Helpful Hints for Establishing Professional Science Master's Programs

Charles R. MacCluer[*] and Leon H. Seitelman[†]

Abstract

In recent years, there has been an increased interest in developing business- and industry-focused programs of study in mathematics and science at the master's degree level as an alternative to the traditional programs. The newest programs in mathematics, many of which were begun with seed money from the Alfred P. Sloan Foundation, are now beginning to reach maturity. Many other institutions are considering starting programs of their own. This paper offers suggestions about best practices for setting up such programs.

Introduction

We offer two perspectives on these new professional science masters (PSM) programs: the focused view of a principal developer of one professional program, and the broader view of an industrial mathematician who conducted a Sloan-sponsored survey of master's degree programs in applied mathematics, with a focus on PSM programs. Our goal is to inform those with an interest in setting up such programs about the "do's and don'ts" of program development. We will also highlight some of the habits that prospective students in such programs need to develop: persistence; working in teams; interacting with nonacademics and accommodating to their needs; developing the important non-technical skills of writing and presentation; and dealing with deadlines and non-technical professionals.

[*]Professor of Mathematics and Coordinator of the proMSc program in Industrial Mathematics, Michigan State University, East Lansing, Michigan.
[†]Consultant, Glastonbury, Connecticut.

The changing world of work

Motivating this metamorphosis of technical education is the need to respond to changes in the workplace. The global marketplace has increased pressure on all businesses (especially technology-based ones) to produce more for "the bottom line." Greater strides in operational efficiency have certainly resulted, but it is also true that the "skunk works" operations (e.g., Bell Labs, Watson Research Center, Lincoln Labs, etc.) that spawned many past technological revolutions no longer enjoy blue sky funding, and have instead become corporate profit centers. Open-ended research projects have become increasingly unpopular with the many technically unsophisticated decision makers who are driven by increasingly shorter-term, profit-focused business models. We do not endorse this mind-set. It is simply there; knowledge workers must adapt to, and function within it. As mathematicians might say, "It is a boundary condition."

Implications for program development

Many traditional technical programs currently allow their business-naive graduates to leave for industrial employment totally unprepared for the environment and working conditions in which they will work, and in which they hope to contribute and advance. A program that couples a strong technical background together with a knowledge of business practices will equip students for substantial roles in both product development and organizational management.

Real workplace experience is crucial to success in an industrial environment. To be of maximum value to its students, a PSM course of study should provide opportunity for real workplace experience. Only with this kind of real-world exposure can students prepare to contribute within an environment in which deadlines, interdisciplinarity, teamwork and communication are critical for success.

Sloan steps up

The Alfred P. Sloan Foundation has supported the development of new PSM programs in a number of scientific fields. The goal of this "seed money" was to discover which program models seemed to be most successful so that they could ultimately be replicated. Although most of the mathematics-related programs (see `http://www.siam.org/students/sloansurvey.htm`) are just now reaching maturity, we can make some reasonably general (and widely applicable) statements about what does, and does not, work.

What now follows is a realistic (but partial) list of steps necessary for establishing a PSM program. We draw freely from the experiences in constructing the Michigan State University program.

Reaching out to industry

Industrial outreach is valued and rewarded at land grant institutions like MSU. However, developing contacts who can provide student access to real-world problems requires great effort that is well appreciated at the chair, dean, (and above) level if not always by research faculty. But unless this effort is expended, the chance of program success is vanishingly small.

Form an industrial advisor board and take their advice!

An industrial program must be grounded in the realities of the workplace. Faculty have little experience and many odd notions about what actually takes place in the workplace. Advice from people *in situ* is essential. A board's advice on curriculum, program structure, and professional development is invaluable.

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

A board of about a dozen has worked well for the MSU program; its current makeup consists of representatives from Ford (2 members), General Motors, DaimlerChrysler, National Security Agency, Veridian, Delta Dental, AAA, S.E. Michigan Council of Governments, McCleer Power, Neogen Corp., and WatsonWyatt.

Anticipate that 30% of the board members will be unable to attend any given meeting because of last-minute emergencies at work. The exigencies of business trump longer term priorities.

In any meeting of faculty with the industrial board, the dynamics of the meeting will be unproductive unless the industrial people far outnumber faculty. The industry people must feel relaxed and free to brainstorm. Faculty need to listen rather than lecture.

Incorporate industrial projects into the curriculum

A portfolio of completed industrial projects is an enormous advantage to your graduates when they interview for industrial positions. Obtaining such projects is relatively simple once you know the "Maki method." D. P. Maki, former Chairman of the Indiana University Mathematics Department, has been soliciting industrial projects for students for decades. In MSU's version of the Maki method, a paid PSM student is given an office with a telephone and an answering machine. The student places cold calls to local companies, explaining to the receptionist that the department is seeking projects, and asking for contacts within the company. The student explains our problem-solving service to the contact, and appeals for "help in better educating our students." The first project is often offered on a complimentary basis.

The student continues to call back; industry people are busy and depend on persistence. The rule is simple: Never give up on a contact until they have supplied two more contacts. Jot down company names seen in travels about town. Ask faculty for their contacts within local industry. Talk with people on airplanes, at gatherings, and at social settings. Never miss an opportunity to network.

Ask prospective project proposers for backburner projects that they would attack, given the time and resources. Offer them the resources of a team of three very smart kids to work on their projects. Their only commitment is the assignment of a company liaison to propose the problem, to occasionally field clarifying questions from the team, and to arrange for a presentation on site at project end.

Any interesting question should be welcomed. At MSU no time is spent clarifying and presolving the problem to anticipate its possible mathematical content and tools required. A better student project results when a company's ill-posed problems are left for the students to untangle. This experience should be a problem-solving, rather than a *mathematical* problem-solving experience. Occasionally team members will continue on with the project as paid consultants.

MSU has far more projects proposed than it has teams to work on them.

Other PSM programs substitute internships or co-ops for this industrial experience with mixed successes (since the university loses control over the experience).

Cultivate faculty facilitators

A more significant hurdle is the need to enlist faculty volunteers to facilitate the development of the student teams. All faculty members believe that they are completely overloaded and can take on no further work. Moreover, they are reluctant to take on industrial problems, worrying, "What if we can't solve the problem." They must be reassured that one can always bite off and solve a portion of any industrial problem, almost always to the delight of the company. Most of the work will be in clarifying the problem, at which mathematicians are truly gifted.

Choose faculty with little or no experience in the particular problem area. It has been the MSU experience that, the more the faculty knows, the more they meddle; and the more they meddle, the worse the final project outcome. Make it clear that faculty members are to serve only as facilitators, not true managers. (This insistence will also ease their fears.) Moreover, because of intellectual property issues, it is best for the faculty not to be involved intimately with the project development.

Once a program has a project track record, it can begin to charge small amounts for projects to be used as stipends (i.e., bribes) for faculty to facilitate projects. MSU now has more faculty volunteers than it can employ.

Provide professional development

The goal of PSM programs (to put it indelicately) is not to train "cubical rats" to serve as cannon fodder for the management MBAs. Instead, we shape our graduates to eventually take on these management roles. PSM graduates must understand the fundamentals of business and must be skilled in writing and oral presentation skills. They will be judged in industry not by their work but by how well they present their work. So it is imperative that the students be exposed to the fundamentals of business communication as well as project, marketing, and financial management; managerial accounting; intellectual property law; consensus building; etc. At MSU, this is accomplished through 10 intensive weekend modules developed and presented by the MBA faculty. We also invite "headhunters" to visit to instruct students on resume writing, dressing, and preparing for interviews. This continuous exposure to the language and culture of business is an enormous advantage for students when they begin to interview.

Students at MSU receive a transcriptable Certificate in Business and Communication for their professional training. Information about this Certificate is available at the web site `http://grad.msu.edu/all/bus_mgt.htm`

Mount a branding campaign

The title "industrial mathematician" is at present relatively unknown. Program developers should take any opportunity to reach out to the business community in order to advertise their product—their "universal problem solvers." A track record of diverse past projects is quite persuasive. Faculty can then plausibly argue that they are training versatile, self-starting, quick-study employees with a deep understanding of computational issues.

Choose a committed coordinator for the program

This cannot be an add-on duty for a faculty member. The coordinator must be essentially full time. There is a heavy load of day-to-day management: recruiting, teaching, advising, industrial outreach, project development, advertising, resource generation, etc. As one looks around the country, the single most effective characteristic of successful programs has been the existence of a committed and energetic coordinator. Programs without committed coordinators are failing.

Recruit, recruit, recruit

Establish a splendid web site describing the program—it is your most effective recruiting tool. MSU has tried many recruiting techniques such as writing personally-addressed, personally-signed letters to all students who took the GRE and expressed an interest in graduate study in mathematics. We also seize on any opportunity to speak to undergraduates at student colloquia or mathematics conferences. But these approaches are too often too late—seniors who would be attracted to industrial work have already transferred to other majors because they were unaware of the rewarding PSM career path. Recruitment must start earlier. To this end Sloan has advertised in the newsletter of the National Career Development Association and similar organizations. Recruiting is the single most troublesome issue, requiring an enormous amount of one-on-one communication with potential recruits.

Resources

The A. P. Sloan Foundation has been the single most effective proponent of PSM programs. The Foundation recognizes that national competitiveness in modern, increasingly science-based industries depends on having science-trained professionals at policy-making levels of industry and government. The Foundation has provided crucial seed money for program start ups and continues to support existing programs in many ways. For example, the foundation maintains an extensive clearing house for information about all PSM programs at

`http://www.sciencemasters.com`

Detailed information about the 7 PSM programs at Michigan State is found at

`http://www.ns.msu.edu/prospective/grad/profmasters.htm`

and information about the industrial mathematics program in particular at

`http://www.math.msu.edu/msim`