

- (a) How do you recruit from the colleges? When you hire, is a degree important to you or do you seek specific skills that may not require a degree?
- (b) What recruiting resources are currently being used by industry?

- (c) What are the current limitations? How can they be improved?
What new system(s) could be implemented?
- (d) How can we design a program that will help you get PSM students when you need them?

3. Current and future demand for PSM

What can we do to ensure the success of the PSM program? (Prompts may include some of the following)

- Transparency
- Developing in context with local & corporate needs
- Tight collaboration
- Specificity of course content
- Tight with best practices in industry
- Accessible and flexible for companies
- Timely and reliable production of educated talent

- (a) What will create a demand for PSM graduates in the next 5 years?
- (b) Would widespread availability of PSM graduates affect this demand?
- (c) Would you consider hiring a PSM graduate today if you could get one from an appropriate degree program? Would an MA with improved PSM-related skills (**such as...**) benefit your company? How?

4. What resources can industry provide?

Are you willing to be a pioneer in this new endeavor?

- (a) (**describe internship... are they paid?**) Would you consider providing an internship for PSM students?
- (b) (**Describe advisory board commitment... paid per diem?**) Would you be willing to serve on an advisory board to a PSM program?

E. Closure

Appreciation

Report available to those who want it

Future contact

For those who indicate interest

11. SAMPLE INVITATION LETTER

<<DATE>>

Dear <<NAME>>,

The California Council on Science and Technology (CCST), in collaboration with <<LOCAL ORGANIZATION>>, would like to invite you to participate in a focus group meeting to discuss a new kind of master's degree program that may be relevant to your company.

CCST has been asked by California State University (CSU) Chancellor Charles Reed to assist the CSU System analyze the need for new Professional Science Master's (PSM) degree programs. As part of this process, CCST will be holding a series of meetings throughout the state with representatives from key high-tech industries to discuss need and level of interest for a potential widespread implementation of such degree programs.

The Professional Science Master's (PSM) is a new professional MS degree in science or mathematics for students interested in a wider variety of career options than that provided by current graduate programs in these two areas. The programs are open to bachelor's degree holders in the sciences, mathematics, or engineering. These programs consist of two years of training in an emerging or interdisciplinary area. Many include internships and "cross-training" in business and communications. The CSU is investigating the benefits of and level of interest in making PSM degree programs more widely available. The <<NUMBER>> meeting, on <<DATE>> at <<TIME>> at the <<LOCATION>>, will consist of companies involved with <<SECTOR>>.

For this focus group, we are looking for industry executives who are in a position to look beyond existing job categories and constructively evaluate potential new roles (or expansion of existing roles) that PSM degree holders could fill in their companies. The discussion will take no more than 1 1/2 hours and will focus on specific parameters of the degrees and how and whether PSM recipients might meet actual or

potential skilled employee needs of participating industries. A total of approximately 5-10 executives are scheduled to participate in each meeting.

CCST is a nonpartisan, impartial, not-for-profit corporation created in 1988 by Assembly Concurrent Resolution 162, designed to offer expert advice to the state and provide solutions to science and technology-related public policy issues. CCST has a proven record of accomplishment in providing timely, impartial analyses of complex issues for the legislative and executive branches of government, including its 2002 report, *Critical Path Analysis of California's Science and Technology Education System*, and its 2004 report, *Nanoscience and Nanotechnology: Opportunities and Challenges for California*, presented to the Joint Committee on Preparing California for the 21st Century.

This is an excellent opportunity for your company to participate in a study that will help shape the future of California's workforce. Participating in this focus group does not oblige you or your company in any way to endorse or support PSM programs or the CSU system. We are simply looking for valuable input from companies such as yours on a potential new direction for high-tech higher education opportunities. If you are not personally able to attend, we would welcome another suitable representative from your company.

We look forward to hearing from you, and would be happy to answer any questions which you may have. I can be reached at (951) 682-8701 or hackwood@ccst.us.

Sincerely,

Susan Hackwood
Executive Director

12. RECENT ARTICLES

The Economic Times – Times News Network

MBA is out, MBS is in by Candice Zachariahs

August 9, 2004

This article points out two facts. The first is that science and mathematics graduates don't naturally move into Ph.D. programs, and the second is that the world of business is becoming increasingly scientific. It reviews the pathways that several students have taken and the benefits of their PSM degrees. Keck Graduate Institute is cited as "an extraordinary example of the PSM."

The Wall Street Journal

August 3, 2004

Science Master's For Business Draws Critics by Nishad H. Majmudar

Schools that offer doctoral degrees have a hard time accepting PSM students. Their belief is that the standards of graduate sciences courses appear to be watered down. Some Ivy League schools have declined the offer of introducing PSM programs into their curriculum. For these schools, master's degrees would still be considered a consolation prize even though that was the original intent.

Triangle Business Journal

July 30, 2004

NCSU Leads UNC System in Granting New PSM Degrees by Leo John

A number of schools within the University of North Carolina System are beginning professional science master's degrees. In 2003, North Carolina State University became the first to offer these programs. The original seven students have secured internships at the Triangle companies and an additional seven have signed up to join the curriculum in 2004.

USA Today

July 19, 2004

Add Science, Business, Mathematics and Stir by Del Jones

PSM degrees are as yet an unknown commodity; many recruiters are not familiar with PSM programs, coursework or graduate capabilities. This article offers testimonies from several PSM graduates, and their success stories. Also quoted are several industry representatives who were originally unaware of PSM programs but who can see the possibility of these graduates as filling a niche in their organizations.

Tribune News Services

May 5, 2004

New Degree Replaces MBA as a 'Sure Thing' for Job Security by Jennifer Tobia

The MBA is a degree of the past. The belief that an MBA will open doors in the business world is no longer valid. Sheila Tobias has provided a detailed description of the PSM programs, expectations for potential students and success stories.

Perspectives Online

Spring 2004 Issue

On the Forefront by Terri Leith

A magazine produced by North Carolina State University's College of Agricultural and Life Sciences. This article reports on the efforts, progress and success achieved by NCSU. A special course dealing with case-studies is a focal point of their program. Three case-studies are explained.

The Scientist

February 2, 2004

Save Money, Hire Masters by Joanna Krotz

Current trends are slowly shifting to hiring master's graduates rather than Ph.D.s for several reasons. Master's are cheaper, they have a broader mix of skills, have been taught to work in a team and they consider time as a factor. The new master's degrees are slowly revising the concept that to receive a master's degree is to fail at receiving a Ph.D.

Science Magazine

September 26, 2003

*Career Opportunities and Graduate Programs for BS/MS Scientists
Predoctoral Possibilities* by Mike May

A bachelor's or master's degree alone can lead to many options in academics, biotechnology, and industry. In some cases, an undergraduate degree can even launch an employee high into management, in fact, many scientists find positions without a doctorate.

The Chronicle of Higher Education

August 15, 2003

The Scientist as Entrepreneur by Chris Woolston

Tracking the plan of scientist Irina Shiyankovskaya and her husband after she left her research position to enter a PSM program. Her goal was to create a business plan to market a photonic device they created. Becoming an entrepreneur would have been difficult without the additional knowledge gained through the PSM program.

Science Record

Summer 2003

A Master's Degree for the 21st Century by Bob Demyan

Oregon State University (OSU) summary of programs started with Sloan Foundation funding. OSU hopes the PSM degrees will be seen as the scientific equivalent of the MBA. They are optimistic that the PSM programs will help Oregon to increase its reputation as a technologically advanced state.

The Chronicle of Higher Education

June 17, 2003

Reviving a 'Lesser' Degree in the Sciences by Chris Woolston

The PSM degree offers an alternative to those students who simply don't want a Ph.D. Prior to the PSM programs, choices were limited to enrolling in a Ph.D. and quitting once a master's degree was accomplished, or simply working to achieve a master's and then trying to find your niche in industry.

Physics Today

June 2003

Masters in the Field by Toni Feder

According to the American Institute of Physics, physics bachelor's degree recipients who earn a master's degree in any math, science, or engineering field have higher salaries and a greater appreciation of their undergraduate training than their counterparts with only a bachelor's.

Council of Graduate Students Communicator

March 2003

Higher Education and the Diversity Initiative

Graduate program statistics are reported including detailed data by citizenship, minority groups, degrees granted (1990-2000), degrees granted by field, and specific data on STEM fields.

Financial Engineering News

June/July 2002

Financial Engineering Education: a Survey of Educational Programs in Financial Engineering by Jim Finnegan

Financial engineering programs are being redefined to produce graduates that can fill a new role in industry sectors. The financial engineering curriculum has merged with business coursework to evolve into programs that produce graduates who are qualified to enter the workforce and fulfill the future leadership models required by today's financial firms. Included are summaries of 29 programs from the U.S., Canada, and other countries. Summaries include program size, descriptions, duration and degrees, graduate career paths, unique features, and contact information.

Notice of the American Mathematical Society

May 2001

The Growth of the Professional Master's in Mathematics by Sheila Tobias, Charles MacCluer and Ralph Svetic

This article chronicles the development of specialized master's degrees in the mathematics field including defining the problems and needs of mathematics graduates, reinventing the master's degree and the role

that various organizations took in developing these advanced degrees. Potential problems include quality control, funding, and how well graduates actually do in the job market.

The Arizona Daily Star

January 28, 2000

UA Science College Creating Master's for Industry by Sarah Garrecht Gassen

Industry lacks people who can apply physics or biology in a practical manner. The University of Arizona (UA) is starting programs that will help industry fulfill its needs and hopefully strengthen the science programs that UA currently offers.

Physics Today

June 1999, Volume 52, Number 6, Pages 54-55

Professional Master's Degrees Promise Quicker Entry Into Jobs by Jean Kumagai

This article was written at the beginning stages of the creation of the PSM programs. It provides an optimistic viewpoint of what PSM graduates will be viewed as and what they will hope to achieve once they receive their degree. PSMs are seen as a step forward in graduate education reform. Ph.D. programs are concerned that the PSM students will be pulled away from the Ph.D. path and will result in reduced numbers of candidates who go on to achieve a Ph.D. Another concern is how students will pay for PSM programs; will students have to pay the price or will teaching assistantships be developed?

FORUMS, PRESENTATIONS AND REPORTS

Rethinking Science as a Career

1995

Sheila Tobias, Daryl E. Chubin and Kevin Aylesworth

This book seeks to answer the question "How can a nation seek to balance the supply and sustain demand for scientifically trained professionals." The authors look at past cycles, review trends in scientific degrees, and examine scientist supply and job market demand for graduates. It suggests the PSM as an alternative to the Ph.D.

The Conference Board

2003

New Career Paths for Science-Trained Professionals by Cassandra Simmons

A survey of PSM graduates was performed to ascertain how they became aware of the PSM programs, the result of their job search, where they are currently working and evaluation of the program they attended. The second half of this paper focuses on the employers' perspectives. A forum was held with industry representatives in conjunction with the New Jersey Institute of Technology. The forum allowed industry representatives to describe their needs as well as presenting the academic programs. Recommendations for graduates, PSM program coordinators, and academic institutions were presented.

The Conference Board

May 8, 2003

New Master's Degree Program Helps Grads Land Hard-to-get High Tech Jobs

The Conference Board partnered with the Sloan Foundation to perform a study of the professional science master's degrees. This article summarizes the findings from the *New Career Paths for Science-Trained Professionals* forum.

Bureau of National Affairs, Inc.

June 23, 2003

Human Resources Report by Larry Silver

Half of PSM graduates are not certain if their employers value their degree. The value of the PSM programs depends upon industry recognition and increased university/corporation partnerships. Students need not only subject area knowledge but must be able to learn the rules of business.

Council on Competitiveness (COC)

December 2003

President's Letter

The Council on Competitiveness launched an awareness campaign on the importance of Professional Science Master's degrees to U.S. competitiveness. President Deborah Wince-Smith testified before the President's Council of Advisors on Science and Technology on the business case for the PSM. COC has found that the PSM programs are

growing, the graduates are getting jobs in their chosen fields and there exists a leveraging of national talent (33% of the first PSM classes have been female). COC plans to raise visibility among business leaders, promote industry-university dialogs to leverage the PSM option to support specialized regional talent and needs, and recommend that federal sources of support be used for PSM programs.

National ACS Meeting

March 2003

Symposium Report – The Master’s Degree – Its Many Faces and Objectives

Part I looks at the traditional master’s degree customarily offered in chemistry departments throughout the U.S., part II discusses new initiatives, particularly Sloan Foundation programs, and part III discusses the potential master’s degree programs via distance education. Presentations were made by academic institution representatives, Sheila Tobias from the Sloan Foundation, and an industry representative from Proctor & Gamble Company.

The Commission on Professions in Science and Technology

October 2-3, 2003

Conference – Master’s Education in the Sciences and Mathematics: Its Value, Importance and Growth

Presentations were made by the Commission on Professionals in Science and Technology (CPST), the Council of Graduate Students (CGS), the Council on Competitiveness (COC) and by Judith Glazer-Raymo. CPST is conducting a series of coordinated activities in an effort to address the value, importance and growth in master’s education in the sciences and mathematics, particularly in the emergence of the PSM degree. CGS is working to expand the PSM initiative to include master’s focused institutions. The COC has undertaken the effort to raise awareness of the PSM degree within the policy community through the Council’s National and Regional Innovation Programs. Judith Glazer-Raymo concludes that the PSM is evolving as an entrepreneurial credential that has the potential to alter the direction of graduate education in the sciences.

Council of Graduate Schools Communicator

March 2004

Trajectories for Professional Master's Education by Judith Glazer-Raymo

Highlights from a plenary address given at the Council of Graduate Schools (CGS) Annual Meeting in San Francisco on December 6, 2003. The master's degree is becoming increasingly professional and this trend is projected to continue into the future. The PSM program is mentioned as one of the programs which the CGS has helped shape and develop in conjunction with the Sloan Foundation since 1997.

Women Chemists

Spring 2003

The Many Faces of the Master's Degree by Eleanor M. Brown

Summary of the 225th American Chemical Society National Meeting, March 23-27, 2003.

The Commission on Professionals in Science and Technology

Science Master's Education Surveys

Surveys were performed by the American Geological Institute, the Society for Industrial and Applied Mathematics and the Society for Industrial Microbiology. Educational departments were surveyed and data was collected on master's programs in the geosciences, applied mathematics fields and microbiology/biotechnology. Graduates from 12 institutions were also surveyed regarding their decision-making process, job search, educational financing and employment status.

American Institute of Physics

2001

Masters Physics for Non-Academic Careers by Stephen D. Norton, Philip W. Hammer and Roman Czujko

This study involves a detailed analysis of all master's programs in physics departments in the U.S. including both those offering a master's as their highest physics degree and those having a master's degree program running in parallel with a Ph.D. program.

13. MEETING TRANSCRIPTS

PSM Focus Group
October 28, 2004
Bay Area Economic Forum
9:30 am
Bio/Nano/Information Systems

Attendees:

Mr. Bo Varga, President, NanoSIG

Dr. Nobi Kambe, Nanogram

Dr. James McGraw, Deputy Director, ISCR, Lawrence Livermore National Lab

Dr. Chuck Castellano, Director of R&D Programs, Bay Area Economic Forum and representative for NASA Ames Research Center

Moderator: Victoria Koehler Jones, Consultant

CCST Staff: M. Daniel DeCillis, Research Associate

Donna King, Executive Assistant

CSU Representative: Stephan Crothers

Introductions were made and a brief description of CCST was given. The goals of the project were outlined and the expectations of the focus group were provided. Background information was provided on the PSM programs, how they differ from other programs, the internship component, workforce needs, and statistics on graduates.

How can CSU align PSM programs with industry? In developing program content, should CSU align with the high-tech industry clusters that are developing in your area?

A connection to industry and the academic community needs to be developed that can adjust to answer those needs.

McGraw - There needs to be joint research projects with current experts to help identify and outline the needed curriculum. People who can actually say what will be needed over the next five years need to be

identified. LLNL can identify those people in their organization that would be best suited to answer this question. In the nano/biosciences area, Ph.D.s are currently doing the work.

Kambe – Nanogram currently has two Singapore graduate students as a result of international networking. They are current graduate students attending Stanford business courses to gain business background. It is important to include a lot of interaction with industries. Nano is a multidisciplinary area; it requires new hires to obtain a wide range of academic basis including both science and business. Management of Technology is a structure used in Tokyo where students are invited to intern and work with companies. This offers a mutual attraction for both sides.

Castellano – The current mentality is that you hire a Ph.D. for the purpose of research. There is usually a narrow focus and scope to the job and you strive to hire the brightest and best. NASA can provide a network to support superstars in technology. They have a set of highly trained scientists who can function in a business world. Industry clusters or individual industries offer few avenues for a broad organization or system cluster. Companies don't normally band together for education purposes.

McGraw - Program content and general curriculum must be flexible and must have depth. LLNL is not interested so much in business since it provides its own training. An interdisciplinary background and teamwork are very important. As people work in teams they are also mentored and do mentoring in teams. This is a very valuable aspect to working at LLNL. LLNL would be happy to look at proposed curriculum and can respond with likes and dislikes and offer informal advice on training since LLNL employs a wide variety of degrees.

How should the program evolve while maintaining current curriculum and incorporating needs and best practices?

McGraw - In house training is critical to teach people how to learn. At LLNL, what they come with gets them in the door and how they evolve is what keeps them there.

Varga – It is very common for scientists to not know business and businesses to not know science. The whole process starts with intellectual property. Partnerships and strategic alliances are very important from beginning development all the way through to the final product. In the

nanotech business, we buy products we don't buy ideas or education. It takes a long time for on the job training. We want students who have access to current science technology with an understanding of business practices. All businesses need to do the same basic things, i.e. price lists, market research, etc.; employees need to be able to accomplish these things.

How important is flexibility?

McGraw – In the not-for-profit arena flexibility is not as big a deal. Nothing is done by one person alone, teams are important. Employees must have communication, organization and planning skills. They will be working with and mentoring others. Education and the training of an individual comes through working with others. There are no individual clusters in nanotech in this area.

Varga - Teams do not necessarily work all at one place, there is remote work as well.

What would a CSU/PSM employment coordination system look like? What is important in developing a curriculum career path?

Castellano - What is important is what happens to the person after 5, 10, 15 years? What we envision for this person is important to setting the agenda. The program needs to be more than just coursework it needs to be science and business programs as a whole package. The goal is to find unusual people who are interested in both sides of the equation, the ones that can span the gap. This is very important because once you have these people you can help define what they become.

Kambe - What is needed is a broad based S&T background with semi-professional depth. The cost is not really a large concern. As it is now, we must retrain technical people to understand a broader area. The need to promote a nano/business combination is necessary. Employees need to have a "T" set of skills. A strong background forms the base of the T and the branches of the T are how the employee can expand and grow within a company.

What are the pitfalls?

McGraw – With B.S. degree holders that want to continue their education and receive an M.S degree, there is a strong bias for technical depth. The need for a technology background exists; you can't do much with them if they have no technical background and depth. The business side usually develops later.

Castellano – Agrees with McGraw, that is how they grow them at Ames. Questions that need to be considered are what is the next degree, where are they going, and what does the bio/nano future look like? Partnering and collaboration is the wave of future; how does this program fit into the future? There is a strong tendency for scientists to know how they will work with other organizations. There is a definite need to have a background in how to write IP and agreements.

Internships are very important but curriculum can vary from program to program.

Castellano – B.S. degrees in engineering are invaluable.

McGraw - Internship are important. Mentors need be identified. Internships can often get stuck with the “cheap labor” perspective. Job skills tend not to be worried about. You need to be careful with your expectations.

Varga - Internships are usually boring and repetitive tasks and mentors don't get a lot done. Interns tend to get turned off by this approach. The internship needs to be clearly defined.

McGraw – One successful example is Harvey Mudd's model of group team projects.

CSU/PSM program should be able to place students statewide. How can recruitment be developed and improved?

McGraw – NASA has a team of professional scientists that go to campuses (15 to 10 per year) to perform on site recruitment. Summer programs that bring in 100 people are also available.

Kambe – Not much recruiting is actually done. CVs are sent in for jobs that are available. Most M.S. students go through recruiters or web based sites while Ph.D.s send CVs directly to the company. There are many Ph.D.s that apply for a single position. It is typical to look at major campus' graduates in the area first, such as Stanford, UCB, and SJSU.

Varga - Ph.D. recruitment is usually not a problem. Applicants need to respond directly to job requirements and give specific responses to job needs. On the protocol side, a seminar to enhance the probability of applicants actually meeting the needs of employer would be good. Employers also need education to clarify what applicant will accomplish and clearly define what the employee will be expected to do. Some communications mediums would include job fairs and websites. A channel needs to be created to post jobs that are very specifically focused.

McGraw – The number of people hired is not that large. Developing a relationship between faculty and staff of firms is very important.

Varga – Agreed, the link between faculty and firms is important. Small companies are doing the largest amount of hiring now.

Castellano – The relationship and reputation of the program are very important as well as internship recruits. You need to set up a structure with the industries that may need these types of graduates.

Kambe – A very active internship outreach will help the success of recruitment and placing graduates.

How to measure success of the programs?

McGraw – If you are producing top-notch talent that is knowledgeable and skilled then the 1st group of graduates will set the tone. There is no substitute for top people who are well trained.

Castellano – Agreed, well trained, top people are the goal.

Kambe - Diversity is a consideration. Any different expertise background is a boost that could lead to the creation of new ideas.

Varga - What is success? Placing how many? Success measurements of the program need to be defined. The discipline of a small company is different; you should expect long hours. Self-starters and proactive employees are what are needed most.

Is there a current and future demand for PSM? The demand will either be there or not and in this case there is a demand.

McGraw - Placing students would be an indicator of success. Set up a group of preferred providers. The question would be: to get a high quality education, are you a place we want to send our employees to? Will there be provisions for students who are employed full-time?

Kambe – The program would be beneficial if it expanded the pool of S&T people in the area. If you can find the right people locally – you don't have to go outside of the area. These programs could increase the California talent pool.

McGraw - Trying to recruit U.S citizens is a very difficult problem. If you hire people that are currently living here, then they are comfortable with the cost of living.

Castellano - Must really know the demand you are trying to fill. For the Hispanic and underrepresented areas, this may be a good niche to encourage those people to continue their education.

Kambe – The local areas are losing talent.

What resources can industry provide?

Varga – This area can provide advisors. There are several people who are interested in these programs but were unable to attend this meeting. It appears that the start up funds must be available and the programs must be self-sustained.

Stephan Crothers gave a wrap up of the current SJSU program and what the CSU is hoping to accomplish. Industry can't speak with one voice; these programs need to be compared on a company-by-company basis, then we can look for patterns. CSU is hoping to produce the best talent. Current SJSU programs require face-to-face interviews with prospective students and requires students to define their motivation in joining the program. One obstacle is the faculty who are used to training graduate students to do research.

With CSU's current reputation, we need to ask how to market this new reputation?

PSM Focus Group
November 12, 2004
Larta
9:30 am
Nanotechnology

Attendees:

Lee Fisher, Director, Tanner Labs

Stephen Jaffe, Director, Materials Methods LLC

Vincent Gau, Co-founder, CEO, President and CTO, Genefluidics

Moderator: M. Daniel DeCillis, Research Associate

CCST Staff: Donna King, Executive Assistant

CSU Representative: José Galvan

Introductions were made and a brief description of CCST was given. The goals of the project were outlined and the expectations of the focus group were provided. Background information was provided on the PSM programs, how they differ from other programs, the internship component, workforce needs, and statistics on graduates.

How can CSU align PSM programs with industry? In developing program content, should CSU align with the high-tech industry clusters that are developing in your area?

Gau – Currently an alumni representative that works closely with UCLA on several boards including an advisory board for engineering. UCLA has a masters of engineering program similar to PSM which folds management and industry skills into the ME. Most jobs in engineering and other industries (i.e. biotech) are initiated by the schools, not the industry. Students have a hard time finding jobs. Advanced education for people currently working and distance learning are different from current degrees offered.

He has found that companies were hiring other graduates (more hired from USC than UCLA). Biotech is not big in Los Angeles and nanotech is in the early development stages. UCLA questioned why their graduates were not finding jobs in the area. Advisory boards were

formed using alumni to provide feedback. UCLA is trying to make changes by responding to the graduate's needs. This type of effort takes a lot of people to make it work. The major challenge has been the budget cuts; most work is done with volunteers. UCLA is hoping to create a model for other schools to adapt.

Fisher – Would be willing to serve on such a committee.

How should the program evolve while maintaining current curriculum and incorporating needs and best practices?

Gau – One problem is that programs can't adapt. It is hard to predict what type of work background someone will need five years from now; it is hard to know what will industry be looking for. Many EE graduates find they don't like the field by the time they graduate. When students first start school, they need to be educated about the degree and encouraged to take courses from other areas.

Jeffers – Had not heard about the PSM program. This may be an opportunity to reach out to UCI, which so far has been an untapped resource. Would welcome the offer of suggesting input and curriculum and have open communication between schools and industry. Personal connections are very important. It appears that industry and universities have different motivation.

Fisher – A channel exists through Pasadena Entretec. Larta also tries to bring companies together but doesn't usually work with the universities. What you need are people that are involved. There are problems with interfaces, the significant investment in new hires, and training investment. New graduate employees are more attractive with skills for proposals, research planning, management product development, and communication skills.

Gau – UCLA requires a new course, BME 101, which consists of writing a NIH proposal. This is very important as it offers a different skills set.

Jeffers – Programs need to be designed so students can hit the floor running. They need the fundamental science skills and the ability to use the language well. At a small company people will learn how to do the things they have to do but you must know the language. Without this knowledge, your ability to do other things is limited.

Fisher – For the technical roles, the Ph.D. scientist is best.

Gau – UCLA started to offer courses in the MBA program to offer students better training to reach the final goal of a company, which is to sell a product.

Jeffers – Large companies are looking for different things from their employees as compared to smaller companies. Larger firms can offer their own training and are not as concerned about school. They want graduates who are smart and can work in a team.

What would a CSU/PSM employment coordination system look like? What is important in developing a curriculum career path? Degree vs. skills set?

Fisher and Gau – The skills set is the most important element.

Internships are very important but curriculum can vary from program to program.

Fisher – There are not a large amount of resources that are put into selection of new people.

Gau – In this industry, you need recent graduates. One of the best plans is an internship with the intent of converting to a position. USC has been more successful with this type of program. They are more aggressive. Two of Genefluidics interns converted last year to employees.

Jeffers – Internships are a great idea.

Gau – UCLA students don't know about any of the internship options. USC sends a list of summer interns available, usually in March/April. Industries like internships, this helps to screen out people that are not serious. (He will forward recent copy of email regarding internships from USC to the group participants.)

CSU/PSM program should be able to place students statewide. How can recruitment be developed and improved?

Fisher – Recruitment can be improved in two ways; 1) R&D – target a specific university and talk with professors and 2) headhunters.

Jeffers – Most employees use traditional means: announcement, Internet, trade journals or personal connections. There has not been a steady stream of graduates. It is difficult because the better students don't want to go into a small company.

How to measure success of the programs?

Jeffers – Statistics.

Fisher – It is hard to predict needed qualifications for someone you want to hire in a year from now. Tailoring the course content may help.

Is there a current and future demand for PSM? The demand will either be there or not and in this case there is a demand.

Gau – How do you differentiate the PSM from the MS? What kind of jobs are the graduates getting?

Jeffers – Stanford has a huge masters program. People are trying to get prepared to enter industry. Most people who get MS don't try to get a Ph.D.

Modify existing programs?

Fisher – Is there a need for these degrees? Is there a need for MBAs or nursing graduates?

Gau – Engineering has been a successful program.

Jeffers – There are a lot of engineering MS degrees being produced. In the life sciences, BS people become mules; industry wants people with more technical experience. MS training could address the issues of how technology and products are merged. Larger companies want MBAs to run P&L units; some amount of business training would be good with smaller companies.

Gau – Training can be provided in other areas. Graduates need skills in the technical areas. They must have at least a concept of commercialization. Technical skills are most important.

Fisher – You need people who are able to work in the labs and write proposals.

Gau – In the life sciences there are too many students and not enough jobs. Finding qualified people is not a problem. The problems exist for universities in placing students and helping them to find jobs. The state of California needs to look at what are they trying to provide.

Additional comments.

Fisher – The release of IP would help many companies to actually start up.

Gau – New companies are hard to start if graduates have IP issues with their universities. One of the focuses of an alumni advisory board should be the need to solve the IP problem.

Jeffers – There needs to be better integration between universities and industry: an alignment of goals. There is currently a lack of strong motivation. Perhaps a reshuffle of the education package would better align goals. Clarification on IP is extremely important. There is a natural connection although driven by different motives. IP is a definite barrier. The historical trends show that labs in small companies are not generating IP. The goal should be to carry technology forward with a push towards smaller businesses generating IP. Universities make money off patent portfolios but are at the same time competing with businesses.

Working relationships with faculty members are very important. Mentoring and sitting on a university committee would be time consuming.

Gau – USC is very flexible and students get credit for internships while UC does not provide credit.

Fisher – Who pays for an internship makes a difference.

Gau – If looking at two resumes, would prefer an MS to PSM graduate.

Jeffers – Would look at both MS and PSM graduates.

Fisher – The position would depend on which degrees were being considered.

Gau – Through internships, students can learn skills.

Galvan – We got what was initially expected from this group; nanotechnology is not a good fit because Sloan is not targeting engineering. We need to create a new perception of the PSM as a viable degree, not that an MS is a consolation prize. Students are encouraged to work together to solve a problem.

PSM Focus Group
November 17, 2004
San Diego Economic Development Corp.
9:30 am
Biotechnology

Attendees:

Alan Honeycutt, Senior Director, Invitrogen Life Technologies

George Thorton, President, Apovia

Paul Zorner, Senior Director, Business Development, Diversa

Moderator: M. Daniel DeCillis, Research Associate

CCST Staff: Donna King, Executive Assistant

CSU Representative: Faramarz Valafar

Introductions were made and a brief description of CCST was given. The goals of the project were outlined and the expectations of the focus group were provided. Background information was provided on the PSM programs, how they differ from other programs, the internship component, workforce needs, and statistics on graduates.

How can CSU align PSM programs with industry? In developing program content, should CSU align with the high-tech industry clusters that are developing in your area?

Zorner – Had heard of the PSM before and has interactions with schools in the area. There is a definite drain of people choosing science as a career.

Honeycutt – How is the adding of a new degree through Cal State adding to the mix?

Thorton – What position would you hire this type of person for? Perhaps a technology transfer position? When looking to hire a scientist, I want to hire a scientist. This degree doesn't jump out as a bona fide credential.

Honeycutt – There are three tracks within the company:

1. General Manager track – look for graduates from top schools with life science degrees and experience.

2. Technical track – look for post docs in the molecular area.
3. Leadership track – looking for a pedigree in the technical side.

All must be in the science area. It is all about patents and publishing, which lead to respect in the field. The opportunities to develop internally will lead to leadership opportunities.

How should the program evolve while maintaining current curriculum and incorporating needs and best practices?

Zorner – The question would be where to place this type of graduate. The management skills are good but would be better placed at the BS level which may serve as a means to coach people into the field.

Thorton – When looking to hire a scientist, want to see a science background. Yes, there is a place for the masters student but they should be very much science based. The thesis is very important and should not be done away with. This could lead to a lack of writing skills, no process of inquiry, and no interpretation skills. This seems an easy way to avoid the rigors of labs and thesis work. Would rather have an employee who is science based. Taking away from the science component of a masters degree by not requiring a thesis would not be beneficial.

Zorner – The lack of a thesis is an issue; this would reduce the need for critical thinking, organization thoughts and the ability to interact and articulate.

What would a CSU/PSM employment coordination system look like? What is important in developing a curriculum career path?

Thorton – The goals from an education are critical thinking, skills and the product of the degree.

Honeycutt – Looks for graduates from certain schools.

Thorton – There should be further emphasis on the need for graduates with the basics in science that will be able to move within the industry. Customizing a program might limit your ability in future years. Pedigree and expertise is important. You want to see a student excelling and make certain that graduates are leaving with basic skills at the highest level possible. They must be well grounded in their given area.

Zorner – The education cannot be too broad; you do not want a jack-of-all-trades. Graduates need to show that they are capable. The PSM sounds like a good program but maybe at the BS level. This could be a

good method for educating teachers. Society as a whole needs a better understanding of social skills. You need to avoid the perception of the PSM as a certificate program.

Internships are very important but curriculum can vary from program to program.

Honeycutt – The more experienced an applicant is the more attractive they are. There needs to be a balance between experience and education.

Zorner – An intern who comes from another company has experience. Post docs can also be used as interns. The internship must be a valuable experience and must produce something. Interns could be a route for recruitment. High school teachers would be great for this PSM training in the sciences. Would offer internships as an in-kind contribution to local programs but wouldn't see interns as potential employees.

CSU/PSM program should be able to place students statewide. How can recruitment be developed and improved?

Honeycutt – Has a relationship with UCSD for recruiting which could be enhanced. Would give more input if asked to.

Zorner – Has personal relationships with Cal State San Marcos and SDSU. A formal business relationship allows him to provide personal input. These types of opportunities are out there.

Honeycutt – Finding the right person to provide input would be helpful for local hiring.

Zorner – Biocom and UCSD Connect represent individuals and groups. Information made available to trade organizations, input into programs in the area and sitting as board members are all useful tools.

Honeycutt – At this point in time, industries in this area are still inventing the industry. It is hard to predict where the magic is going. The employees you hire are a reflection of where you see yourself going. It is a non-mature industry, which is filling white space.

How to measure success of the programs?

Zorner - KGI is certainly a good degree but it is not really an advantage to a graduate.

Honeycutt – The institution and training are the core. Where the program comes from and how it was shaped are very important.

Zorner and Honeycutt – In the past the MBA was considered just another degree, which didn't necessarily translate into more money. This may be seen as a way to increase pay, which isn't necessarily true.

Zorner – The thesis is still important and needs to be included.

Is there a current and future demand for PSM? The demand will either be there or not and in this case there is a demand.

Thorton – We hire post docs who come with much more than a MS. What they want to do with their life is important to their career choices. The MS can fill a role as support to the Ph.D., but is not Ph.D. material. There is a need for support people, which certainly hasn't been given the glory it deserves. Accomplishment is more important than the actual degree.

Zorner – There are already people working that are gaining this type of experience.

Honeycutt – The expectation the graduate has when he completes the degree program is important. If upward movement is a goal, this won't automatically happen.

Thorton – Experience is the ticket, a degree cannot replace on the job experience.

Zorner – The projections of the expectations for the PSM graduate are important.

Thorton – In the corporate culture there is an overlap between the Ph.D. and non-Ph.D. people. Both are employees that you don't want to lose. You can choose to provide a career track for non-Ph.D.s that puts them on the same level as the Ph.D.s.

Honeycutt – There is not a pure science route, you need leadership, sales and marketing experience as well. The challenge is that post docs and Ph.D.s are relatively inexpensive. Why would you choose to hire a lower degree?

Zorner – Ph.D.s have the same types of skills and experience.

Additional comments.

Thorton – How are students tracked?

Zorner – There are many students who leave California to continue their education after they receive a BS degree. These need to be computed into the statistics.

Honeycutt – As a Californian, I would like to see the highest quality possible in graduates, not just dots of excellence. As a San Diegan, I want to see my community excel.

Thorton – Teacher preparation and certification could be a great use for this degree. This curriculum could be more useful for a BS since the masters level needs to be extremely focused.

Zorner – There may be a problem with people pursuing science degrees of this type.

PSM Focus Group
November 17, 2004
San Diego Economic Development Corp.
1:30 pm
Telecom/Computer Science

Attendees:

Stephen Rockwood, Executive Vice President, SAIC

Barbara Abelin, Vice President, Human Resources, Cubic

Moderator: M. Daniel DeCillis, Research Associate

CCST Staff: Donna King, Executive Assistant

CSU Representative: Faramarz Valafar

Introductions were made and a brief description of CCST was given. The goals of the project were outlined and the expectations of the focus group were provided. Background information was provided on the PSM programs, how they differ from other programs, the internship component, workforce needs, and statistics on graduates.

How can CSU align PSM programs with industry? In developing program content, should CSU align with the high-tech industry clusters that are developing in your area?

Rockwood – Has worked with SDSU on the supply of people who know bioinformatics. Has also worked with the business school and the biosciences centers specifically with the requirements of graduates. Also involved with the UC engineering advisory board and University S&T Council.

Abelin – Has worked with the school of engineering advisory board at both UCSD and SDSU and provided financial support to both campuses.

Rockwood and Abelin – Current employees are encouraged to be involved and active on boards and committees from the local schools.

Abelin – Cubic has more connections within the San Diego area than in other parts of the nation.

Rockwood – SAIC is very large in the DC area and has lots of connections with universities throughout the nation. They hire the best and the brightest and their employees are alumni from all over the US.

How should the program evolve while maintaining current curriculum and incorporating needs and best practices? Are institutions responsive to the needs of the industry?

Rockwood – You need to be proactive. Universities should have industry representatives on their advisory boards. The curriculum should not be developed solely by the university.

Abelin – Technical people should sit on advisory boards. Most of the masters graduates at Cubic are from the engineering field. As you move away from the engineering field, other skills are needed as well as a technical background. Current employees go on to obtain further degrees and on-the-job training is also provided. Employees need to acquire financial abilities and leadership skills either at work or in classes.

Rockwood – Universities need to produce life long learners; those that can teach themselves and are always learning. Motivation needs to be ingrained. There are never enough systems engineers to fill the industry's needs. Organizational skills and project managers who have the bigger picture in mind are necessary. We don't serve to build a gadget, but to build a system. SAIC usually doesn't hire new graduates, they prefer people who have worked and received some on-the-job training.

Abelin – We also look at the bigger picture. Cubic hires new graduates and interns. Ninety percent of interns will convert to employees. Productivity is very high for these people.

What would a CSU/PSM employment coordination system look like? What is important in developing a curriculum career path?

Rockwood – Team projects are important. Working with others from other disciplines is also important. A good example is the Harvey Mudd 5th year projects that are performed. Financial mobility of the student is a concern. You usually do an internship in the area where you are attending school.

Abelin – The needs in the Bay area are probably different from what San Diego needs. The localized advisory boards should work on discovering what is important for the area.

Internships are very important but curriculum can vary from program to program.

Rockwood – Interns are found through local contacts, we ask for a list of available students. This system is not well organized. A large problem is the unemployability of foreign nationals.

Abelin – If they have technical, bright people, we will take them.

CSU/PSM program should be able to place students statewide. How can recruitment be developed and improved?

Rockwood – There is a need to recruit at the college level. The government workforce is aging and the newer graduates know what is relevant to the industry.

Abelin – Recruitment is done at career fairs, through referrals, paid internships, and by having a general presence on campus. The main focus in area is UCSD and SDSU because they are already here and the students are established in a local residence.

Rockwood – SAIC is not really trying to grow in the San Diego area due in part to the high cost of living. The corporation is staying small in this area, while growing rapidly in others.

Abelin – Young people in San Diego are moving out of state to buy homes. Company growth is in other areas in California and other states.

How to measure success of the programs?

Rockwood – The credential will sell itself. The knowledge of who the graduates are and how good they are will help to sell the program. A statewide network can help with this.

Abelin – There will need to be a branding of the individual. The degree needs to be seen as a real addition to the S&T community. Non-branding may also occur. The package needs to be seen in a positive light. Where are the current graduates working and in what type of positions?

Is there a current and future demand for PSM? The demand will either be there or not and in this case there is a demand.

Rockwood – Relevancy is important. Do these students have skills and relevant knowledge? If I don't know these graduates exist, how will I find them? Again, they must be employable in the US.

Rockwood and Abelin – Both would consider hiring PSM graduates and would offer internships.

Additional comments.

Rockwood – Younger people have lost the ability to use analytical skills.

Abelin – SDSU reputation has grown and is very tied in with the business community, which helps for local recruiting.

Valafar – The goal is to bring students to companies and provide what is needed.

Rockwood – The PSM seems to be a generalist degree with more management and team structure where the Ph.D. is self initiated research.

PSM Focus Group
November 30, 2004
Bay Area Economic Forum
9:30 am
Computer Science/Software

Attendees:

Jim Spohrer, Director of Almaden Services Research, IBM

Moderator: M. Daniel DeCillis, Research Associate

CSU Representative: David Bieber

Sloan Foundation: Sheila Tobias

Introductions were made and a brief description of CCST was given. The goals of the project were outlined and the expectations of the focus group were provided. Background information was provided on the PSM programs, how they differ from other programs, the internship component, workforce needs, and statistics on graduates.

How can CSU align PSM programs with industry? In developing program content, should CSU align with the high-tech industry clusters that are developing in your area?

Understands the program fairly well because of the research he has done. The challenge is to expand the program with local industries. IBM has done research on the academic disciplines trying to understand service information better. They are developing an organization theory based on the 30 disciplines they are looking at including how they were developed, and what the drivers are from government, industry and academia. There are a lot of statistics on the evolution of the service economy.

Service science is an emerging field that is imperative to the growth of a business.

Initial assessment of PSM programs by IBM was positive. IBM questions whether we need to depend on academics or should industry step in to train graduates? Most new hires need recent training in the specifics of the business.

How should the program evolve while maintaining current curriculum and incorporating needs and best practices?

The basic drivers need to be defined. At IBM business people and technical people both talk with clients. There needs to be a strategy. The MBA has been questioned; who hires them and does an MBA really matter?

There are two career paths. The first are those that come from a lower social economic status. To them, a credential matters very much. Do we depend on academic institutions or should industry do something for the long-run education/training process (five years)?

The second path is an intensive two month training period that would be a benefit to for certain corporations. This would provide recent training specifics of the business. One program, the Business I2 Gap, combines business people, technology, and the need to create a strategy for combining the two; organizational synchronization.

There is an increasing demand for generalists in a modern organization. The level of generalists vs. specialists needs to be fully optimized. PSM is a step in the right direction. There are implications that PSMs could radically modify service science degree programs.

An interest in science is imperative to a business. But MBA information is also important.

IBM hires a few hundred people a year (combination of scientists and business people). By hiring PSM graduates, this would be displacing both Ph.D. and MA current hires

What would a CSU/PSM employment coordination system look like? What is important in developing a curriculum career path?

Increasing the education foundation is helping to create disciplines that are needed. Certain majors are emerging as better for the long run.

The old theory of thought was to simply sell technology (i.e. a faster server) the new thought includes return on investment, how will this change my business, strategy, etc. It became clear to IBM that technologists are aware of new technology; they don't have the organization's transfer and return to investment included into the equation. More experienced employees can sell better and be faster at visualizing the whole picture. For the last two years, research was creating technologies and then the service relationship began to develop.

There is not way to solve the challenge; computer science came along as a degree because of the need to hire scientists to work on software. Those people used to be trained in physics and as scientists. Now you need the evolution of the service science side of the equation. If you are serious about science, you need to develop this other side. IBM looked at the data, talked to academics, and determined that they were ready for this evolution.

Multidisciplinary programs are shifting to the services areas, 80% of the economy is in service. Business values are being integrated into the sciences. As organizations change, the people and subsystems change and multidisciplinary users are being developed. The goal is to take a system science and turn it into something powerful.

Sciences evolve naturally towards complexity and probabilities. The interesting thing is that in old science (hard sciences), the history of services existed. Services were an included element in production and the innovation of production. Optimizing distribution of technical systems are unpredictable as well as dynamic.

There was a book written about Germany, their chemistry education, and patents. They are very advanced in services and China has the fastest growing services sector. Government, industry, and academia are all mired together.

Internships are very important but curriculum can vary from program to program.

Internships are a great bargain and are part of the IBM process. With the proper controls in place, the mentoring process can bring people together and end up with quite impressive results.

Industry/university partnerships are important. Internships and additional training through higher education are an important knowledge set.

CSU/PSM program should be able to place students statewide. How can recruitment be developed and improved?

Collaboration exists between IBM and higher education institutions. There are a lot of people on academic advisory boards, on a personal level, that have been initiated by both sides. IBM is huge and has a good working relationship with universities, networks, and on-campus recruiting.

IBM targets top students by degree and are constantly gathering information on the top graduates and have open communication with faculty.

Is there a current and future demand for PSM? The demand will either be there or not and in this case there is a demand.

Multidisciplines tend to attract a lesser student. They can't make it in a specialized area so they are working on a lesser degree. PSM has the same flavor; you can't hack it as a life sciences students or an MBA so you lower your standards. The quality of students, the perception of the programs, the other disciplines and their reactions are all obstacles to the success of a program. If you have the best and the brightest students being attracted to this program your perception can be changed. It is not fatal.

PSM really is a good program and there is a demand for it.

PSM Focus Group

November 30, 2004

Bay Area Economic Forum

1:30 pm

Environmental Technologies

Attendees:

Pamela Gordon, President and Founder, Technology Forecasters Incorporated

Gary Floyd, Principal Scientist, Tetra Tech Incorporated

Moderator: M. Daniel DeCillis, Research Associate

CSU Representative: David Bieber

Sloan Foundation: Sheila Tobias

Introductions were made and a brief description of CCST was given. The goals of the project were outlined and the expectations of the focus group were provided. Background information was provided on the PSM programs, how they differ from other programs, the internship component, workforce needs, and statistics on graduates.

How can CSU align PSM programs with industry? In developing program content, should CSU align with the high-tech industry clusters that are developing in your area?

Gordon – Has heard of clubs with an environmental/business focus but has not been aware of any formalized or interdisciplinary academic programs in California.

Floyd – UC San Francisco has a similar program in environmental science. Requirements for the program include a bachelors degree in science and current work experience in a professional setting. This gives students an opportunity to become familiar with the jargon and to acquire some networking skills. The downside is that it precludes any students that don't have experience from joining the program.

Gordon – There are existing industry groups that could be leveraged. CSU could tap into these groups as a resource to fill in the gaps. She is currently working with UCB and other schools as a guest lecturer.

Floyd – Environmental Leadership Roundtable breakfasts would be one avenue that could be explored. The San Francisco Chamber of Commerce has meetings of business leaders and involves academia as well. Has taught for Extension through UC Santa Cruz.

How should the program evolve while maintaining current curriculum and incorporating needs and best practices?

Gordon – Managers are trained as engineers; they become good managers because of the coaching they receive. Some times companies pay for employees to be trained or counseled in business practices such as teams, writing, and professional development; practical things. It would be a great asset if employees had these skills prior to employment. People can learn sales/engineering skills, but usually only through on the job training.

Floyd – Graduates with an MS and a few years of entry-level experience are a little more expensive to hire than the lower level staff, but would be able to bring more to the table. Organizations tend to get top-heavy; lower level staff with experience is desirable.

What would a CSU/PSM employment coordination system look like? What is important in developing a curriculum career path?

Gordon – Perhaps a study done with human resource vice presidents or directors; people who recruit or do the interviewing would help to find out what is needed and to assess ways to determine what curriculum needs to be included.

Floyd – The San Diego Environmental Business International Journal is a group of forecasters interested in trends and new focuses in the field. They may be a good resource.

Gordon – Senior consultants are generally former clients who have accumulated skills over the years and have a technical background.

Internships are very important but curriculum can vary from program to program.

Floyd – UC Santa Barbara has approached Tetra Tech.

Gordon – Bren School at UC Santa Barbara is very science oriented but they do not have enough of the skills that we are talking about today. Some business skills would be good. There is a trade program at UC Berkeley.

Floyd – Has recruited exceptional, bright students from courses he has taught.

CSU/PSM program should be able to place students statewide. How can recruitment be developed and improved?

Floyd – Some times there just isn't enough time to post a job. Meetings with the campuses may force you to sit down and think about what you really need and would like to see.

How to measure success of the programs?

Gordon – Students today are learning how to build things – not how to dismantle them. Science discovery to build and then return spent resources would be good. To be successful, a university needs to teach a brand new way to deal with consumption. They have to bring U.S. students up to and beyond global par with what it will take our organizations to survive. A final goal needs to be how to consume less resources.

Floyd – Networking with industries is very important. Universities need to be approached and asked what they have and what they are producing.

Is there a current and future demand for PSM? The demand will either be there or not and in this case there is a demand.

Floyd – Multidisciplinary roles are needed. You need generalists as well as specialists. A diverse set of electives that can adjust to the demands of the planet would be useful. The program needs to be forward looking.

Gordon – To be successful, you need state of the art techniques taught by people that know world topics, not just a U.S. perspective. An awareness of global issues is absolutely necessary. The programs that are out there need to be well advertised.

Floyd – This would be a great opportunity to partner with industries.

Gordon – Interactions with non-government organizations (i.e. Sierra Club) would also be helpful.

Floyd – There aren't any current programs in California that are producing what we need; very focused environmental science programs with electives.

Gordon – The ability to learn new ways of applying engineering to sustainable methods is very needed. U.S. products are environmentally behind in comparison to Europe and China. The U.S. is unaware of world activities and we don't have the skills to adapt to what is needed worldwide.

Gordon - Testimonials from industries that have hired PSM graduates would be beneficial. The PSM programs need to leverage some of the latest skills in facilitating groups, getting work done, and leading people.

Bieber - Communication, teamwork and flexibility are the three most required characteristics in a graduate.

14. INTERVIEW TRANSCRIPTS

AltaGen Bioscience Inc.

Mr. Rick Srigley, President and CEO

What problems do you foresee?

The first thing is, how will the program be funded? There is an entrenched mentality in education that is different from industry in style and approach. The educational system is not efficient. People and process get in the way of change. They are not tuned to serving the needs of industry. They may say, “this is not a vocational school. We are here to serve the needs of the community.”

The second thing is, the university must acknowledge when things need change. This can be a political issue especially with the community colleges and I imagine the same would be true at the university level. Berkeley high schools revamped entirely because of the new perception of science needs. They are much more integrated now. We were not so fortunate with the community colleges.

Also, you need feedback in terms of seeing how the kids are doing before and after they graduate.

Ask Mary Alice Rathburn who was the first executive director of EBBI. Lives in the East Bay Area. Working with Rich Gillis.

How can CSU align PSM programs with industry & structure course content?

Berkeley Biotech Industry Inc (EBBI) was started in 1992 to help disadvantaged kids in Berkeley get biotech jobs. They targeted high schools and community colleges. Here’s how they connected successfully with industry: they got half a dozen scientists from Chiron, Bayer, etc. to provide information on what the curricula should be like. They still tweak it from time to time but the basic program is over 10 years old and still working.

How do you recruit currently?

We care which institution confers the degree of an applicant but we don’t actually hire from universities. We are a small company of 40 people and we’re looking for people with industry experience.

How can recruitment be improved?

2-3 months ago in SF, a group of biotech HR managers met to discuss common HR issues. They would know the answer to these questions better than I.

What can we do to ensure the success of existing and new PSM programs?

Be persistent. Be in it for the long haul. Make a 5-year investment. Maybe 10 years. It has to be funded. You need a champion to get the funding. Must be clear on targeting and objectives. Develop networking.

Would you hire PSM today if available?

Do you currently use internships? Paid or unpaid? Use them for hiring?

The company pays the interns but they also need to provide mentors so it takes a commitment. Takes effort. EBBI has people making these connections. Professionals.

Other comments?

Will the PSM program be in competition with the EBBI in the Bay Area?
It would be better to leverage by building on existing programs.

I want to talk to Susan Hackwood regarding funding.

Althea Technologies Inc.

Dr. Joe Monforte, VP and Chief Scientific Officer

Have you heard of the PSM prior to our contacting you? What has been your experience?

Yes. I know about the Keck graduate institute. They emphasize the technical part plus they have a business and internship component.

I haven't had any personal experience with their students but I know some of the faculty. I know they've been successful with it.

What problems do you foresee?

Potential problem: It depends on what you're trying to do. If you're trying to do a management track, is this an MBA-lite?

How can CSU align PSM programs with industry & structure course content?

UC schools have offices of people who do outreach. They sell themselves, inventions, etc. They would be a good example to follow.

Currency is an issue. It's hard to keep current because everyone needs something different. Give students a good background. Have university lecturers keep up. Invite industry to come give lectures and make presentations.

UC campuses are unique to their environment. Some have biotech while others, like Berkeley, do not.

Do you currently provide input to local university programs? How? Who initiated this contact?

Senior management here has an informal connection with educational institutions.

How can recruitment be improved?

Make people aware of this program. Send out "resumes" for the program (like a job applicant would for himself). SD State has a department that goes around to businesses seeing what they need and selling itself.

How can we get you graduates when you need them?

We have an HR department so they are the people to liaison with for hiring. Make a relationship with them. We don't do job fairs but you could do that. Listing positions. Networking.

What can we do to ensure the success of existing and new PSM programs?

Stick with it. Build a reputation.

CSU reputation: Cal State reputation is mixed. Cal Poly is good but Cal Poly is not. We hire from them though. We look at the skill set.

Would you hire PSM today if available?

I'm not sure the PSM program is a good fit for us. [We do it ourselves...] we might advance someone internally by sending a scientist to school to get management skills.

Do you currently use internships? Paid or unpaid? Use them for hiring?

Interns: We've not been super successful with them. We have hired them more as a moral issue to help out. Whether we would do it or not depends on what we need. We have to be pragmatic. Occasionally we have hired an MBA intern for a market analysis or a statistical intern for a project.

Would you sit on an advisory board?

We are members of UCSD Outreach, and with Scripps Institute and with Burnham Institute. Whether we would participate on a board of directors for PSM depends. Maybe.

Other comments?

Maybe it's a bias of mine but I would not start out with 17 programs. I would start out with 2 or 3. You have to build and expand if [and only if] the program is successful. You must build not only the curricula but also the associated administrative support. There's a lot to do. I doubt CSU could do it all at once.

Bayer Corporation

Mr. Thomas Malott, Project Portfolio Manager

Have you heard of the PSM prior to our contacting you? What has been your experience?

No, but it would have been useful for me personally. I would have liked that kind of background before taking this job.

What problems do you foresee?

Just be sure students have a strong background in the fundamentals of science.

How can CSU align PSM programs with industry & structure course content?

The program MUST cover the fundamentals of science. The student must understand chemistry, molecular genetics, and so on, AND they must understand the processes such as genetics and microbiology.

ALSO they should have an understanding of industrial bio-processing. This was not taught when I was in college. Or if it was I didn't know about it. The student should know how to get the product to market. What are the steps involved in reproducing a product... know how to commercialize it ... what are the scenarios...

ALSO, they should know about financial investment. That's what I do. But my job is based on my knowledge of chemistry. A pure finance person couldn't do it.

Do you currently provide input to local university programs? How? Who initiated this contact?

We fund an educational program for a junior college and we support a high school.

How should CSU be connecting with industry? Is it doing this?

Have a lecture series from industry. Use the team concept from industry to form a lecture series. Visiting lecturers will tell students and faculty what's going on. It won't be theoretical.

How do you recruit currently?

I have no idea. Ask HR.

How can we get you graduates when you need them?

Internships. We hire a lot of interns as technicians. We get them from the junior college program we fund. If you partner with a company for a lecture series you've got one foot in the door. The company knows they have access to a talent pool.

What can we do to ensure the success of existing and new PSM programs?

No more than I just said.

Would you hire PSM today if available?

Yes. We'd hire them if they were good. Would the graduating institution make a difference? No. It wouldn't matter. There is more of a demand than UC can meet.

Would you offer an internship to a PSM student?

I'm not in a position to say. It would be OK with me.

Would you sit on an advisory board?

Maybe. You can keep my name on the list.

Cal EPA, Air Resources Board

Richard Bode, Chief, Health & Exposure Assessment Branch

Have you heard of the PSM prior to our contacting you? What has been your experience?

This program sounds good. I like the applied aspect.

I know about a similar program; UCLA has a Ph.D. program in environmental sciences where an internship is required. It has an applied orientation rather than a research orientation. But it does require a dissertation. I hired two people out of that program and the dissertation tended to take them away from work. Overall though, it was good. We hired them as interns but they were hired into open, full-time positions, so it was the same as hiring full time people; they took the Civil Service exam and got on the list. We hired based on the skills they came in with.

In our agency I find that master's level people with an applied orientation are often better than Ph.D.s. They don't get so bogged down in the detail. They are more general in their approach.

What problems do you foresee?

Biggest problem: Could be the labor management thing. I think an internship program would probably be OK. [i.e. relationships with the union should be considered.]

How can CSU align PSM programs with industry & structure course content?

Curricula: For our agency the graduate must have engineering or public health, stats, and modeling, and then the communication and presentation skills are a must. We make many presentations to both industry and the public. We specifically look for communication and presentation skills in job applicants. Experience with project management is a bonus.

We have paid some employees to go to school but basically we want them to have the skills and knowledge up front. We want to know they have it because it's hard to get rid of them if they don't.

Connecting with CSU in an advisory capacity can conceivably create a relationship where you can help shape the education students get. It's a good idea. There is a strong need for this focus on practical application.

Do you currently provide input to local university programs? How? Who initiated this contact?

I currently serve on a toxic substances committee at UCD . We meet and share information on research. Also we use that connection to get student help.

How should CSU be connecting with industry? Is it doing this?

CSU alignment with government: Government could learn quite a bit. Connecting with universities is a good way to bring ideas into government. Our agency regularly learns from students.

My suggestion is to develop an understanding -- at the agency level -- between government and the university. Develop an understanding that would allow students to come in as interns. We've had staffing problems recently; the youngest leave whenever there is a hiring freeze. With an intern you get to see how they do and maybe try to hire them. Hiring can be problematic because, unlike industry, you can't get rid of a non-productive employee very easily. With an internship you can see how they do and if you see talent you can possibly hire them. If you can't hire them you can at least give them practical experience which they can use to get another job.

What can we do to ensure the success of existing and new PSM programs?

Ensure success: Form a relationship with an agency. Develop a memorandum of understanding regarding the disciplines that will be covered in the coursework. [Ensure that curricula are relevant.]

The agency and the department should make and renew personal relationships once or twice a year.

Would you hire PSM today if available?

Would I hire: Theoretically, yes, if the graduate had the training.

Would I hire an intern: The internship arrangement would be a whole lot easier if it was a non-paid internship. The student should get paid because it provides incentive to take it seriously. If it could be done that the agency doesn't pay for it, it would be easier to work an agreement with CSU.

Do you currently use internships? Paid or unpaid? Use them for hiring?

We hire student interns through the Hornet Foundation. It's very helpful because when the state has a hiring freeze we can still get help. We can get students from UCD there too; they do not have to be CSU students to sign up with the Hornet Foundation. We can actively search them out at UCD because we know the faculty. We know faculty we've worked with and served on committees with. Student support has been necessary to us, and it's been fun too because we learn from them.

We used to have positions for student assistants and graduate student assistants but in the early 90s they were cut loose and they all disappeared. I think it was a budget thing. A couple of years later we established the Hornet Foundation agreement.

Would you sit on an advisory board?

Yes, theoretically. I'm overcommitted right now but yes if I had time.

CALTRANS

Mr. Robert Wiswell, Chief, Division of Aeronautics

Have you heard of the PSM prior to our contacting you? What has been your experience?

No, I've not heard of anything like it. I liked the teamwork, multidisciplinary part. It's absolutely necessary to the Department of Transportation. We have highway engineers and transportation planners who have to learn about aeronautics to work with our pilots. We all have to learn about each other. I think the program is a good idea because of the teamwork and communication components.

What problems do you foresee?

The program description is written for industry, not government. We don't innovate but we provide funds to others who buy off-the-shelf. Also, "business" is a term that should be explained or modified because we do budgets but we don't have creativity with the financials like they do in business. Aspects of "business" definitely apply but government people might not recognize that.

We had a leadership training program here recently and about 50% of my people came out of it thinking, "Wow, I'm a leader and I didn't know it." The other 50% came out of it thinking, "I don't know what that was all about; I'm just a manager." So some people just don't get it. The concept of applying science and technology is good but it needs to be wrapped around government. I came from outside state government so I appreciate business but most people here do not.

How can CSU align PSM programs with industry & structure course content?

The way to construct the curricula is to convene a working group or advisory group to talk with. I'd be happy to work with CSU on developing course content.

Regarding change: PSM sounds like a program that teaches basic training so the student can learn to appreciate the search for science and technology. Only the hands-on stuff is transitory here and workers pick it up. [In other words, keeping current is not a big issue.]

How can we get you graduates when you need them?

How to align PSM with government recruiting needs? Because the government is unionized -- which means job candidates from all programs have to be treated exactly the same -- it would be hard to foster a relationship with an academic institution. You'd be bucking an institution. This program [PSM] is for non-exempt positions, which are the entry-level positions, which is what this program is designed to produce.

A management position is not an entry-level position, and it is exempt or, what we call, "unrepresented," meaning non-union (Note: managers are no longer exempt. Victoria Koehler Jones). This would be a better target market but it would mean that students would already have job experience. So in developing a relationship between CSU and government, you should know that you'll be drawing adult students from within government. These students would be more experienced having worked in the real world.

In government, testing is job specific. Transportation planners (for example) have a test built around transportation planning, land use planning, etc., all of which is currently being taught in college. Once the candidate passes the test they are on the list. Sometimes people are on the list for years and years. The candidate must continually monitor the situation to find a job at an entry level. When they find one, they can then apply. [The implication here is that PSM may not be a very attractive option for traditional students.]

Would you hire PSM today if available?

Would I hire a PSM graduate? They would be better qualified to submit an application or to perform on the orals.

CALTRANS

Dr. Don Dean, Research & Innovation Division

Have you heard of the PSM prior to our contacting you? What has been your experience?

I've never seen it before but the PSM program looks good. It is very exciting. It could be done.

What problems do you foresee?

Biggest problem: Make it clear that the PSM is not a consolation prize for a Ph.D.. Clarify the reasons why a PSM is different from an MS and a Ph.D..

How can CSU align PSM programs with industry & structure course content?

One thing I would add is "systems engineering." A lot of projects coming out of the federal government require it. It's about making sure all the pieces fit together. It encompasses probability theory and statistics and engineering techniques. The idea is to make sure you don't focus on one thing without looking at how it fits in with the whole. It's what we used to call "industrial research," which focuses on such things as queuing theory... getting things done and processing things. This is sometimes touched on in the undergraduate program -- usually in the 4th year -- but it's better developed in graduate programs.

Another thing not mentioned in the description, but important; the student must learn to apply information to a difficult problem in the technical/professional area. How do you show that a student can bring it all together and solve a difficult problem? How do you show you can apply all the things you've learned? Have them do a senior project at the graduate level... a capstone demonstration. These students aren't learning skills to conduct good research but they are learning skills to solve problems. This is the chief benefit of this kind of training.

A capstone example in the policy area: The governor uses the power of public referendum to by-pass congress. What are the current and future effects of this way of governing? A real problem with real outcomes. Start by asking what are the difficult problems that need to be solved?

Curricula: has to focus on the basic tools.

How should CSU be connecting with industry? Is it doing this?

Alignment issues and changing curricula: I've been on a civil engineering committee at CSUS. Determining the relevance of training is part of the accreditation process now. Example: In civil engineering programs we used to spend time surveying. Now we use aerial reconnaissance. We don't even take pictures; mapping is digital and electronic. So the accreditation process would look at how many hours of survey are required at CSU. When technology changes, curricula should change. Keeping up is getting harder because of rapidly changing IT.

The advisory committee is where you bring ideas to the table. We had meetings where CSUS would ask questions of us. We would also participate in senior projects. Again, a lot of this is related to the accreditation process. They want to make sure the school provides a foundation in reality. It's an excellent interface.

How can we get you graduates when you need them?

Regarding a PSM graduate getting a full-time job: All hiring goes through the civil service process but a graduate who has had an internship with us will score higher on the exam and be more likely to get hired.

What can we do to ensure the success of existing and new PSM programs?

Ensure success: Have a capstone project that demonstrates accomplishment.

Would you hire PSM today if available?

Would you hire: Yes, absolutely. We go to UCD but they focus on studying "interesting phenomena." What we need is answers. We need ideas that lead to solutions

Do you currently use internships? Paid or unpaid? Use them for hiring?

Using interns: We hire interns and we have student assistant programs and so on. All hiring goes through the conventional civil service process but the intern process is easier because we contract through the Foundation at CSUS. This means they are the ones who actually hire the student, thereby getting around civil service requirements.

Would you sit on an advisory board?

Would you serve on an advisory board: Yes.

California Energy Commission

Scott Matthews, Chief Deputy Director

Have you heard of the PSM prior to our contacting you? What has been your experience?

Sounds intriguing. I liked the part about teamwork, communication and presentation skills and project management. We use a combination of folks here but they all do that.

When we hire technical people we look for communication skills. Sometimes we send them to classes. We highly value those skills. I just came out of a meeting where we decided to add more writing to our test. Also the oral component. We make presentations all the time. People almost always work in groups and teams in a multidisciplinary way.

How can CSU align PSM programs with industry & structure course content?

Connecting with universities: We have professionals connected with these institutions (UCD & CSU). I would suggest you use them. Have the University set up a meeting with us to lay out the curricula. Because government is so large I suggest targeting a few departments to start with. We're not the most technical (EPA is) but we would use students like this. We do the policy side. We use technical knowledge to develop policy.

Currency: People learn about the Energy Commission on the job. (Berkeley has a course where they teach this but it's not perfect.) I recommend students get a good grounding in the basics and not worry about change. There is a lot of learning on the job.

How do you recruit currently?

In hiring we depend on the civil service process where we identify the skills and abilities we need (I am responsible for the administration of this department so testing reports to me). We look for what else (besides classroom) they've done so if they've got some intern experience that's good.

Recruitment: We use the Hornet Foundation at CSU. They manage our student program so this helps us connect up with students. At UCD we focus on econ students through the Econ Dept. We don't provide input

to their programs. We advertise jobs. We do job fairs to hire CSU and UCD graduates full time. We focus on those campuses because they are close.

How can we get you graduates when you need them?

We hire people out of master's programs and we hire students part time (student interns). We pay. This gives some students entrée. Some find they like it and we like them and we hire them. Pay is not a terribly important issue; students can work in their field, which is important to them.

Civil service rules are the same across State government but implementation differs depending on culture.

What can we do to ensure the success of existing and new PSM programs?

Ensure success: Who wants the degree? Does the degree confer status? It's important to get the right student so you can build a good reputation. You must advertise the value of a PSM but it takes time to establish credibility.

Would you hire PSM today if available?

Would you hire a PSM today? Yes but for an entry-level we have a set of approved degrees necessary to get in the door. CSU should make sure the PSM is on our list (I think it should fit based on the description). Then the candidate must take an exam. After the test there is an oral interview. . We hire for analytical thinking skills. For example, we might say, "There is a proposal to dispense with the front license plate and keep only the rear. Think about what the issues are and tell us what factors should be considered in making this decision."

A PSM student would probably be better prepared to compete on the oral and written part. So, yes, if they could pass our requirements we would hire them.

Would you sit on an advisory board?

Sure.

Crucible Partners

Mr. Brad Ward

Have you heard of the PSM prior to our contacting you? What has been your experience?

I have heard rumors through SMI (Small Manufacturing Institute), where I used to be the treasurer, that CSU is interested in cranking up PSM programs.... this PSM topic is a favorite of a niche group within the Cal State System. Personally I think that because of the money situation in CA, this PSM attempt would be a longshot.

In the mid-90s LMU started a master's degree in production management where curricula was designed -- theoretically -- _ by the business school and _ by the College of Letters and Sciences. I am a program advisor for them. They now produce 2 -3 dozen graduates a year. Students are working adults whose employers -- mostly defense contractors -- subsidize their education. So employers were involved early in the program and helped shaped the program. This is not a technical degree (except for statistics and so on) but students do have educational components introducing them to IT, nano, etc. This is for familiarity only, not in-depth knowledge. So I have some familiarity with this kind of a program and I think the PSM is a longshot.

What problems do you foresee?

The biggest pitfall would be to ignore the importance of tying the degree directly to new job prospects and/or existing job enhancements. This is what students are after.

How can CSU align PSM programs with industry & structure course content?

You must have business involvement to drive both curricula and jobs. Invite them to participate from the beginning. Say, "we must hear from you and we will respond to what you believe is important." As past treasurer of SMI I experienced CSU as an institution that would say "thanks," but then ignore all input. Put them (industry leaders) on front end committees regarding both curriculum and assessment techniques.

What can we do to ensure the success of existing and new PSM programs?

First, by turning out valuable students. Then establish a quid pro quo where industry helps you provide future employees for them. This is never a total bridge but you can establish a level of trust. It's a chicken and egg problem because you need to start out with both, valuable students and industry trust.

Harness power on the side of industry. Find pockets of interest in industry and exploit them. Find that area where there is a need for a generalist. Nano is too narrow a niche. Today nano is composed of a range of disciplines but eventually only a handful of companies and products will emerge.

Industries that cross over will be more interested in PSM. For example, environmental tech cuts across several industry lines. Find the advocates and get them to sell to others. Life sciences is the same way ... it cuts across industry lines).

Would you hire PSM today if available?

If industry is involved from the beginning it will happen.

Other comments?

Industry may be skeptical because private schools (like LMU) think CSU is defective. They believe they themselves are at or near the top and that students from CSU need remediation.

The idea of a professional master's degree has been successful outside of California because there has been more support and loyalty than one can get in California

I'm very familiar with the USC campuses and I know there is variability in quality. CSU would be perceived as being even more uneven. They would be seen as having no uniformity of excellence and uniformity of excellence is what the private universities emphasize, and this is why they are trusted by business.

Find the low hanging fruit such as environmental technologies. Find specific companies that can be recruited to be involved in the development of the program. If you can't find them, if there is no enthusiasm, don't do it. It won't fly

You need the early involvement of industry before investing any assets.

Entropic Communications

Tim Pappas, Director Operations

Have you heard of the PSM prior to our contacting you? What has been your experience?

The program sounds like something I would have taken myself. It would interest me to have people like this on our staff. We would want this.

What problems do you foresee?

Possible being out of touch with needs.

How can CSU align PSM programs with industry & structure course content?

The big thing today is communication, communication, communication. Communication is more important than the technical stuff, which you can find anywhere. Also keeping current; the technical industry is dynamic so keep the curricula up to date by depending on the advisory group.

How can we get you graduates when you need them?

Get grads to you when you need them: Industry is proactive. They will look for what they want but you have to get the word out. CSU has to communicate what they've got.

I'm agnostic regarding institution. UC and CSU are the same to me. I look for the instructors and industry expertise.

What can we do to ensure the success of existing and new PSM programs?

From an operations standpoint the PSM program would give students a great advantage in the workplace. PSM would also be applicable to other types of engineering. Not so good for companies heavily into R&D. This is for companies dedicated to producing a product at a profit... companies large enough, and with enough experience to recognize the value. PSM graduates would blend in and add value immediately.

Ensure success: Get something off the ground and get industry talking about it. Have the right advisory team. Names can mean a lot.

Would you hire PSM today if available?

I would like to. Yes.

Do you currently use internships? Paid or unpaid? Use them for hiring?

We hire interns, both from high school (from what we refer to as High-Tech-Hi in SD), and college from BS and MS programs. Since we're a startup and only have 45 people can't hire that many people. We use interns for overhead needs. If they're a real superstar we'd hire them or if we couldn't do that we'd give them a glowing recommendation.

Would you sit on an advisory board?

Yes. I'd be honored. I'm busy but it's needed.

First Nano, Inc.

Mr. Cary Chee, CEO

What problems do you foresee?

A program with no thesis is too easy. We do not have big expectations of our interns. We're real lenient on them. It requires barely any thinking on their part. It's just kind of outside lab work. Their work with us is insufficient for a master's degree. The internship is not hard enough.

How can CSU align PSM programs with industry & structure course content?

Trade shows and exhibits keep one current. The university should sponsor trade show events.

Engineering students lack the ability to write. They should be asked to write a paper on what they expect to get out of attending a trade show, then write a summary of what they got out of it after they get back.

For us, the candidate should have engineering courses. Actual job experience (not internships) is what really helps.

What we're doing is extremely specialized. General coursework would be good.

Maybe have special courses for start-up companies. Teach them to formulate business plans. Have them develop business plans and compete with each other across the university system. Have awards for winners.

Internships, sponsored by a university, are valuable for students. We use about 10 per year... maybe 3 per quarter. We offer to pay them a little bit. If they work during the school year the university should sponsor them. Internships help develop students. Lab work helps but working directly with a company helps them the most. However, we expect very little from interns. We just expect them to follow instructions. (i.e. Internships are good for students but not as valuable for the company. Victoria Koehler Jones)

How should CSU be connecting with industry? Is it doing this?

Sometimes we recruit from interns. We sign up for interns at universities close to us. Last summer we used internships from UCSB and other UC campuses but it could have been a CSU campus. If CSU offers interns

it's OK with us but we've only had UC students in the past. We don't expect a lot from interns but we'd look for engineering. CSUSJ has a good engineering program.

How do you recruit currently?

We mostly hire by word-of-mouth. We only have 10 people.

Having had an internship is not much of an advantage. Most internships are too short.

How can recruitment be improved?

It's hard to find well-rounded engineers. It would be great to find an electrical engineer with mechanical engineering skills... very hard to find. It takes somebody with 10 years experience working with another company. It's stuff learned in the field, not at a university. Straight finance, straight mechanical engineering, electrical engineering, chemists, are not hard to find.

What can we do to ensure the success of existing and new PSM programs?

A company [like mine] would probably hire specialists. A cross-over guy would be a manager but a PSM graduate would be a long way from managing.

It's better to have an engineer go back to school to get an MBA. Better management material.

Overall the PSM is not that attractive to me. Take a UC engineer and add some MBA experience and that might be good if you have a limited budget but it's more likely you'd just hire a part-time finance guy. An engineer could pick it up.

What students need is to be taught ethics of hard work. The program should enhance the competitive spirit.

CSU would need a closer partnership with industry. For example, the UC system has offices for the Center for Technology Transfer.

Would you hire PSM today if available?

Yes. We should help students as much as we can. Today it's an international competition.

Would you sit on an advisory board?

Yes. I serve on boards.

Genentech

Rob Arathoon

What problems do you foresee?

California has innovative industries. Support is needed for both the innovative side of Genentech and the manufacturing side. The breadth is scary. The fundamentals of manufacturing may be more manageable.

How can CSU align PSM programs with industry & structure course content?

By consulting with industry. Ask industry. There is a huge range of industries so it will be difficult. It would be hard.

Do you currently provide input to local university programs? How? Who initiated this contact?

How should CSU be connecting with industry? Is it doing this?

On the intern side of the PSM issue, have a liaison maybe. We have ties with SF State and others so it's possible. Getting real jobs is harder to predict. We look for technical applicants. In manufacturing we have a greater need for a generalist than on the innovative side. On the innovative side we look for a hybrid chemical engineering person for example.

How do you recruit currently?

We are doing a lot of recruiting right now. We have a broad search for talent both here and abroad. We have well-defined job gratifications so 90% of the time we know what we're looking for. We've hit the visa ceiling so that is a problem.

We have post-doc programs helping people publish. Also we have a program where we bring in recent MBA graduates who want to be in manufacturing. We train them... we tailor them to our needs. We might send them to an area for 6 months to learn about an area that is important to us. The program is too young to quantify it's success but we'll make it successful. Young people in this program are only guaranteed a job for 2 years. After that they may get hired or they may be out on their own.

We have college outreach for summer interns. Much of the time students approach us. We get a lot of resumes. Also we go to favorite institutions (Berkeley, Stanford, MIT, Davis, UCSB, etc.) to recruit. We have strong ties with education. Most of us have strong ties with our educational institutions so we are already cooperative with each other.

How can recruitment be improved?

We've hired over 100 scientists and engineers in the last year. It takes a lot of energy but it works. We go to science fairs, conferences and so on.

It's been harder to fill slots on the logistical (business) side.

What can we do to ensure the success of existing and new PSM programs?

Do a lot of liaison work with industry. Much more so than for traditional programs.

Would you hire PSM today if available?

It's not clear what the need would be. We would rather take an MBA or a scientist and train them ourselves.

Again, manufacturing or logistics and supply may have a greater demand.

HRL Laboratories

Dr. Matthew Ganz, CEO

Have you heard of the PSM prior to our contacting you? What has been your experience?

No, this is the first that I've heard of it.

How can CSU align PSM programs with industry & structure course content?

Most larger (e.g., aerospace) companies have senior individuals whose job it is to help universities align their curriculum. I believe that these folks could advise you and that their recommendations would serve both large and small companies.

Do you currently provide input to local university programs? How? Who initiated this contact?

Yes, through direct contact with Deans and faculty and through participation on Industrial Advisory Committees

How should CSU be connecting with industry? Is it doing this?

Probably the HR departments are the most appropriate interface.

How do you recruit currently?

Word of mouth (mostly to professors) and via our web site primarily.

What can we do to ensure the success of existing and new PSM programs?

Be selective in your early candidate choices and make sure that they are placed in good jobs upon graduation.

Would you hire PSM today if available?

Yes probably. However, our technical staff is very Ph.D. heavy (75%) so we are probably not the best target for you.

Yes, assuming that the right IP arrangements could be made. (NOTE: This comment suggests that the non-research orientation of the PSM may have been lost to the respondent. Victoria Koehler Jones)

Do you currently use internships? Paid or unpaid? Use them for hiring?

Yes. Both paid and unpaid. They are a great way to screen potential employees. Intellectual property rights for unpaid interns can be an issue (We must own the rights to the work done under our roof).

Would you sit on an advisory board?

I could probably find someone within HRL to serve. However, due to our skill mix, someone from one of the larger aerospace companies might be more appropriate.

IJ Research, Inc.

Dr. Rick J. Yoon, President/CEO

What problems do you foresee?

If you don't know what something is it's hard to sell it, so if an employee is trying to communicate something technical, but he doesn't really understand it, he cannot communicate effectively.

Students need in-depth knowledge of their technical area. The basic skill learned from school is the most critical thing. I can teach some of the other skills after an employee is hired.

We are unique. What we teach is specific to our company.

How can PSM be structured to meet the needs of industry?

Advanced degree programs should include non- or less technical curricula so students can perform more effectively. The PSM program sounds like the educational system in Germany where they teach more practical things.

There are three areas that I think could be improved.

1. Practical skills. We need employees with knowledge at high levels of science and mathematics but I would also like them to have hands-on training in with applications.

They should know computer-aided drawing. Many new graduates do not know how to read or draw schematics and I spend too many hours training them.

My major professor, Dr. Thomas D. McGee, gave me a tool box [with hammers, screwdrivers, etc.] when I entered graduate schools. (Every student should know how to use hammers, screwdrivers, etc.)

2. Skill at practical levels of communication. My school did not teach me how to communicate. Communication skill is not really related to the command of English. Communication is an art and it is a good tool or skill for students to have.

3. Business sense. This is about timing. Research people can finish tomorrow what they do not finish today. In industry, we need to finish today because by tomorrow it will be too late to get paid. This is especially important in small businesses. (Students should be taught to understand this motivation.)

This is also true of employees at regulatory agencies such as Planning and Zoning. These processes take [too much] time and money. Because people there have no business sense things take too long and we get hurt. (Government employees also need courses in business.)

How should CSU be connecting with industry? Is it doing this?

We don't have interns because we don't have short-term projects. If I had some confidence that they would be there longer I would seriously consider it. Having an intern who may move into a more permanent position would reduce the cost of training.

How do you recruit currently?

We call our local university. Sometimes we put an ad in the newspaper but that doesn't work so well. We know the names of the department heads. We let them know what we need, they find someone for us. This works pretty well.

Nanosolar (and/or Unisun)

Dr. Chris Eberspacher, VP Engineering

Have you heard of the PSM prior to our contacting you? What has been your experience?

I did my Ph.D. at Stanford and some of the departments there viewed their masters as a terminal degree that either offers increasing specialization or a broader skill base. So I'm familiar in general with the concept.

The program looks good. As my Mom would say, a BS in physics goes nowhere. At Nanosolar, some members of the staff are of great value because of their knowledge of solid state materials, etc. Others are of great value because they know how one does "some thing," even though, on the face of it, their resumes are wrong. In fact, they are of great value.

How can CSU align PSM programs with industry & structure course content?

I have several ideas about curricula:

The "scientific method," as laid out 500 years ago, must be taught. People don't know it is an iterative process moving through conjecture, experiment, data collection, analysis, and back to a more informed conjecture. Science is iterative and one must go through all the steps. Students must get this. Make it the first order of business.

Then equip them with the tools. (1) Lab procedure. Give them experience with beakers, cleanliness issues, etc. Teach them how to choose and operate tools, prepare work spaces, etc. Teach materials preparation and characterization. Teach how elements of hardware may fit together.

Then (2) have them learn something about equipment. There are levels of accomplishment with analytical tools, but the PSM graduate must know something about them. There may be 5-10 essential analytical tools central to any given field. The student should know what they are and what they're useful for. Know the acronyms.

Give them experience and exposure to the "erector set." This is a problem with new hires. They should know temperature, pressure, flow... how things operate in a vacuum and in different environments. These skills are similar in an integrated circuit facility. These are generalizable skills.

Third (3) is record keeping. Students must learn to write it all down in a permanent fashion. They need to learn to use record keeping and data gathering in a way that works.

Fourth (4) is environmental health and safety issues. They must know how to read a materials safety data sheet. Know the guidelines. Know preparations needed and agreements needed from colleagues.

These are the basic tools. Then shift toward more modern techniques like statistical process controls, and related to that, experimental design. Experimental design is well developed now, reducing the amount of experimenting that's necessary. Understand statistical error and design.

Then know digital data flow. How to get data from one format to another. What data sets look like. What spreadsheets look like. Digital data handling. This, again, is a skill that can cross boundaries.

Then, after that, comes teamwork. Early experience with team sports teaches something but elements of teamwork are generally not known. Does one work for consensus or majority, etc. How does brainstorming work effectively? There are techniques for how people work together.

Then, project planning. Create the receipt so it all arrives together. Teach how to plan for and implement multi-faceted projects. Also know the software designed to help with this.

Then intellectual property and so on. But the things I've outlined are general and are needed.

How to keep curricula current: It's a moving target but basically the tools don't change as fast as the knowledge. Make sure they know the basics.

How should CSU be connecting with industry? Is it doing this?

The advisory board is a useful concept. You might also want to have a statewide coordinating board.

How do you recruit currently?

Current recruiting: We recruit in one of three ways: 1) post job openings on a local computer job bank; 2) post job openings on our web site; 3) word of mouth.

CSU as a granting institution: It matters but... let me put it this way, Stanford is close ... we're interested in talent wherever we find it but 1/3 of the staff is from Stanford. In reality there's some commonality in where we came from.

What can we do to ensure the success of existing and new PSM programs?

Start the program and have it build on itself. Gradually any attitudes [about CSU] will erode. Focus on a few locations that offer best hope; CSU Palo Alto would work better than CSU Chico.

Ensure the success: We're now facing increasing competition from China. It used to be that the touchstone of free trade was that different geographic regions could specialize to everyone's benefit. This is no longer true. We aren't necessarily the best for hi-tech. We simply have to stay ahead of the curve. In the spirit of staying ahead, give them a mixture of basic knowledge and skillful application. Practical application.

Would you hire PSM today if available?

No

Do you currently use internships? Paid or unpaid? Use them for hiring?

No. We don't use them. We're too small.

Would you sit on an advisory board?

Theoretically I would serve. (I'm overcommitted right now.) Many people would have an interest in seeing that the skill set is what they need. This would be good for the electronics industry.

NASA Ames Research Center
Mr. G. Scott Hubbard, Director

What problems do you foresee?

Biggest problem will be staying current. Comes from engagement in the network. They [faculty?] must know the leading lights. Have a summer party with wine and cheese and invite people from some of these companies.

How can CSU align PSM programs with industry & structure course content?

To really answer this question you need to talk with the people who do the hiring in engineering, R&D, line management, and so forth. Not HR.

This program could be valuable for those seeking leadership roles such as project and program managers. It would be good for promising line managers.

Yes, it's an entry-level program... but these graduates could start with senior oversight. The problem we have is how to develop people who know the applications or design areas and also have management savvy. There is a gap. We try to grow these people ourselves. We need people for marketing and translating. We need people who have skills with management capability. These people could be part of proposal development or technology partnerships (tech transfers) because they would know the law, know how to write, know finance, etc. They would appreciate the technology but be able to make presentations.

Mainly we would use them in the areas of advanced planning and advanced studies, proposal development, technology partnerships, and project development. [So coursework should support these objectives.]

This is a big issue. Must make sure the course work and faculty are up to speed. First of all, train for today. Do not train for yesterday. Help ensure this by going to conferences and workshops to be exposed to late-breaking news.

Also when students spend time at the company they learn. We have a NASA Academy for seniors or 1st year graduate students. Members of this academy spend time with, not only researchers, but also those in technological applications.

How should CSU be connecting with industry? Is it doing this?

We have an in-house project management course. This could be used as a pipeline.

How do you recruit currently?

Currently, we use everything. We have connections on campuses because people stay in touch with campus peer groups.

How can recruitment be improved?

Get engaged with broader community groups such as Silicon Valley Mfg. Group, Joint Venture Silicon Valley, BASIC, etc. Make presentations to them.

What can we do to ensure the success of existing and new PSM programs?

Biggest problem as a startup will be the issue of establishing credibility. Fighting ignorance about the program. Be sure you've got a good informational campaign going so potential employers will know who these students are. The first class will be critical. Must step out smartly. Must be well-advertised ahead of time. Start with good people in the program.

My best advice is always: VISIBILITY, EXCELLENCE & IMPACT.

Would you offer an internship to a PSM student?

Yes. We're looking for people in those areas (as described in 1 a-b). We just established a bids and proposals office. We will know in a few months whether we have any vacancies there. Call Dennis Cunningham, Head of Human resources.

Would you sit on an advisory board?

Yes

Other comments?

This type of degree can be well positioned. Success depends on reputation in a given area. It's a different market niche than other CSU programs. One of the best small spacecraft training grounds is at one of the CSU campuses. So the most important thing is to establish it as a high quality program.

Palo Alto Research Center

Mr. John Pauksta, (HR)

Have you heard of the PSM prior to our contacting you? What has been your experience?

I'm somewhat familiar with it.

We are part of XEROX plus we have outside research agreements and government contracts (250 employees).

In 2002 we were spun-out as a wholly-owned subsidiary of XEROX. We shifted from pure to practical research which required more collaboration. Suddenly we needed to be more in tune with customers. Some researchers had trouble with it. Business concepts were Greek to them. Now we have all-hands communications meetings where we go through the financials... where are we in terms of meeting our objectives, financial and otherwise.

So this [PSM] program is a great opportunity for students to learn not only technology but also business collaboration. They can learn to work together to meet objectives. Now we place a big emphasis on communication. This [PSM program] is what industry really needs. Project management, business basics, intellectual property... now these are important for everyone to know about. You can tell I'm enthusiastic about it.

What problems do you foresee?

The biggest problem that I see is that adding more to the curriculum could take the student longer to finish. (Note: This respondent was apparently under the impression that the program would offer standard scientific curricula with business/IT modules added on to it.)

How can CSU align PSM programs with industry & structure course content?

Develop course content using experts from several disciplines. Get business managers in technical companies to help you craft the curricula. Lure them with the possibility of future intern and hiring options. This requires establishing a close relationship with industry... even if the company moves you should stay in touch with them.

The program is good because it's not an MBA. It gives someone on a technical track better insight on what to expect in the real world. This program is on the right track. These days, one has to go out and win before they can even start to work.

Keeping curricula current? You need advisors from industry. Universities should have guest speakers from industry. It's better for students to get it live than from a book.

Do you currently provide input to local university programs? How? Who initiated this contact?

No.

How do you recruit currently?

The way we recruit: We use the higher level sciences so we look for Ph.D. researchers already at a university. Or we get them out of industry... already working. We do summer intern programs but these are all Ph.D. students and sometimes we hire from that group.

CSU? The institution is considered. We do look at the university. It's usually the first topic asked of a hiring committee, "where did he get his degree from?" Most of our people are from MIT, Carnegie-Mellon, Stanford, etc.

How can we get you graduates when you need them?

Recruitment: (1) Make sure businesses know what curricula is all about in PSM. (2) Try to get business to come on campus. We don't hire that way but others go to campus for recruitment. They make offers to students contingent on finishing the program. (3) You've already got business helping guide curricula development so use them.

What can we do to ensure the success of existing and new PSM programs?

What's needed to get it off the ground? Proving it works. Follow a graduate and get success stories. Provide good feedback.

What's needed most of all? Getting in touch and keeping in touch with business. Everything in the program description seems pertinent. All aspects mentioned are critical. So the difficulty will be communicating it to industry.

Would you hire PSM today if available?

No.

PSM intern? No. The PSM intern is not good for us. It would be good for SRI, IBM labs, HP, Apple, and other places where a Ph.D. is not required. Any engineering company would be great.

In all honesty someone coming out of a masters program would be biased against. Even though I myself have only a master's degree, it would be hard to place them here. Everyone has a Ph.D..

Do you currently use internships? Paid or unpaid? Use them for hiring?

Yes, we use summer interns who are working on the Ph.D..

Would you sit on an advisory board?

No.

PIXAR

Mr. Randy Nelson, Dean, Pixar University

Have you heard of the PSM prior to our contacting you? What has been your experience?

I haven't heard about a program like this in the academic world but it's what people usually do here. We have jobs that belong to the hyphenates; technologists are artists here.

How can CSU align PSM programs with industry & structure course content?

To be sustainable you must have reciprocity with industry. Reciprocity in a fundamental sense, not as an abstraction. Industry will find what it needs [because it is pragmatic]. It's not forward looking so much as in the here and now [so it's not looking to invest in future workers]. Partnerships with industry will be expensive to the university; it will be their job to build relationships. The relationship is number one, overarching. Then comes common goals [things that are shared]. Next comes complementary needs and skills (think of puzzle pieces and things fitting together) both in the short run and the long run. Filling in a missing piece.

So the program will need internal champions (internal to a company); a person in an industry who will say they'll come talk and give advice. Someone for whom it's easy to say, "We get what we want, and all the University wants is advice." This internal champion can tell the successful story. Otherwise it won't work. HR can't do it. They don't develop talent.

Develop it in stages with deliverables and milestones. Each one should build the relationship further.

The university must have adaptability and must be nimble and ready to learn. The pace of change at a university is historically glacial. To succeed you must have an upfront, strong commitment, to being able to say, "I can deliver this in x number of months." No maybe's, possibly's, or perhaps'. To succeed will require a tremendous ability [on the part of the university] to tell the story in a compelling, doable way including both, the big picture and the small scale implementation.

They say you must be able to tell the story in an elevator. This is true. You may get 4-5 sentences in which to capture the point in a clear and interesting way that shows you know what you're talking about. Universities are really bad at this skill. They want to drag out the power point presentation and so on.

Do you currently provide input to local university programs? How? Who initiated this contact?

We use interns. We have a university relations program where we send instructors and recruiting people and provide some feedback (they ask us and we tell them but with no presumption on our part... we just tell them Pixar's view). We hope interns will want to work for us after they graduate.

How can we get you graduates when you need them?

What has to happen: you need a very integrated relationship with your industry partner, with good, reciprocal internships and externships. (An externship is where industry goes into academia. Many companies have sabbaticals which allow an employee to return to campus for 6 weeks to teach. Share what you know.)

As you filter for partners, you must look for those who see themselves as life-long learners. Not those shaving a bit off cost. Some cultures focus on cutting corners to produce something more cheaply. A manufacturer competing on a per-piece price is not the right partner. Innovation is costly. Steer clear of those that aren't in favor of innovation. You need an innovative or adaptable and interested partner.

Schools are under a time limit but it's a long sell cycle. It will take a general investment [on the part of the university] and it's a tough sale because you are also fighting other, existing programs.

So choose a few really good partners. Develop a good set of heuristics to target candidates [so you don't waste time and money]. They must be doing something that hasn't been done before and they must be life-long learners.

What can we do to ensure the success of existing and new PSM programs?

To make a program like this successful the student must be (1) a master of something, (2) competent in several things, and (3) literate in the entire domain. Smart people have done it outside of the academy. The PSM is a practical program at heart.

General competency must not leave out specific mastery. The student must be good at something. For us it's portfolio-based; we can see what they've really done.

Would you hire PSM today if available?

CSU: Because we're portfolio-based we don't care too much about which graduating institution the candidate comes from. We even have some people who haven't graduated at all. With some schools we look at the size of the population knowing that a large school will have some good people. So the status of the institution is no big issue for us.

Hiring: It would depend on whether the candidate has mastery in something we need. The candidate must deliver the goods on the first day. This is a potential problem I see with the PSM program. It sounds like you're building marketing people. The fear is that they may not be able to do something. This is the most important issue. They must have an immediately deployable skill. I wouldn't hire them because they came from a PSM program. I would only hire them if they had a deep mastery, with breadth, communication skills (not emphasized in this program description), and collaboration. They'd get no special in because of the PSM program.

Our internships are probationary hires. We can be more blue sky about internships so a PSM internship might have a slight edge. But here our people are technical so the best blend for us would be scientific and fine arts.

Do you currently use internships? Paid or unpaid? Use them for hiring?

Yes.

Would you sit on an advisory board?

Advisory board: I'm happy to share what I can. I limit my advisory activities but in theory, yes.

Other comments?

This [the PSM program concept] is a need for us. But clearly expressed mastery (such as the portfolio) is most important. Industry shies away from the generalist. You must have a demonstrable mastery. The internship may be the next best bet [after the portfolio].

Overall, the student has spent, what... 6-7 years in school. They should be able to say, I can do these things. Usually the skills you're talking about can be built in the second year on the job.

State Personnel Board

Shelly Langdon, Manager, Test Validation & Const. and Technical Training

What problems do you foresee?

State and other public sector employment depends on passing a Civil Service test to establish eligibility. The idea is to establish merit so hiring is egalitarian and nonpartisan.

Exceptions include:

- Lateral transfer (to a position making within 10% of present pay with no required changes in classification)
- Layoff lists (this ensures priority to those who have been laid off within 5 years)
- CEA appointments (Career Executive Assignments are high-level political appointments. These exempt positions are non-Civil Service.)
- Student internships (The State contracts directly with the Hornet Foundation at CSUS. The Foundation does the actual hiring, but the job is temporary.)
- Temporary or seasonal appointments can be treated with flexibility but they are also not permanent.

But in most cases the CSEA union requires that people go through a testing process as a way of entering the system. After passing the test, the candidate is eligible to apply for a position. During the recruiting process the Civil Service procedure controls the actual selection of an applicant from the field of candidates so they can ensure that only the most qualified is hired.

This rigor makes it problematic for PSM faculty to establish relationships that result in jobs for graduates. Even though many government leaders may wish to serve on an advisory board, they do not have the power to control entry.

But the internship may serve as a vehicle to gain an edge: “Anytime we meld internships with Civil Service it gets quirky. Civil Service wants the testing but as soon as we start to know people [who are interns], preferences come to the top. Even if a student is not that great, just being on the inside increases your chances,” (Shelly Langdon).

Other comments?

In the next 3-5 years, state government will have a real problem filling positions because the average age of state employees is just over 50 today. The majority of managers and leaders are even older. The next major event for these people is not promotion, it is retirement. To make matters worse, the number of people wanting to get into state service has dropped. Workforce planning issues are becoming critical.

Governor Schwarzenegger's task force for the "California Performance Review," includes a subcommittee assigned to take an extensive look at human resources. They are dealing with just this employment issue. The question is how to build the kind of workforce we need. Their findings are not out yet.

In 2003 there was something called "The STAR Project" headed up by Elizabeth Montoya, who was at that time with the State Personnel Board. Members of this group were trying to establish some kind of connection between education and government to provide for the development of needed skill sets and knowledge base. The budget may have been cut because the group was disbanded. (This is by recollection from Kathleen O'Connor.)

PSM and government applications: This is an area that definitely needs more investigation. A crunch is coming and, as of this date, it appears that no one has solutions. The seriousness of the situation may loosen some of the red tape. There may be opportunities to develop new protocols.

A thorough investigation of public sector educational needs should include other public sector entities like SMUD. They also operate under Civil Service guidelines but they may be more flexible in application.

15. SURVEY OF EXISTING PSM PROGRAMS

CCST contacted 31 PSM programs by phone and email throughout the country, selected on availability of contact information in the program listings provided by the Sloan Foundation.²² Nineteen programs responded to our inquiries. Responding programs were asked:

- How long the program had been in place?
- What factors led to the establishment of the program?
- Were local industries surveyed to assess potential interest in PSM graduate placement?

Following are brief descriptions of the responses obtained from the 19 programs.

California State University, Fresno

Biotechnology and Forensic Science

The biotechnology program is currently a certificate program that has been active since 1988. It is a one-year laboratory-intensive program that is designed to offer “breadth and depth” of coverage in the areas of molecular biology, genetics, biochemistry, and the plant and animal sciences. The forensic sciences program is currently under development. The program is designed to cover instruction, research, collaboration (including field trips), and application (attending seminars and workshops).

Case Western Reserve University, Cyrus Taylor, Professor of Physics

Biology for Entrepreneurship, Chemistry for Entrepreneurship, Mathematics for Entrepreneurship, Physics for Entrepreneurship, and Statistics for Entrepreneurship

The Case Western Reserve University’s programs are unique in several ways. They are all centered on entrepreneurship. They also require fewer courses and a much more extensive master’s thesis project. Students are encouraged to expand their ideas for starting new companies or creating new technology and innovation. Courses started in 2000 and they have had three classes of graduates. The physics entrepreneurship program was the first to be started and the Sloan Foundation approached Case to begin additional entrepreneurship programs in statistics, biology, chemistry and mathematics. The programs are self-supporting with

virtually no new staff added since they began. All programs are partnered with the management school and have an external advisory board. The physics program began after conferring with alumni who felt their education would have been enhanced by an entrepreneur focus. A generous alumni donation began the process.

Eastern Michigan University, Ben Keller, Assistant Professor of Computer Science and Henry Zot, Chair of Biology, State University of West Georgia

Bioinformatics

Industry representatives (approximately six people) were gathered for a single meeting to discuss the aims of the PSM programs. Most of those representatives agreed to form the advisory board. Students were extensively surveyed through focus groups and telephone interviews to gauge student reaction to the PSM concept. The program started in 2002 and currently has 20 students enrolled for Fall 2004. New coursework was developed for the programs, using only a few existing classes. The effort was nearly all faculty driven. The Council of Graduate Schools initiated the proposal of programs and invited Eastern Michigan University to apply to the Sloan Foundation.

Illinois Institute of Technology, Liz Friedman, Program Coordinator

Materials and Chemical Synthesis, Analytical Chemistry, Health Physics, and Biology

One of the Illinois Institute of Technology's programs started in 1996 and has had 63 graduates. This particular program was started without the aid of the Sloan Foundation. Sloan funding has since been used to implement three additional programs. These programs are mostly distance learning and consist mainly of people that are employed full-time and have received their bachelor's degree 10 to 15 years prior. There are two full-time staff members that coordinate the four programs. Groundwork consisted of defining a very clear niche that the students would fit. The naming of the program and the niches are key elements of each program. For the most part, existing coursework has been the basis of the programs. One interesting note is that over 50% of their students are women.

Keck Graduate Institute, Henry Riggs, President Emeritus

Computational Molecular Biology/Bioinformatics and Biosciences Management

Henry Riggs began promoting the concept of professional science master's programs by personal contact with industry representatives and colleagues. The largest obstacle was getting others to understand the concept and benefits of this type of training and coursework. Keck Graduate Institute is a great model of success for professional science master's programs. The capstone of the MBS program is the Team Master's Project in which teams of three to five students work with sponsoring companies to solve real problems. This project replaces the master's thesis work required in traditional programs.

Michigan State University, Estelle McGroarty, Senior Associate Dean

Computational Chemistry, Industrial Microbiology, Integrated Pest Management, Industrial Mathematics, Zoo and Aquarium Science Management, and Food Safety

Michigan State University initiated contact with the Sloan Foundation to set up PSM programs. Sheila Tobias assisted in drafting the proposal. They did not perform a needs analysis, but did interact extensively with their advisory boards to develop the programs. Pre-existing coursework was used with the addition of one or two new classes. One of the programs is on-line. Students are required to complete a certificate in Business Management and Communication Skills that includes 10 modules of extensive business coursework (approximately 120 hours).

Northeastern University, Mansoor Amiji, Associate Professor, Pharmaceutical Sciences

Biotechnology, and Computational Molecular Biology/Bioinformatics

A six month internship is required for all graduates as well as an extensive business 10-week program taught by industry faculty, that covers, IP, patents, presentation skills, etc. The programs also require a specific laboratory course, for practical experience. All classes are offered in the evenings (with the exception of the business program held on Saturdays), 60% of students are also employed full-time with the goal of potential advancement in the workforce. The programs started in 2003 and they currently have 22 students.

Oregon State University, Stella Coakley, Associate Dean, College of Agricultural Sciences

Applied Biotechnology, Applied Physics, Applied Systematics (Botany), and Environmental Science

Industries in the area were contacted before Oregon State University applied to the Sloan Foundation. The president of the university was hoping to further industry connections as well as the connection to the laboratories in the area. Current enrollment is at 14. They have two types of students, those that are straight from the undergraduate program and those that are older and are not sure what they want. These older students are earning a master's degree in the hopes of boosting their economic situation (some are receiving financial support from their employer). An internship, research paper and oral presentations are required.

Pennsylvania State University, Donald W. Genson, Executive Director
Applied Statistics, Bioanalytical Chemistry, and Biotechnology

An ongoing dialogue existed between Pennsylvania State University and Sheila Tobias. The result was an invitation for Pennsylvania State University to apply to the Sloan Foundation for PSM funding. Several ad-hoc industry surveys regarding employment potential were conducted. Alumni and companies already hiring were contacted and the input from the industry representatives was incorporated into the application to Sloan. The programs are currently fully enrolled. The programs accessed existing course offerings and developed new coursework tailored to the three master's degrees offered.

Rochester Institute of Technology, Gary Skuse, Director of
Bioinformatics

Computational Molecular Biology/Bioinformatics

Rochester Institute of Technology has both undergraduate and graduate programs in bioinformatics. Currently there are 65 undergraduates and 5 graduates. The director saw a niche in industry for such a degree and approached the Sloan Foundation. They performed a very specific needs analysis of six industry groups nationwide (Washington DC, Seattle, San Francisco, the Industry Triangle, etc.) to ascertain the need for PSM graduates. The program is different from most in that they do not require an internship for the graduate students. For both the undergraduate and graduate programs, 18 new courses were created and several new faculty members were hired. The development of the program was faculty driven.

San Diego State University

Computational Science

The computational science graduate program at San Diego State University is a recently established, novel educational initiative. The aim of the program is to educate professional researchers capable of effectively utilizing modern computational tools to tackle a variety of cutting-edge scientific problems. The distinctive feature of the program is its interdisciplinary character; using computation as a powerful tool to achieve progress where analytical methods are inadequate, the program exposes students to a broad cross section of scientific and applied areas.¹

San Jose State University, Dave Bieber, Director, Master of Biotechnology Program

Biotechnology

An informational meeting was attended by Sheila Tobias, the dean of the College of Sciences and two key biology faculty members. The potential for developing a PSM in biotechnology was apparent and momentum to develop a proposal was initiated. No formal survey was performed but the perspective of former students was sought and unofficial advisors in the field were polled. The curriculum was put together using existing courses and a few new courses were developed, but little new content was required.

Stanford University, Betty Cheng, Biomedical Informatics Training Program

Biomedical Informatics

This program is somewhat different in that it offers distance learning through the taping of graduate level courses. This approach is an attempt to offer the same experience for distance students as for on-campus students. Primary contact was made by Michael Teitelbaum from the Sloan Foundation. Coursework is derived from existing coursework. There have been four graduates, two are employed in industry and two have entered graduate programs.

University of Arizona, Alaina Levine, Director of Special Projects

Applied Biosciences, Applied and Industrial Physics, and Mathematical Sciences

¹ http://www.csrc.sdsu.edu/csrc/education/graduate_programs/

The University of Arizona has three programs that started in 1997. Sheila Tobias approached the university regarding starting the programs. Informal interviews were performed with several industries in the area to ascertain the ability to place PSM graduates. They have an industry advisory board that oversees the programs.

University of California, Los Angeles, Fred Fox, Professor of Microbiology and Molecular Genetics

Computational Molecular Biology/Bioinformatics

Initial contact was made between the Sloan Foundation and the college level dean. Jobs listed in the “jobs offered” section of *Science* were carefully reviewed over a one-year period. Using data that was collected previously for an National Science Foundation Integrative Graduate Education and Research Traineeship (IGERT) Program application, there appeared to be outstanding opportunities for industry employment in bioinformatics. Visits were also made to about a dozen companies in the Bay and San Diego areas. The curriculum followed is the same as for the Ph.D. students. Master’s requirements of a participating department must be met, plus three courses in bioinformatics and three courses in a minor topic. The bioinformatics programs core was in place for a year before the start of the Sloan PSM program. Students usually stay on campus for a research practicum rather than doing an internship in industry.

University of California, Santa Cruz, Richard Hughey, Professor and Chair, Computer Engineering Department

Computational Molecular Biology/Bioinformatics

The Sloan Foundation provided program start-up funding. This program does not require an internship, but does require a thesis. Bioinformatics courses have been expanded and developed to provide the core coursework, business courses are not required. When the program was first conceived in 1995, there was a boom in the economy in the area that could support these types of graduates. The bioinformatics program began in 2003 after a lengthy process of approval. The computer side has been going strong for several years. Currently 1/3 of the students are working towards their master’s, while 2/3 are working towards a Ph.D. Many students are looking for retraining, those that have worked in industry and are looking for something new and different.

University of Pittsburgh, Steven Husted, Associate Dean of Graduate Studies and Research

Geographical Information Systems and Quantitative/Financial Mathematics

Sheila Tobias began correspondence with the University of Pittsburgh and provided a presentation to interested faculty. There were no surveys performed, but contact was made with potential employers in the area. They currently have only a handful of students in each program. Curriculum consists mainly of coursework that was already developed. Students are required to complete a non-degree course offered by the local business community which University of Pittsburgh pays the tuition costs for the students to attend.

University of South Carolina, Jeff French, Program Manager

Biotechnology, Environmental Geosciences, Modeling for Corporate Applications, and Bioinformatics

The dean of science and math at the University of South Carolina worked with Sheila Tobias to develop PSM programs at Michigan State University. He brought the idea with him to the University of Southern California. The areas of study were developed based on two factors: the specific strengths of the faculty in each department and whether they could assemble a reasonable group of local business leaders who worked in the respective fields and felt that their businesses would benefit from the availability of such a program. The industry leaders met several times during the development of curriculum to help shape the program. Although most coursework already existed, they did develop a 40-hour course of rigorous writing and presentation seminars taught by the journalism school that each student is required to attend. There have been seven graduates.

University of Southern California

Computational Molecular Biology/Bioinformatics, Computational Linguistics, and Physics for Business Applications

The objective of computational linguistics program is to prepare students for a professional career in natural language processing. Students will obtain a solid background in theoretical linguistics as well as hands-on training in current computational techniques.¹ The Physics for Business Applications program is a two-year program (including an industrial or commercial internship) designed to attract recent graduates or technically

trained workers in business and industry who hold a bachelors degree in physics, applied mathematics, or a physical science (chemistry, electrical engineering, aerospace engineering).²

University of Connecticut, Linda Strausbaugh, Professor of Molecular and Cell Biology

Applied Financial Mathematics, Applied Genomics, and Microbial Systems Analysis

The University of Connecticut started with two master's programs that they wanted to re-tool because these traditional degrees were not serving the people. An internship is required, but no thesis. Students are required to work in a laboratory setting and receive lab credits. A hybrid between a thesis and coursework exists in the form of an exit exam which is a scholarly review or journal article. This is required of all students and usually includes a summary or report on the work performed as an intern. A weekend intensive laboratory class is also required. This offers a very realistic aspect of seeing a project through the phases of lecture, lab, and analysis.

University of Dayton, Paul W. Eloie, Professor and Chair, Department of Mathematics

Financial Mathematics

Industry perspective was sought through a very labor-intensive phone survey of approximately 30 organizations. Most courses within the program are newly created. An internship is not required of all graduates, but will eventually work into becoming a requirement. A research project is also included in the requirements for graduation. The program began in Fall 2004 and has four students.

University of Utah, Jennifer Schmidt, Project Administrator, Graduate School

Computational Science, Environmental Science and Science Instrumentation

This program started in 2002 with the three program tracks listed above and has had seven graduates (current enrollment is 31). Most graduates are employed full-time or have had the connections needed to find

¹ <http://www.isi.edu/natural-language/MSCompLing/about-prog.html>

² <http://www.usc.edu/dept/physics/SloanWeb/physicsforbiz.html>

employment. The internships are developed by the individual student and their advisor and usually consist of a written proposal, which includes design and implementation. Students contact companies directly for setting up the internship. They have one full-time staff member that coordinates students, classes, and instructors.

16. REVIEWERS

The California Council on Science and Technology has the highest principles in providing independent, objective, and respected quality work. All work that bears the Council's name is reviewed by Board members, Council members, and selected Fellows. The Council also seeks peer review from outside experts. The process as well as the outcome is reviewed. This results in a protocol that ensures the issue is well addressed, the response is targeted, and that the results are clear and sound.

We wish to extend our sincere appreciation to the reviewers listed below, whose expertise and diligence in reviewing this report has been invaluable, both in rigorously honing the accuracy and focus of the work and in ensuring that the perspectives of their respective disciplines and institutions were taken into account. Without the insightful feedback that these reviewers generously provided, this report could not have been completed.

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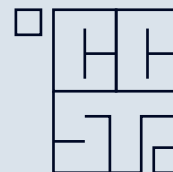
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