# CAREER COACHING FOR PH.D. STUDENTS

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In recent decades, there has been a shift in employment options for engineers in the United States.[1, 2] For engineers with Ph.D.s, the shift has been from academic to non-academic positions. During this time, the focus of doctoral research has also shifted from basic research to applied research.[2] In 2006, 70% of doctoral recipients in engineering did not hold positions in academia. According to National Science Foundation (NSF) Division of Science Resources statistics, approximately 55% of engineering Ph.D.s were employed in the for-profit sector, 30% were in educational institutions, 7% were in government, 4% were in private non-profit institutions, and 4% were self-employed.[3]

To prepare students for work in the for-profit sector, seminars have been designed at various engineering doctoral programs within the United States in order to develop breadth of technical knowledge and transferable skills (often referred to as soft skills). For example, some chemical engineering departments require Ph.D. students to present their research to fellow graduate students at a seminar. By presenting the doctoral work to their peers, students' oral communication skills may be further developed.[4, 5] Some seminars have been designed to keep students informed of new developments within their field of engineering, thus developing students' breadth of knowledge.[4, 6] Other topics discussed in seminars include a critical review of literature, intellectual property, managing non-human resources, ethics, mentoring, and teaching.[6-10]

Seminars are also used to encourage doctoral students in

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their program of study by equipping them with "doctoral survival skills."[6, 11] These survival skills are important because only 64% of students who begin engineering doctoral programs complete their degrees within 10 years, according to the Council of Graduate Schools.[12] Topics in these "doctoral survival skills" seminars include how to choose an advisor, creating a resume, and career options for Ph.D.s, but they do not discuss the industrial research environment.[7, 11] Although seminars are offered at several universities, little research is available that uses a seminar course to present the industrial research environment to graduate students and documents students' perspectives on such seminars. The purpose of this paper is to first present the development of a non-technical seminar course for engineering doctoral students and then to discuss how students perceive the value of this seminar course.

## COURSE DESCRIPTION

A seminar course was created with the following objectives: 1) to give students a greater understanding of the industrial research environment, 2) to develop students' awareness of transferable skills needed in this environment, and 3) to help students find a position within industry. To simulate an industrial research environment and encourage class discussion, the seminars were held in a conference room in lieu of a traditional classroom setting. The course was first offered on an experimental basis during Summer 2010. The process to permanently approve the course was initiated in Summer 2011 so that it can be repeated. In Summer 2010, students voluntarily enrolled in the course and received a one-credit-hour pass/fail grade. Class participation and attendance were 60% of students' final grade, with the remaining portion consisting of reading assignments and a two-page reflection paper. The reading assignments included journal articles, book chapters, and web resources discussing seminar topics. The final assignment was a two-page reflection paper asking students to discuss how a seminar topic of their choice had impacted them. The students had two weeks to complete this paper.

The instructor for the course held three positions in industry prior to obtaining his Ph.D. in chemical engineering. During his industrial experience, he observed that most engineers in industry not only spend time on technical tasks, but also on tasks that required transferable skills. These skills he observed included: communicating with coworkers to provide or request information; organizing and scheduling projects, collaborating with vendors and customers; and managing compliance, safety, and regulatory issues. As a result, he realized that transferable skills are critical for success in industry. While teaching the course he was an associate professor in the chemical engineering department. He invited several different speakers to the class to discuss their past and present job responsibilities and skills in order to help students gain an understanding of the different types of positions available to engineering Ph.D.s. The topics discussed in the seminar included intellectual property, managing customer and product requirements, engineers in business, and career management. A list of the course topics can be seen in Table 1.

The guest speakers had various combinations of experiences working in small businesses, large corporations, national labs, and academia. Several of the speakers were Ph.D. engineers who were working in industry or had significant industry experience prior to their current position. The speakers who did not have their Ph.D. in engineering were selected because of their unique expertise that would enrich the seminar. Speakers were encouraged to prepare a 15-20 minute presentation on their topic and to allow the remaining 30 minutes for questions and discussions from the students, with an occasional ice-breaking question from the instructor. Some presenters prepared an hour lecture while others had a list of topics they were willing to discuss and allowed students interested in the listed topics to guide the class discussion.

| TABLE 1 | |
|---|---|
| Topics Discussed in Seminar Course | |
| Topic | Discussion Leader |
| Overview and History of Graduate Research | Instructor |
| Career Services | Career Advisor from university's Career Services |
| Professional Etiquette | Instructor and Participant Observer |
| Intellectual Property | Attorney with a B.S. in chemical engineering and M.B.A. currently working for the university's Intellectual Property Office |
| Professional Ethics | Ph.D. working in industry |
| Negotiation, International Issues, and Networking | Instructor |
| Who's Really Your Boss? | Ph.D. engineer |
| Managing Customers and Product Requirements | Ph.D. engineer from a large corporation |
| Engineers in Business | Engineering professor with extensive industry experience, who is currently pursuing his p.B.A. |
| Career Management | Ph.D. with experience in industry, national labs, and academia |

## Helpfulness of Seminar Topics
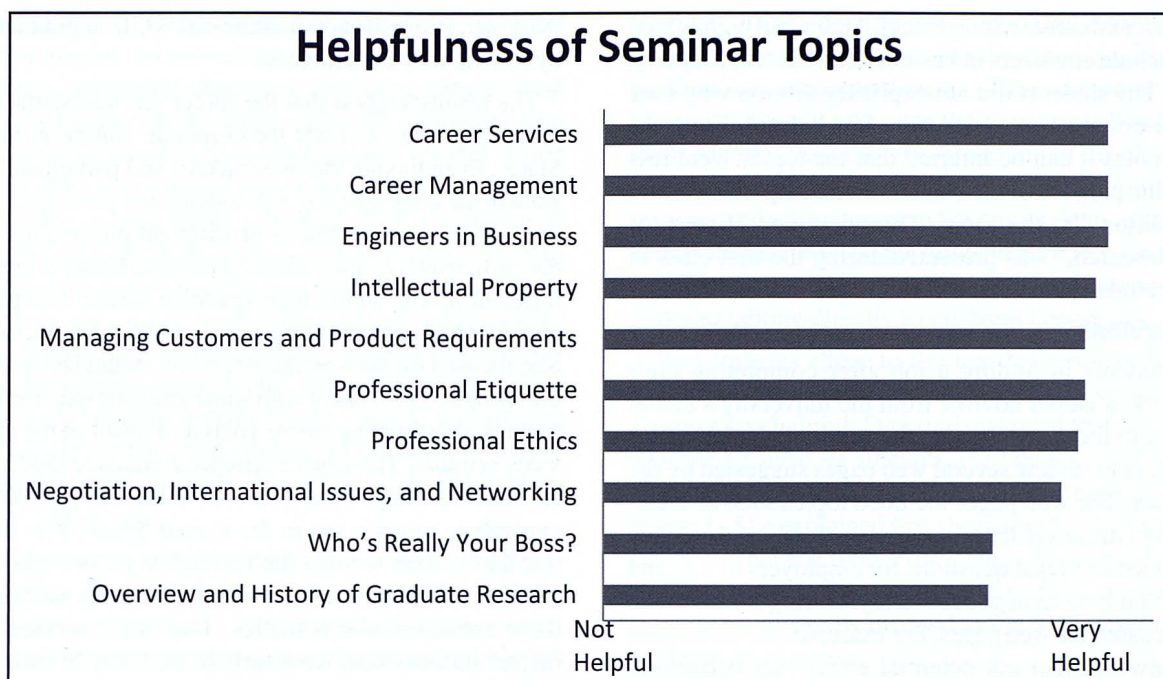


**Figure 1.** *Average response to the question: The topics discussed in ECHE 598Z are listed below. Please mark the one answer to indicate how helpful this topic is to your career.*

Fourteen students voluntarily enrolled in the course. The majority of students were in chemical or mechanical engineering doctoral programs. They had been enrolled in graduate school for various lengths of time. For example, one student was in her first semester of her graduate studies, while another student was graduating with her Ph.D. the semester the class was taught. Female students consisted of 42% of the class, and underrepresented minority groups made up 21% of the class. These proportions are higher than the university's graduate engineering program consisting of 23% female and 10% underrepresented minority groups.

## METHODOLOGY OF DATA COLLECTION AND ANALYSIS

To address the question of how engineering doctoral students perceive the value of a non-technical seminar course, three different methods were used to collect data. The first data collection method was field notes taken by a participant observer during each seminar. Before pursuing her Ph.D., the participant observer had experience working in industry and in intellectual property. The notes she took included observations on the speakers' discussion and students' interaction with the speakers.

The students' two-page reflection paper was the second method of data collection. The reflection paper asked students to choose a seminar topic and discuss what they knew about the topic prior to the seminar, what they learned in the seminar, and how this knowledge might impact their future. As part of their final assignment, students were also solicited for

suggestions to improve future "Graduate Student as Leader" seminar course.

The data analysis began by summarizing the field notes of the participant observer into paragraph form. The seminar summaries and reflection papers were analyzed to determine if students believed they had gained an understanding of the industrial research environment, transferable skills needed in industry, and information on how to find a position within industry.

The third method of data collection was a survey designed to assess the helpfulness of each seminar topic. Students were asked to respond according to the following question:

*The topics discussed in ECHE 598Z are listed below. Please mark the one answer to indicate how helpful this topic is to your career.*

A list of the topics can be seen in Table 1. Students were given a four-point scale with choices ranging from "Not Helpful" to "Very Helpful." The survey results were then averaged.

## HIGHLIGHTED SESSIONS

Rather than provide a detailed description of all the seminars, this paper focuses on the topics that students indicated were the most helpful topics discussed in the seminar as seen in Figure 1. These topics were also specifically discussed by one or more students in their final reflection papers. This enables one to gain some understanding of the actual student learning outcomes. The highlighted topics include career services, professional etiquette, managing project and customer

requirements, and career management. Additional highlighted seminars include engineers in business, intellectual property, and ethics. The students did not explicitly discuss why they felt that the bottom two topics were less helpful. From the observer's notes it can be inferred that the topics were less relevant to the purpose of the course when compared to other topics. Additionally, the topic "Overview and History of Graduate Research," was presented during the first class in which the course syllabus was distributed.

## Career Services

To aid students in finding a job after completing their doctoral work, a career advisor from the university's career center spoke to the class. Prior to the seminar, the instructor asked the class to review several web pages suggested by the career advisor. The web pages included topics such as creating a resume/vita, cover letter, examples of typical interview questions, a list of illegal questions for employers to ask, and information on how to negotiate salary. During the class the speaker discussed the web pages. For example, she mentioned that interviewers often ask potential employees behavioral questions. These questions allow potential employees to give specific instances of past behavior as a means to predict future behavior. To effectively answer behavioral questions, the speaker suggested first explaining the situation, and then the tasks and actions required to accomplish the end result. One of her concluding remarks was that while interviewing and after starting work, one should always be aware of actions and dress, because they reflect upon oneself.

At the end of the semester, two students wrote their reflective paper on the career services seminar. One student, who had been in the doctoral program two years, stated that he had never thought about work after graduate school. After the career services seminar he began thinking about his career. He realized that he needed clear objectives in order to create a plan to reach his career goals. In his reflection he did not specifically mention his career goals. He has, however, set himself several interim goals that he believes will give him tools to reach his career goal. His interim goals are: 1) to improve his spoken English (English was not his first language), 2) to work hard on his research, and 3) to consider joining student organizations to enrich his graduate student experience.

The second student was in her first graduate class in the United States. In her words, the seminar "blew her mind" because it made her realize the steps she needed to take as a graduate student to find employment in the United States after graduation. In her reflection paper, she stated that the career services seminar had given her strategies to answer tough interview questions, and motivation to develop professional networks and to have experiences outside the research lab. In her reflection paper, the student stated that networking is vital to a professional career because an opportunity may come through a friend, teacher, or neighbor. The student also mentioned that the speaker suggested that students discover their own strengths and weaknesses while in graduate school by having new experiences.

The results suggest that the career services seminar helped students prepare to enter the corporate culture in the United States. Even though the two students and participant observer were in the same seminar, the students and participant observer appeared to place emphasis on different information. Perhaps the participants heard different messages because they were at different places within their graduate career. The participant observer had approximately one year left in her doctoral work. She focused on the specific interview strategies discussed by the speaker. The student with some graduate experience began to think about setting career goals as a result of the career services seminar. The less-experienced graduate student gained an understanding of how to maximize her graduate school experience to get a job in the United States. It is interesting that the students focused their reflection papers' discussion on listing items on their resume/vita, not the skills learned through these extracurricular activities. The career services seminar helped students who were early to mid-way in their graduate career realize that activities outside of the research laboratory are important to develop their vita while those later in their graduate career learned about interview strategies.

## Professional Etiquette

Both the instructor and the participants in the course provided content for the professional etiquette seminar. Topics covered in the seminar included appropriate conversations, greeting people, dining etiquette, and proper business and business-casual attire. For example, the instructor suggested avoiding topics such as politics and religion in the workplace. He suggested an appropriate topic such as the latest ballgame. Because different cultures have different styles of shaking hands, the discussion of how to greet others included instruction and a brief practice session on giving a firm handshake.

An international student wrote his reflection paper on this seminar. Prior to this seminar, he did not think etiquette mattered in the United States. He realized that professional etiquette is important and can be formal, especially in an interview. The student admitted that talking with Americans was difficult for him, but through this seminar he has begun to develop some talking points, such as discussing the latest football game.

Data suggests that this seminar gave international students a better understanding of American professional etiquette and culture. The student's reflection paper also indicated that the discussion may help him become more comfortable talking with Americans in a professional setting. This seminar appeared to be helpful to students who had little to no experience working in industry in the United States.

## Managing Project and Customer Requirements

Engineering Ph.D.s need an expertise in teamwork to be

successful in the industrial work environment.[13] In order for students to gain an awareness of these skills, a speaker from a large corporation discussed managing projects and customer requirements by using effective teamwork and communication strategies. For instance, the speaker stated that he was often the technical expert for the marketing team. As the marketing team wrote a contract with a customer, it was the speaker's job to be critical of engineering specifications because he would be held accountable to the contract specifications after it had been signed. He advised students to define explicit expectations when creating requirements in formal documents. Specifically, he suggested not to use words such as "similar, maximize, etc." but to make terms measurable. He also advised students to not allow others to define how a solution should be developed unless those others are experts in that area.

One student discussed the project and customer requirements seminar. He stated that he wanted to work in industry upon completing his Ph.D., but he had not known about project and customer requirements prior to attending this discussion. He mentioned that he had learned the importance of communicating effectively with the sales and marketing teams to ensure that project requirements were designed to address the specific issue. For example, he learned that a goal must be able to be measured in order for a design team to understand the goal. He reflected that words such as minimized and maximized are too vague for design teams. The student felt that the speaker had clarified the role that new Ph.D.s may have within large corporations. He also has gained clearer ideas of different career ladders for engineering Ph.D.s from this seminar.

In the managing customers and product requirement seminar, both the participant observer and the graduate student reflected on the importance of effective communication strategies while developing formal documentation for customers. This seminar also gave the student a greater understanding of potential careers that will allow him to make more informed decisions as he completes his graduate degree and enters the job market.

## Career Management

The purpose of the career management seminar was to give students some basic advice on how to have successful careers after completing their Ph.D. The seminar was given by a guest speaker who had a Ph.D. in physics. She had worked in national labs, industry, and academia. Most of the seminar, however, was focused on working in industry. The seminar included many different techniques to help employees bring recognition and exposure to themselves. Some of these techniques include developing professional networks, finding mentors, and taking an inventory of accomplishments. Through developing networks and finding mentors, younger employees may gain exposure within a company as the mentor becomes the newer employee's advocate. Another technique she recommended was occasionally creating a list of greatest professional accomplishments. This technique forces employees to clearly articulate their accomplishments, helping them advance their careers. At the end of the class there was a question-and-answer session with discussion focusing on resumes and job experience. Several students asked questions about internships while pursuing their Ph.D.s. Ideas discussed on pursuing internships include working with students' advisors and talking directly to different companies.

Two students chose to discuss this seminar in detail, and a third student mentioned in his reflection paper that this seminar was helpful. One student stated that she enjoyed the seminar because, as students, they do not learn about career options in industry because they are focused on school and research. She explained that she learned to evaluate herself in terms of what she likes to do, things she is good at, and how she sees herself. The student enjoyed the speaker's discussion on how to grow professionally and on how employers evaluate employees.

The second student felt that this topic, along with other seminars from the Graduate Student as Leader seminar course, had broadened his career options. Before the seminar course, his goal was to work in academia. The seminar course gave him a better understanding of the work environment in industry. Now he believes that a career in industry is an "equally viable option" for him. The career management seminar gave him an understanding of opportunities to grow professionally in industry and the importance of technical knowledge, social skills, business skills, and communication. The student also learned about the importance of self-reflection to ensure that an employee is earning his or her company money.

The results indicate that this seminar gave students a greater understanding of the work Ph.D.s perform in industry. It also created an awareness of the importance of transferable skills and self-reflection. Before this seminar, both students indicated that they were unsure of how to grow professionally, but this seminar brought some understanding to this issue.

## Engineers in Business

The purpose of the engineers in business seminar was to introduce entrepreneurship and business skills to the students. The guest speaker was an engineering professor. The professor had extensive industry experience and had recently returned from a two-year sabbatical as an industry consultant. At the time of the seminar, he was pursuing his master's of business administration. To begin the seminar, the professor distributed a list of topics that focused on entrepreneurship and business that he was prepared to discuss with the class. This list included topics such as:

- *Business Activities—financing, investing operations*
- *Corporate Structure—Board of Directors, CEO, CFO, COO*

- *Financial Statements—balance sheet, income statement, retained earnings, statement of cash flows*
- *Finance—finance instruments, derivatives, hedging, indexing and dollar cost averaging*
- *Intellectual Property—patents, copyrights, trademarks*
- *New Ventures—corporate structure, raising capital*

He asked students to choose the topics they wanted to discuss. The topic of new ventures was chosen, which included corporate structure and financing new ventures. The professor explained that most of the finance terms he encounters could be learned in a beginning finance class. The professor also had some suggestions on how to raise funding for a new venture company. One method for funding was identifying "angels" otherwise known as rich people who want to invest in companies. A second option was a private offering of stocks. Another option was a venture capitalist. The venture capitalist option comes with less freedom because the funders often have stakes in the company's future revenue. A fourth option was going to the bank with a well-written business plan. The students appeared to be very interested in this topic and asked many questions during the seminar.

One student chose to discuss this topic in his reflection paper. The student wrote that before this discussion, he did not know how start-up companies were funded. This student stated that he had learned several different methods of finding funding and a better understanding of the liabilities of running a business. From this seminar course, the student confirmed that he did not want to become a professor. The student also mentioned that he enjoyed the informal nature of this particular seminar because it was more engaging and allowed the class to determine the direction of the discussion.

Results indicate that several students were interested in learning more about how to start a small business. It appeared that some students may have an entrepreneurial spirit, but they have not had the time and/or guidance to explore this career option. This seminar began to answer students' questions on starting a small business and gave them some understanding of common business and finance terms.

## Intellectual Property

A discussion of intellectual property (IP) was lead by an attorney from the university's intellectual property office. He has a background in chemical engineering and completed his master's of business administration before going to law school. During the seminar, the basics of patents were introduced, such as filing disclosures and preliminary patents. Additionally, the speaker discussed the rules and regulations surrounding patents, trademarks, and copyright laws on the national and international stage. The speaker mentioned different business aspects important to intellectual property, such as the value patents add to a company's portfolio and the relationship between branding and intellectual property. The issue of entrepreneurship and small-business startups was raised but was not discussed in detail.

One student discussed this seminar in his reflection paper. Prior to the seminar he stated that his knowledge of IP was limited. He had not known the complexity and pervasiveness of IP law. After the seminar, he realized that he had underestimated the influence of IP law in the academic and business/engineering setting. An example he gave was that academia is influenced by IP law during the publication process. While the information published remains the authors' intellectual property, the presentation of the information and any illustrations become property of the publishing company. The student also stated that the guest speaker had emphasized that industrial employers often insist on retaining all rights to employees' intellectual property while employed with the company and for some time afterwards. He also felt that in order to be successful, he needed some basic knowledge of IP law.

Students appeared to be interested in IP since the discussion lasted 15 minutes over the allotted time. From the reflective paper, results indicated that students were not aware of the complexity of IP law. After the seminar, the importance and influence IP has in a business setting and academic setting was clearer to the student. The student now has a better understanding of the basics of IP law that, regardless of his career path, is essential to his success.

## Ethics

An ethics seminar was given by a local Ph.D. chemist. She discussed issues such as plagiarism, data fabrication, and the importance of understanding workplace policies. For example, she stated that very few people would write a journal article without citing others appropriately, yet it is common, but not correct practice, to present information to a group without citing appropriate sources. Another example she gave was who pays for a business dinner. Depending on the situation, it may be a business expense or a personal expense, one person may pay for everyone's meal or each person may pay individually. Other topics mentioned, but not discussed in detail included dating in the workplace and taking work home. In her concluding remarks, she cautioned students to keep e-mail and comments on social networking sites professional or private.

One student chose to discuss the ethics seminar in his final reflection paper. As an undergraduate student, he knew ethics was important, but he was never able to fit an ethics class into his schedule. Before the class discussion, he thought ethics was a set of rules that had to be followed. He stated that he had learned in the ethics seminar that it included avoiding conflicts of interest and ensuring the safety of others. Additionally, the student gained an awareness of "gray" areas in ethics, such as dilemmas that may save the company money, but threaten public safety or may not be entirely legal. He stated that he was interested in taking an ethics course that included case studies with multiple approaches and open-ended questions. He also felt an ethics course should include how other cultures deal with the same ethical questions.

From the ethics seminar, results indicated that students gained an understanding of the breadth of ethical concerns that engineering Ph.D.s may encounter. Ethical dilemmas are often gray areas. The seminar helped students understand that ethical decisions include more than just following a list of rules.

## DISCUSSION OUTCOMES, LIMITATIONS, AND RECOMMENDATIONS

Overall, students gained a better understanding of the opportunities that come from possessing a Ph.D. in engineering. The students felt that they now know how to maximize the various opportunities that graduate school offers to find a position once they graduate. The degree of student interaction with the speaker was an indicator of the class's interest in a particular subject, as noted by the participant observer. It is also noteworthy that the most helpful topics for students in this seminar course were similar to topics students considered the most important in a similar seminar series at Oklahoma State University discussed by Madihally.[6]

Like any study, this one has limitations. The study was a qualitative study. The number of participants was kept small to enhance class discussions. One drawback of the limited number of participants was that demographic information was not collected in order to protect the anonymity of participants. The purpose of this study was not to generate generalizable results, but to provide information to aid the future development of non-technical seminar courses.

The course instructor was satisfied with the overall format of the course. For future seminar courses, he would consider adding additional assignments, as students were often very passive. The challenge will be balancing the ability of additional assignments to better engage the students in class discussions with the consideration that workload not exceed the time available to the students. In recruiting students to the course, some faculty members voiced their concern about the course detracting from students' research during the summer semester. Unfortunately, some faculty members did not allow their students to enroll in the course.

There are several suggestions for others in planning a similar seminar course. One suggestion is to allow students to control more of the class discussion. This suggestion would help prevent significant overlap between guest speakers. Each class could begin with the guest lecturer distributing a list of topics he or she is prepared to discuss with the class. The class can then choose the specific topic(s) of the discussion that interest them or that they have not previously discussed.

Other suggestions for future seminars include information on how to pursue internships, preparing for an academic career, and a basic business course. Students were interested in internships as graduate students, but there was little or no guidance on how to pursue this endeavor. Another seminar course could be developed introducing the topics covered

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in a master's of business administration program in order to give students some foundation in business, but without the time commitment. Management skills were one of the most helpful topics in this study, and students rated that as one of the most interesting topics in a similar seminar course.[6] Additionally, similar seminar courses could include a discussion on the skills needed for an academic career, such as teaching. It is worth noting that in Madihally's study of a seminar that included teaching pedagogy and management skills, students did not find teaching topics interesting and did not consider them as important as management skills. These opinions may influence the sustainability of these seminar topics.[6]

## CONCLUSIONS

A seminar course was developed to help engineering graduate students have an awareness of skills needed for careers in industry. Students' reflective papers and the participant observer's summaries suggested that the seminars accomplished this goal. The seminars on preparing for a career included discussions on resumes, cover letters, interviewing, and etiquette. The industrial work environment seminars entailed topics such as project and customer requirements, engineers in business, and career management. Topics such as intellectual property law and ethics were also discussed in the seminar course. By exposing students to this range of topics in a seminar setting, they gain more awareness of career options and the skills needed in an industrial research environment, thus students can make better decisions to help prepare them for careers in industry.

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