

Adding Ph.D. Students to the Chemical Engineering Alumni Student Mentoring Program

**Heather L. Walker,^a W. Kent McAllister,^b Michael W. Mourot,^c
J. Robert Dean,^d Greg Nesmith^e and Edgar C. Clausen^a**

University of Arkansas, Ralph E. Martin Department of Chemical Engineering,^a

Audubon Engineering,^b

Sinclair Group,^c

Ruggiero, McAllister, and McMahon LLC,^d

Dow Chemical Company^e

Abstract

In 2022, 20 Ph.D. students were added to the Chemical Engineering Alumni Student Mentoring Program to provide much-needed help for chemical engineering Ph.D. students in obtaining industrial employment. As in 2021, the program utilized departmental alumni as mentors and emphasized career path identification and professional development for the students. The 12 undergraduate and Ph.D. mentoring circles averaged four mentoring events during the Fall semester, followed by a Program Review and Celebration over ice cream sundaes in February. The undergraduates received resume feedback and tips on preparation for the Career Fair and learned about a variety of careers that are available for chemical engineers. They also learned about the importance of soft skills on the job and ways to stand out to employers. The Ph.D. students interacted with international graduates who had great careers in the U.S., heard about the differences in research carried out in industry and academia and received help in navigating the interview process. The mentoring process was also a networking opportunity for the Ph.D. students and an opportunity for personal and professional development. The mentors noted that the students were very interested in being mentored and that mentoring really helped the students learn about industry, search for employment, develop a good work/life balance and provide ideas and goals to aspire to. In addition, the mentors were able to connect with other alumni through their participation in the mentoring process.

Keywords

student mentoring, alumni interactions, personal relationships, communication, career skills

Introduction

Mentors play a significant role in our development as professionals. Just as the seasoned coach mentors players to develop their abilities in sports or the seasoned craftsman mentors the apprentice to develop into a master craftsman, a supportive and caring mentor-student environment can go a long way in promoting student success at the university and in life [1]. Mentors at the university level can come in many forms including faculty, staff, other students, employers and alumni. Mentoring often results in the development of a personal relationship between the student and the mentor, with the relationship sometimes lasting years after the student's graduation [2].

In 2021, the Ralph E. Martin Department of Chemical Engineering at the University of Arkansas (UA) developed a mentoring program for its undergraduate students that used departmental alumni as career development mentors [3]. The program was patterned after a similar program in the Industrial Engineering Department at the UA [4] and other successful mentor programs in industry and was designed to group alumni mentors and students in small mentoring circles. The mentoring program was launched in Fall 2021 with 36 alumni mentors and 55 students grouped into 12 mentoring circles.

In 2022, Ph.D. students were added to the mentoring program in an effort to provide much-needed help for chemical engineering Ph.D. students in obtaining industrial employment. Table 1 shows National Center for Science and Engineering Statistics (NCSES) data for the employment of recent engineering Ph.D. graduates by sector (academia, government, industry or business, nonprofits or other) from 2000-2020 [5]. Only 10.3 % of the Ph.D. engineering graduates entered academia in 2020, a percentage that was at its lowest level since the year 2000. Conversely, 77% of the Ph.D. graduates took a job in industry or business, showing the highest level since 2000. The placement of chemical engineering Ph.D. graduates at the University of Arkansas showed similar trends, with 68% of the graduates taking jobs in industry in fields such as biotechnology, pharmaceuticals, environmental, consumer goods, materials science, fuels, electronics, catalysis and consulting. The purpose of this paper is to briefly describe the alumni mentoring program with the addition of Ph.D. mentoring circles in year two of the program and to report the results from student and mentor surveys from the program.

Table 1. Employment of Engineering Ph.D. Graduates, 2000-2020 [5]

Employment Sector	% Employed in Each Employment Sector				
	2000	2005	2010	2015	2020
Academia	14.8	18.5	16.9	14.5	10.3
Government	9.0	9.3	12.9	9.8	8.5
Industry or business	72.9	68.7	64.3	72.0	77.0
Nonprofits	1.8	2.3	3.1	3.2	3.2
Other or unknown	1.5	1.2	2.8	0.6	1.1

A Brief Review of the 2021 (Year 1) Mentoring Program

The first step in building a Chemical Engineering Alumni Mentoring Program was the formation of a Steering Committee (the authors of this paper), who provided direction and scope for the program that was detailed in a Mentoring Program Handbook. Mentor selection began in July 2021, from a pool of Academy members (distinguished alumni that had graduated more than 20 years ago) and alumni that had graduated 5-15 years ago. Ten Academy members and 26 younger alumni agreed to be mentors and 12 mentoring circles were formed. Some consideration was given to forming mentoring circles around expertise in certain technical or nontechnical areas but, in the end, it was decided to have a blend of expertise and experience in each circle.

Student selection began in late August (soon after school started), with the goal of filling all of the circles with chemical engineering juniors. When all of the circles were not filled, the

program was expanded to also include sophomores and seniors. The program began with 15 sophomores, 29 juniors and 11 seniors. Each circle had three mentors (10 of the 12 circles had an Academy member) and 4-6 students. Students were sorted by class yielding four sophomore mentoring circles, six junior circles and two senior circles.

The mentoring program began with a Kick-off Event in September, which served as the initial opportunity for the students and mentors and students to meet, participate in some initial mentoring activities and schedule meetings for the balance of the semester. This event, as well as all other events throughout the semester, had options for both virtual and in-person attendance. Some circles chose to have two additional mentoring events (beyond the Kick-off), while some circles had as many as five events in the semester. Topics for discussion in the sophomore mentoring circles most often centered on obtaining co-ops and internships and the dos and don'ts of interviewing. The discussion topics in the junior and senior groups focused on similar topics, but also dealt with permanent employment, selecting a job, day-to-day activities on the job, personality traits and conflict and effective communication.

A few of the circles decided to continue mentoring into the Spring semester and the Steering Committee also scheduled special presentations by selected mentors on topics of interest to all of the students. These Spring activities were not well attended because everyone (students and mentors) is very busy in the Spring. The final event for the school year was held in April as an in-person celebration of the mentoring program and a look toward the future. During this final event, Dr. Kim Needy, Dean of the College of Engineering, spoke to the group about the importance of mentoring and described the mentoring that she has provided and received during her career in industry and academia.

2022 Mentoring Program

Recruitment and Participation

As in Year 1, the 2022 mentoring program began in July with the recruitment of mentors. With the addition of Ph.D. students to the mentoring program, two of the 12 mentoring circles were dedicated to Ph.D. students and their mentors. When the Ph.D. student response was greater than expected, an additional mentor was added to each of the Ph.D. circles. Seven Academy mentors and 31 younger alumni agreed to be mentors, with 25 of the mentors carrying over from 2021. With this arrangement, each circle was able to have a blend of experienced and first-time mentors. The Steering Committee decided to use Ph.D. alumni as mentors for the Ph.D. circles, with each circle also having one international mentor who had experience in dealing with immigration, visas, and student sponsorship.

Student recruitment began with the start of the Fall semester on August 22. Eighty students chose to participate in the program including 20 Ph.D. students. The Steering Committee realized that returning students who had participated in the program in 2021 might have different needs than first-time participants, but ultimately decided to group new and returning seniors together because of their shared interest in permanent employment and graduate/professional school. Returning juniors were separated from new juniors because many of the returning juniors had participated in co-ops and internships, while most of the new juniors had not yet had

internships but were actively looking to participate in these activities. Thus, the 12 mentoring circles had the following composition:

- Two mentoring circles with 10 Ph.D. students and four mentors with Ph.D.s—hindsight says that additional circles should have been formed
- Three mentoring circles with 5-6 seniors (many, but not all, participated in 2021) and three mentors
- One mentoring circle with four returning juniors from 2021 and three mentors
- One mentoring circle with seven juniors who had not participated in 2021 and three mentors
- Five mentoring circles with 6-7 sophomores who were new to the program and three mentors

Program Activities

After a careful review of the feedback and lessons learned from the 2021 program, the Steering Committee prepared a short training program for the mentors prior to the 2022 Kick-off. The focus of the training was to allow the mentors to present a program that brings positive experiences in professional development for chemical engineering students but also provides an opportunity for alumni to give back to the department. The mentors were told how the circles were organized, given important dates and a few fundamentals for effective mentoring in this student-driven mentoring program. Each circle was asked to provide one mentor as a contact with the Steering Committee throughout the semester.

The Kick-off event was held on September 20. Figure 1 shows a photograph from the Kick-off where a member of the Steering Committee is addressing the mentors and students. After the students and mentors were given a short introduction on the purpose, scope and set-up of the mentoring program, the circle participants were given ample time to get to know each other, discuss topics of interest for future discussion and set important dates for mentoring activities. Each circle decided how often and when to meet. Throughout the remainder of the semester, the circles met an average of three more times, with two groups meeting four times and two groups meeting only twice. It was interesting that one of the graduate circles (ten students and four mentors) decided to split into two student groups and meet twice for each discussion topic, while the other graduate circle functioned as a single large group. Figure 2 shows a photograph of a mentoring session from one of the sophomore circles and Figure 3 shows a mentoring session from one of the Ph.D. circles, with one of the mentors participating remotely.

Topics for discussion in the circles were very similar to 2021 and included the dos and don'ts of interviewing; obtaining co-ops, internships and full-time jobs; selecting a job; day-to-day activities on the job; personality traits and conflict; and effective communication. Additional topics in 2022 included transitioning to the workforce, changes in your priorities after school, using your skill set, leadership, teamwork, improving on the job, building a network and the role of areas such as sustainability and math in industry.

The program ended with a Program Review and Celebration over ice cream sundaes on February 23. It was determined in 2021 that the Spring semesters are just too busy and that any additional scheduled mentoring activities in the spring will not be well attended. The Program Review

covered the highlights of the 2022 program, as well as the results from the mentor and student reviews of the program. The highlights of the 2022 program included a 45% growth in student participation, breaking new ground with the addition of Ph.D. students and undergraduates who participated in the program for a second year, and an increase in positive views of the program over 2021.



Figure 1. A Member of the Steering Committee Addressing the Students and Mentors at the 2022 Kick-off



Figure 2. Mentoring at a Sophomore Circle



Figure 3. Mentoring at a Graduate Circle (one of the mentors is remote)

Attendance

Table 2 shows a summary of mentor and student attendance at the Fall 2022 events. As was noted earlier, each circle decided how often and when to meet, but most circles met for the kick-off and three additional mentoring events. Except for the Kick-off, mentor and student attendance was mostly virtual because most of the mentors were not local and could not easily attend a one-hour mentoring meeting. Engagement, calculated as the percentage attendance at mentoring events (either in-person or virtual) compared to the opportunities to attend (shown in Table 3), was > 90% for the mentors except for the graduate student mentors, which was only 56%. Student attendance and engagement was a problem. Student engagement was only 50% for the sophomore, junior and graduate student circles and about 64% for the senior circles. While only two students decided to drop out of the mentoring program, nine students did not attend any of the mentoring events.

Table 2. Mentor and Student Attendance at Fall 2022 Events

	Fall 2021 Kick-off	Fall 2022 Mentoring Events				
		Kick-off	Event 2	Event 3	Event 4	Event 5
Mentors						
Attended in-person	18	21	2	3	1	0
Attended virtually	18	13	33	29	21	6
Did not attend	0	4	3	6	7	0
Total	36	38	38	38	29	6
Students						
Attended in-person	48	48	5	9	2	0
Attended virtually	1	0	54	31	28	10
Did not attend	6	32	21	38	30	1
Total	55	80	80	78	60	11

Table 3. Mentor and Student Engagement at Fall 2022 Events

Circles	Overall Mentor Engagement	Overall Student Engagement
Sophomores	92%	56%
Juniors	92%	50%
Seniors	95%	64%
Graduate Students	56%	50%

Perhaps the attendance problems started with the Fall 2022 Kick-off. The second column of Table 2 shows much better student attendance at the Fall 2021 Kick-off than was observed at the Fall 2022 Kick-off and Fall 2021 attendance was better in general. The Steering Committee discussed the attendance problem and decided to remind the students and mentors during recruitment for Year 3 (2023) that they are making a commitment to actively participate in the mentoring program.

Program Evaluation

The mentors and students were asked to complete a survey prior to the Program Review and Celebration to determine the level of satisfaction with the program and areas for improvement. The mentor survey had 12 questions and 27 of the 38 mentors (71%) participated. The student survey had 11 similar questions and 55 of the 80 students (69%) participated. Table 4 shows the results from the surveys which were quite similar to the survey results from 2021. Overall, the mentors and students were satisfied with the program, felt that the number of mentoring sessions was about right and the topics were helpful, and were likely to recommend the program to others and participate in the program again.

Communication was an area of concern in 2021, with only one of the 32 mentors (3%) stating that the students communicated very well and 22 of the 32 mentors (69%) saying that the students communicated well. E-mails from the mentors often went unanswered by the students and occasionally the mentors discovered that there was an exam that many of the students in the circle had to attend, but no one had told the mentors. In 2022, seven of the 27 mentors (26%) said the students communicated very well and 22 of the 27 mentors (81%) said the students communicated well. Despite the problems with attendance, the mentoring program overall was a huge success.

In looking at specific mentor comments, the mentors noted that the students were very interested in being mentored and that mentoring really helped the students learn about industry, search for employment, develop a good work/life balance and provide ideas and goals to aspire to. In addition, the mentors were able to connect with other alumni through their participation in the mentoring process. The mentors would have preferred an earlier starting date to allow the students to better prepare for the Career Fair and would have liked more structure in planning, communication and engagement. They noted that the mentor circles worked best with 2-3 mentors and 4-6 students. As was noted above, better accountability and commitment to the program was needed by both the mentors and students.

Table 4. Summary of Student and Mentor Final Survey Results

How satisfied were you with the overall Mentoring Program?	Total Responses	Very satisfied	Somewhat satisfied	Neutral	Somewhat dissatisfied	Very dissatisfied
Mentors	27	12	13	1	1	0
Students	55	24	23	6	1	1
The number of sessions was:	Total Responses	Too frequent		About right		Not enough
Mentors	27	0		24		3
Students	55	0		43		12
How well did your students (mentors communicate)?	Total Responses	Very well	Well	Neutral	Not so well	Poorly
Mentors	27	7	15	3	2	0
Students	55	33	15	4	1	2
How helpful were the topics that were discussed?	Total Responses	Very helpful	Somewhat helpful	Neutral	Somewhat unhelpful	Very unhelpful
Mentors	27	14	13	0	0	0
Students	55	32	20	2	0	1
How likely are you to recommend the Program to another alumnus (student)?	Total Responses	Likely		Neutral		Unlikely
Mentors	27	24		3		0
Students	55	47		8		0
How likely are you to participate again in the program?	Total Responses	Very likely	Somewhat likely	Neutral	Somewhat unlikely	Very unlikely
Mentors	27	21	3	1	2	0
Students*	55	20	18	2	4	2
Knowing what you know now, would you have participated in the program?	Total Responses	Yes				No
Mentors	27	23				4
Students	55	52				3

* Three students indicated they will graduate prior to Fall 2023

The undergraduate students said that they received very good resume feedback and good preparation for the Career Fair. They enjoyed learning about a variety of careers that are available to chemical engineers, learning about the importance of soft skills on the job and learning of ways to stand out to employers. While the authors did not formally connect participation in the mentoring program with job placement, the authors heard several stories about job placement success from students who participated in the program. On the negative side, the students would have preferred an earlier starting date for the workshops to better prepare for the Career Fair and were interested in possibly pairing mentors and students by interest. They also recognized that poor communication and student engagement were problems.

Additional Comments on Ph.D. Mentoring

Since Ph.D. students were new to the mentoring program, the Steering Committee decided to also solicit the strengths and weaknesses of the program from the eyes of the Ph.D. students. The Ph.D. students were highly complimentary of the program. They enjoyed interacting with international graduates who have had great careers in the U.S., hearing about the differences in research carried out in industry and academia and navigating the interview process. They also viewed the mentoring process as a networking opportunity, as well as an opportunity for personal and professional development.

Some Ph.D. students felt like the circles should have met more frequently and with more flexible scheduling, perhaps even in a year-long program. As expected, the Ph.D. students noted that the mentoring circles were too large. Some would have preferred mentor/student matching, more structured sessions with the topics sent ahead of the meetings and some suggested using pre-surveys that are sent out prior to meeting to help identify gaps or needs among the students. It was also noted that some of the mentors did not seem to be interested, perhaps alluding to the previously mentioned problem with Ph.D. mentor attendance.

Conclusions and Future Work

The second year of the Chemical Engineering student mentoring program, with the new addition of Ph.D. students, was successful in many ways. Although the number of mentors and undergraduates was about the same as in 2021, some of the undergraduates returned for a second year in the program and 20 Ph.D. students were added to the student ranks. Unlike 2021, the 2022 mentoring program effectively ended in December, except for a Program Review and Celebration over ice cream sundaes in February. The undergraduates received very good resume feedback and good preparation for the Career Fair. They enjoyed learning about a variety of careers that are available for chemical engineers, learning about the importance of soft skills on the job and learning of ways to stand out to employers. The mentors noted that the students were very interested in being mentored and that mentoring really helped the students learn about industry, search for employment, develop a good work/life balance and provide ideas and goals to aspire to. In addition, the mentors were able to connect with other alumni through their participation in the mentoring process.

As new additions to the mentoring program, the Ph.D. students were highly complimentary of the program. They enjoyed interacting with international graduates who have had great careers in the U.S., hearing about the differences in research carried out in industry and academia and navigating the interview process. They also viewed the mentoring process as a networking opportunity, as well as an opportunity for personal and professional development.

The biggest problems with the 2022 program were poor attendance by students and a few of the mentors and the large Ph.D. circles due to an unexpectedly large turn-out of Ph.D. students in the mentoring program. The attendance program will be addressed by the Steering Committee by reminding the students and mentors during recruitment in Year 3 that they are making a commitment to actively participate in the mentoring program. The Ph.D. circles will be improved by limiting the size of all circles to two mentors and 4-6 students. Mentoring in 2022-23 (Year 3) will begin with mentor recruiting in July and student recruitment in August. The program will effectively end with the Fall semester in order to respect the students' time in the busy Spring semester, with a final celebration and group mentoring event scheduled for January or February.

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References

- [1] B. Christie, "The importance of faculty-student connections in STEM disciplines: a literature review," J. STEM Educ., vol. 14, no. 3, pp. 22-26, July-September 2013.
- [2] P.A. Vesilind, "Mentoring engineering students: turning pebbles into diamonds," J. Engr. Educ., vol. 90, no. 3, pp. 407-411, July 2001.
- [3] H.L. Walker, W.K. McAllister, M.W. Mourot, J.R. Dean, G. Nesmith and E.C. Clausen, "Chemical engineering alumni student mentoring program," Proceedings of the ASEE Midwest Regional Conference, September 2022.
- [4] Department of Industrial Engineering, University of Arkansas, Industrial engineering mentor program handbook, 2020.
- [5] National Center for Science and Engineering Statistics (NCSES), Survey of earned doctorates, National Science Foundation, Directorate for Social, Behavioral and Economic Sciences, <https://nces.nsf.gov/pubs/nsf22300/report>, November 2021.

Heather L. Walker

Dr. Walker is a Teaching Assistant Professor and the Associate Department Head for the Undergraduate Program in the Ralph E. Martin Department of Chemical Engineering at the University of Arkansas. Her research interests include engineering education, increasing student engagement and student advising.

W. Kent McAllister

Mr. McAllister is a Project Director for Audubon Engineering. He has over 27 years of energy industry experience in engineering, project execution and leadership roles managing project teams and business units in the Upstream, Midstream and Downstream sectors. He is active in mentoring and supporting the young engineer engagement groups at the companies where he has worked.

Michael W. Mourot

Mr. Mourot is Senior Vice President for Sinclair Group, a management consulting group located in The Woodlands, Texas. Prior to his consulting role, Mike spent over 27 years with Dow Chemical in numerous operations roles, including serving as the college recruiter for Arkansas, resulting in hiring over 90 UA engineers. He continues to enhance his global reputation as an energetic, passionate change agent in people leadership. Mentoring programs are one of the key deliverables with numerous clients.

J. Robert Dean

Mr. Dean recently joined the law firm of Ruggiero, McAllister, and McMahon LLC as a member after 22 years at the law firm of Ohlandt, Greeley, Ruggiero & Perle LLP, both located in Stamford, Connecticut. He was also previously associated with The Dow Chemical Company for 12 years. He has practiced intellectual property law for 34 years. He is a past president of both the Arkansas Academy of Chemical Engineers and the Connecticut Intellectual Property Law Association.

Greg Nesmith

Mr. Nesmith is a Process Safety Risk Analyst with Dow Chemical. He has over 32 years of experience in chemical manufacturing. He is a registered professional engineer in the state of Louisiana, a Six Sigma Black Belt, and a Certified Functional Safety Expert. He is active in campus recruiting and currently serving as the President of the Arkansas Academy of Chemical Engineers.

Edgar C. Clausen

Dr. Clausen is a University Professor in the Ralph E. Martin Department of Chemical Engineering at the University of Arkansas. His research interests include engineering education, teaching improvement through hands-on experiences and enhancement of the K-12 educational experience. Professor Clausen is a registered professional engineer in the state of Arkansas.