A Student-Directed Professional Development Program for Doctoral Students Seeking Industry Placement

Mr. Daniel P. Dempsey, University of Massachusetts Lowell

Daniel Dempsey is a Ph.D. student in the Department of Plastics Engineering at the University of Massachusetts Lowell. He obtained a B.S. in Plastics Engineering Technology from The Pennsylvania State University, and an M.S. in Plastics Engineering from UMass Lowell. His primary research interests involve microscale surface engineering and developing manufacturing strategies for nanoscale feature enabled polymer substrates.

Dr. Carol Barry, University of Massachusetts, Lowell

Carol Barry is a professor of Plastics Engineering, director of the Nanomanufacturing Center, and associate director of the Center for High-rate Nanomanufacturing at the University of Massachusetts Lowell. She received her Doctor of Engineering degree in Plastics Engineering from the University of Massachusetts Lowell and her Bachelor of Science in Chemistry from Boston College.

Prof. Joey Mead, University of Massachusetts Lowell

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Abstract

Although industry requires young Ph.D.s. with well-rounded professional skills, many new graduates lack these skills. The typical focus for placement of doctoral students, for many universities, is in academia or government research facilities, and so the impetus of skill refinement is often geared towards that end. Skills required for placement in such fields, i.e., research abilities, communication skills, interviewing, and even job searching, while applicable to both academia and the private sector, often are employed in different ways. An example of the nuances between academia and industry preparation is the differences between writing a resume versus writing a curriculum vita. It becomes more difficult for a student with industrial career aspirations to learn the distinctions in how to utilize common skills for different ends, and adapting skills learned for academia to industry often leave the student looking ill-prepared to make the transition.

This paper presents steps taken by the graduate students of the Center for High-rate Nanomanufacturing (CHN) at the University of Massachusetts Lowell for professional skill improvement and job placement strategies intended for careers in industry. Prior to this work, no outlined professional development program at the University was focused solely on doctoral student placement in industrial oriented careers. Therefore, the CHN students formulated a professional development program tailored to meet their specific needs. After considerable consultation with industry human resource representatives, university professors, and the university's career counselors, a professional development program was formed to address three main areas of interest: the improvement of core research abilities, the development of skills required for transition from academia to industry, and the necessity of projecting a professional disposition in the workplace. The graduate students organized a yearlong series of workshops in which university and industry professionals addressed each of the three areas of interest. The program was evaluated through a combination of peer and self-reviews, writing improvement rubrics, and industry representative criticisms. The results showed not only a high degree of satisfaction among the graduate student population, but also a general improvement of skills in each of the three main focus areas.

Introduction

Although industry requires young Ph.D.s. with well-rounded professional skills,[1] many new graduates lack these skills. First, with large number graduate students matriculating from international undergraduate programs, many students lack the ABET-required skills such as working in multidisciplinary teams; understanding professional and ethical responsibility; and understanding the economic, environmental, and societal impact of their decisions.[2,3] Communications skills are also an issue.[4] Second, for many universities the typical target for placement of doctoral students is in academia or government research facilities, and so the impetus of skill refinement is often geared towards that end. Programs tend to focus on research skills, better communication,[4,5] mentoring,[6] and sometimes, approaches to teaching.[7,8,9,10] Since

limited programs enhance management skills such as how to "resolve conflicts, initiate projects, and provide guidance,"[11] graduates often seek management degrees after joining industry.[12] Third, skills required for placement in academia or government research fields, i.e., research abilities, communication skills, interviewing, and even job searching, while applicable to both academia and private sector, often are employed in different ways. An example of the nuances between academia and industry preparation is the differences between writing a resume versus writing a curriculum vita. It becomes more difficult for a student with industrial career aspirations to learn the distinctions in how to utilize common skills for different ends, and adapting skills learned for academia to industry often leave the student looking ill-prepared to make the transition.

Prior graduate student-led programs at CHN

The Center's faculty recognized many of these problems and asked the newly-formed Graduate Student Council to develop an approach to tackle the situation. When the graduate student-led professional development program was started in 2009, the diverse body of graduate students first identified some common research and communication-related problems, specifically:

- Culture-dependent differences in learning styles that provide a majority of students with good passive skills (e.g., lab work, data collection), but inadequate active skills (e.g., presentation of their ideas, formal presentations);.
- International students learning subject matter in their own language, and so, lacking the vocabulary to clearly explain their ideas;
- An apparent lack of openness of idea expression in many of the international teaching systems. Most international students had few opportunities to practice presentations during their previous learning experiences. This lack induced a fear of public speaking, and English as their second language added another barrier to good public presentations.
- Varying abilities to analyze data, organize written material, and write appropriate papers, etc.

The Graduate Student Council's approach was a weekly graduate student meeting (separate from the weekly research group meeting). Since a majority of graduate students found it difficult to express their opinions or accept their mistakes if a faculty member or post doctoral researcher was present, these meetings were for graduate students only. The Center provided a food budget. To celebrate different cultures, the graduate students alternated the assignment of selecting the food for a meeting. These sessions were (and are still) well attended.

During the 2009-2010 academic year, the focus was analytical skills, specifically the ability to identify strengths and weaknesses in the analysis of a new scientific paper. The Graduate Student Council members suggested five different fields, i.e., physics, chemistry, material science, biomedical, and polymer science. Graduate students selected one article for their presentation beyond articles related to their research work. The students also explained their thought process when making the presentations. Each individual's presentation was peer reviewed and the individual was given suggestions for improvement. The Graduate Student Council also conducted voting among the peers to select the best presenters. This professional development program proved useful in (1) expanding the students understanding of the "good" and "poor" presentation of technical data; (2) improving students' comfort level when presenting

at research group meetings; (3) increasing the students' willingness to critique, question, or comment on other students' results; and (4) creating an appreciation for international foods. The fall 2010 student meetings focused on improving the writing skills of the graduate students. The subject matter for the presentation was related to individuals' research area. The Graduate Student Council leaders felt that this approach would not only make the other students comfortable for the presentation, but also would give them a chance to show their logical understanding of the subject matter. So, each student wrote a paragraph about his or her progress in the research. The paragraph was provided to the other students before the meeting and also presented during the meeting. The other students in the group analyzed the paragraph and provided suggestions, comments, and critiques. The most common problems associated with writing the paragraphs were (1) poor organization of thoughts; (2) unclear content; (3) insufficient information; and (4) poorly-written objectives for presentations or papers. The spring 2011 meetings were follow-up sessions in which the revised paragraphs were presented. In addition, three interational students were required to take a new University-wide course "ESL for Graduate Students;" (this course was so popular with research advisors that the University created three sections for spring 2011). *A total of 19 students participated in the 2010-2011 UML communications meetings; this group included seven American students and 12 Asian students (4 Chinese, 5 Indian; 1 Korean, and 2 Thai).*

In addition, the Boston Museum of Science and CHN team provided *Sharing Science* workshops in science demonstration skills and inquiry-based learning for over 60 graduate students in fall 2009. The students spent a day at the Museum, training to engage the public in nanotechnology with hands-on, inquiry-based activities. The students followed up on this training by delivering an outreach practicum on the Museum's exhibit hall floors, reaching hundreds of Museum visitors with their demonstrations. In February 2011, a select group of researchers returned to the Museum for additional training. The morning session included a lecture on presenting technology to general audiences and a practice with hand-on activities. Some faculty and more experienced graduate students assisted the newer students with their activities. In the afternoon, the graduate students practiced their new skills with Museum visitors.

New graduate student-led program

During 2011-2012, the program to improve research and communication skills was continued with three thrusts:
- Better communication skills (continued),
- Improved training on proper and safe operation of laboratory equipment, and
- More efficient and effective literature searches.

Since about 88% of the 25 students in this graduate student group are interested industry careers, the new thrust in the 2011-2012 program focused on developing researchers with well-rounded skillsets (i.e., professional, literary, communication skills) that are needed in industry. Since many domestic and international students enter into the American workforce without such skills, these new graduates require a certain amount of time for "professional acclimation," which results in reduced production for the individual and affects the young researcher's psyche as well as the hiring company's bottom line. The graduate students themselves idenitified these problems, so the Graduate Council Student leaders spearheaded new professional development for:

- Writing of resumes and/or vitae,
- Identifying and searching for positions that required doctoral degrees,
- Proper use of social media outlets (e.g., LinkedIn™),
- Interviewing skills,
- Workplace diversity, and
- Workplace etiquette.

The effectiveness of each program thrust was evaluated using pre-test and post-test questions which were answered on a scale of 1 (needs work) to 8 (excellent).

Although the graduate students attended yearly safety training, most of this training was focused on proper handling of chemicals and biological agents as well as safety procedures for injuries, fires, and other problems. Some students also had attended department-specific safety programs - usually in the first year of their graduate programs. To upgrade all students skills, the lead operator(s) of each piece of major equipment led a short workshop on using that peice of equipment. Students attending the workshops were enthusiastic about the training. As shown in Table 1, Question 1, students ranked their base knowledge of operating the laboratory equipment relatively high (5.9 out of 8), but still felt that the workshops significantly improved their skills.

Table 1. Evaluation of 2011-2012 Program, Part 1

Question	Before	After	Change
1. How to operate lab equipment safely and correctly	5.9	6.9	1.0
2. Knowledge of database content at the University library	4.5	6.4	1.9
3. Ability to perform a robust and efficient literature search	5.7	6.8	1.1
4. Quickly discerning papers to determine main points	5.6	6.9	1.3
5. Knowledge of technical writing standards and ability to follow them	5.2	6.6	1.4
6. How to effectively form a professional presentation	5.2	6.9	1.6

For more efficient and effective literature searches, the Graduate Student Council teamed with the librarians at the University to offer a three workshops: "Introduction to Library Resources," "Efficient Identification and Use of Databases," and "How to Read a Research Paper." The first workshop was a standard offering. As shown in Figure 1a, the students attended the workshops in the library and were led through interactive, hands-on demonstrations of the various database options offered by the library system. The latter two workshops were designed specifically to address the graduate students' needs. Evaluation showed that all three workshops produced the significant improvements in searching the literature (Table 1, Questions 2-4). Although the group included students with various levels of research experience, even more senior doctoral students reported a 1.0-point increase in their skills levels after the first workshop. With the second two workshops, increased knowledge was reported primarily by the less-experienced graduate students. In the evaluation, one student commented:

"I had just started here at Lowell when these workshops were held. I didn't have any experience in graduate research, and had never really learned how to read a research paper. I didn't even know what went into the different parts. I was glad to go through these workshops because afterwards I could easily find the important parts of papers, speeding up my ability to perform literature reviews. Also, it was great to know what databases the library offered, and which would be more useful for specific searches.

> *Marion* [the librarian who gave the workshops] *was very helpful in teaching me how to research faster and smarter. She was also very approachable and was always available to help."*

The senior graduate students reported that the second two workshops produced little or no change in their skills, but did not report their skill levels as "excellent" (8). Comments included with the evaluation suggested that (1) the first workshop should be attended multiple times during a student's graduate studies to update skills; (2) the workshops "Efficient Identification and Use of Databases" and "How to Read a Research Paper" were more suitable for newer graduate students, and (3) a more advanced version of the latter two workshops would be useful for the senior graduate students (and possibly, the post-doctoral researchers).

| (a) | (b) |

Figure 1. Professional development: (a) workshop on library skills and (b) resume/vitae writing workshop.

Improvement of communication skills involved three programs. First, the weekly presentations by individual graduate students were continued in 2010-2011. Second, a new focus on improving general writing skills was addressed by the hiring of three "wordsmiths," senior English majors who acted as writing tutors to the group. The Graduate Student Council leaders and the wordsmiths worked together, creating a curriculum to administer and track improvements in the ability of the students to organize and compose their thoughts within the bounds of proper grammar and scientific writing standards. Each student was required to perform weekly grammar assignments from texts chosen by the wordsmiths based on their individual level of competency. These assignments were then reviewed by the wordsmiths with the students on a weekly basis. Monthly writing assignments were also required from the students and could address any issue the writer chose. Commonly, the students would submit writing samples from an upcoming poster presentation or an intended publication. Those assignments were reviewed by the wordsmiths with the students during one of their weekly meetings. Third, science educators from Boston Museum of Science provided several workshops on targeting technical content to various business audiences - e.g., research managers and marketing professionals. These workshops were built on the success of the *Sharing Science* workshops.

The overall evaluation of the communication programs is shown in Table 1, Questions 5 and 6. On average, the students reported a 1.5-point increase in knowledge and skills compared to moderate starting levels (5.2 of 8). While the improvement was similar for most students, there were a wide variety of self-reported skill levels. Generally, the less experienced, international

students reported the lowest skill levels (i.e., 1 to 3 out of 8). The more experienced students, both U.S. and international reported higher skill levels with some at "excellent." (When presented the anonymous results of the evaluation, the faculty advisors did not always agree with these students' rating of their writing and presentation skills.) Students who actively collaborated with the "wordsmiths" reported more significant (3-4 point) gains in skills. For example, one student wrote:

> *"I worked with Ashley, the writing tutor hired by the CHN, fairly extensively in the winter of 2011-2012. In addition to supplying me with exercises to help develop an understanding on properly structuring sentences, she was willing to help with writing pertaining to my research, and encouraged me to use her as a source of knowledge and assistance. With her help, I was able to format an abstract for a poster session at a conference that had a better flow and focus than what I sent to her originally. She was a great help, and I look forward to working with her in the future as I prepare larger and more in-depth abstracts and journal submissions."*

Several students, however, refused to work with the "wordsmiths" - even though they would have benefited from the program. Through comments included with the evaluation, these students indicated that the wordsmiths' technical knowledge was inadequate for correcting their writing; they wanted to work with the far-more-expensive technical writer. The impact of science educators workshops was not apparent in the evaluation, but comments showed that the students enjoyed the workshops.

The skills for obtaining and being successful at a professional position included writing of resumes and/or vitae; identifying and searching for positions that required doctoral degrees; the proper use of social media outlets (e.g., LinkedIn™); interviewing skills; workplace diversity; and workplace etiquette. The University of Massachusetts Lowell has a active Career Development Center, but most of their efforts and programs are focused on positions for students with baccelaureate and masters degrees. The Career Development Center, however, was willing to develop new materials. So, the Graduate Student Council and Career Development Center developed and delivered workshops on (1) resume writing; (2) job hunting; (3) social media; and (4) interviewing skills. These workshops were held throughout the academic year and were attended by the entire graduate student group as well as friends from other research groups (Figure 1b). After each workshop was completed, the students met independently to discuss the material that was covered, and to put into practice the subject matter. Each graduate student member compiled a resume which was critiqued by the rest of the group. Those resumes were then uploaded to the Center's website. Additionally, a majority of the students also created their own LinkedIn™ page as per the guidelines set forth by the Career Development Center. After the workshop on interviewing skills, students were required to perform mock interviews with the Career Development Center. Along with proper interviewing techniques, the students held an internal discussion regarding the best practices for job searching at a Ph.D. level. The conversation was driven by Center alumni who had already been through the process with further details added by students who were currently going through the process. Students focused on utilizing websites such as monster.com, indeed.com, and linkedin.com; contacting and maintaining relationships with professional recruiters; and using networking opportunities at conferences and Center poster sessions.

Table 2, Questions 7-9, presents the evaluation of the Career Development Center workshops. Overall, the students reported a 1.5-point increase in their ability to write a resume. Newer international students reported greater confidence in their ability to write resumes. All U.S. and the more experienced international graduate students felt that they learned how to fine tune their resumes for each position that they sought. Many of these students applied these skills during job searches over the last six months. The students also reported better use of LinkIn and other social media; (most also cleaned up Facebook pages). The the interview skills workshop and mock interviews were also a success, with the students reporting a 1.7-point increase in their interviewing skills. Students' baseline rating of their social media and interview skills varied, depending on their background and experiences. As many students have implemented job searches, all have used their enhanced skills for phone and in-person interviews; they also felt that even better skills would be an asset.

Table 2. Evaluation of 2011-2012 Program, Part 2

Question	Before	After	Change
7. How to write a resume	5.1	6.6	1.5
8. Use of social media (i.e., LinkedIn) for professional networking	5.1	6.5	1.4
9. How to prepare for and be interviewed	4.8	6.4	1.6
10. How to dress in the workplace	5.4	6.9	1.7
11. Diversity and tolerance in the workplace	5.9	6.9	1.0

Job search strategies and skills were not formally evaluated because these skills would not be used until the students were actually searching for positions. Informal discussions with senior graduate students, however, indicate that the students have employed most of the strategies suggested during the workshops. These students have also had their baseline resumes evaluated by industry professionals - primarily university alumni and individual industry contacts. The industry professionals provided feedback on the content of the resumes and suggestions for improvements.

Two outside contractors presented the workshops on workplace etiquette and diversity. The first workshop focused on dress for success. The presenter showed a slide show with examples of good and bad work outfits and practices. She also brought along a selection of male and female attire to show how to smartly select items for a professional wardrobe. A demonstration showed best practices in mixing and matching pieces of clothing. The subsequent lively discussion included topics like when to wear or not wear jeans and sloganed tee-shirts; the proper length of men's pants; the necklines for women's clothing; the use of business casual vs. formal attire (e.g., suits); and how to identify proper attire for international business meetings. As shown in Table 2, Question 10, the students reported a moderate base knowledge of how to dress for the work place (5.4 out of 8) and a significant 1.7-point improvement after the workshop. Although students with significant work (industrial) experience did not learn much about proper workplace attire, they found the information about building a professional wardrobe was very useful.

The second workshop focused on workplace diversity. The workshop leader first presented U.S. anti-discrimination laws, their origin, and impact on work place practices to the students. He then presented a series of diversity-related situtations or cases to the group. With each case, the

smaller groups with diverse composition discussed the case and formulated solutions. The entire group then discussed the subgroups' idea about and solutions to each case. Finally, the real world solution was presented. As shown in Table 2, Question 11, the students reported a 1.0-point improvement in their "diversity skills" after the workshop. Comments, however, suggested that the workshop was too condensed and that the subtleties of the cases eluded the students. Although the Graduate Student Council discussed this issue with the Center directors, the revised version of the workshop has not yet been determined.

The Graduate Student Council did not hold a formal dress-and-dine-for-success event; (it was deemed too expensive for their budget). They substituted a series of networking events throughout the summer and into the school year. These *Grilling with Geeks* events were a series of cookouts held during the work week at the university (Figure 2). The Center, in addition to the Nanomanufacturing Club and the Student Rubbr Group, allocated funds to purchase a gas grill and the necessary accoutrements for these cookouts. The events were successful not only in providing a welcome interruption in the daily work schedule, but because of the inherent diversity of the research group, also served to improve the students' ability to share the details of their work with their peers; promoted understanding in diversity; and ultimately helped the students grasp an understanding in how to conduct themselves in a similar corporate situation.

Figure 2. The *Grilling with Geeks* events attracted graduate students, faculty, undergraduate researchers, and University visitors.

Conclusions

At the Center for High-rate Nanomanufacturing, a graduate-student-led program improved the overall communication and professional skills of 25 graduate students. This relatively-inexpensive program used existing university resources such as the library and career center as well as some outside contractors. The program not only focused on the communication and research skills typically needed for graduate students, but also added the skills (e.g., resume

writing, job searching, interviewing, dressing, and diversity) needed to obtain and be successful at a professional position in industry. A diverse group of graduate students agreed that the program improved their professional skills and all of these students have implemented their new skills into the research, communications, and in some cases, their job searches. To date, four students have successfully used these skills to obtain industry positions and another two are expected to receive job offers within the next month; all received multiple interviews. In addition, a group of graduate students employed these skills when they successfully manned a trade show booth without staff assistance in fall 2012.

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