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ChE curriculum

A ONE-HOUR PROFESSIONAL DEVELOPMENT COURSE FOR CHEMICAL ENGINEERS

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IN THE EARLY DAYS of our profession, many departments had a technical course to orient students to the industrial world before graduation. Courses of this nature fell out of favor, however, and now only a few departments have courses solely intended to ease the transition of seniors into the marketplace. Some of the material has, of course, been incorporated into other courses, *e.g.*, design or engineering economics. At the University of Florida, the senior seminar continues, although a humanistic emphasis was introduced in the 1970s by inclusion of topics such as interviewing skills and engineering ethics.

This one-hour course is required for all graduating seniors and is usually taken at the beginning of the last year of classes. The goals of the course are: to prepare the student for interviews and for career decisions; to develop an awareness of ethical choices; to develop an awareness of professional concerns such as chemical toxicity and patent law; and to develop skills in presenting technical information in short talks. In a sense, this is a capstone course for the professional development of our students in much the same way that design or unit operations laboratories provide a capstone for their technical development. To our knowledge, this type of course is not at all common, and we believe that similar offerings should be seriously considered by other departments.

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CLASS STRUCTURE

The structure of the course closely followed a syllabus developed and used by John O'Connell when he was in this department. The final class schedule for a group of sixteen seniors is presented in Table 1, and

TABLE 1
Schedule: Professional Development Course

Session	Topic
1	Organizational meeting and introduction
2	Self analyses—careers • Open-ended discussion of possible criteria to be used in selecting the ideal job. Assignment I due. Assigned listing of personal top ten criteria for selecting a job.
3	Interview preparation • Open-ended discussion of possible criteria to be used in selecting the ideal job applicant. Assigned interview partners and companies to be represented. Assignment II due.
4	Interviews (role playing)
5	Interviews (role playing)
6	Interviews (role playing)
7	Graduate School • Guest speaker, graduate school coordinator.
8	Ethics and Values • Assignment III due
9	Ethics and Values
10	Chemical toxicity • Guest speaker from Division of Environmental Health and Safety
11	Inventions and patents • Guest speaker, patent attorney
12	Individual talks
13	Individual talks
14	Individual talks
15	Individual talks
16	Individual tralks • Closure

the homework assignments are presented in Table 2. The objectives of the course follow.

- **To prepare the student for interviews and for career decisions.**

A number of homework assignments and class exercises were selected for this purpose. The initial assignment required that the students write a five-page paper on their goals in life and the aspects they considered to be important. We wanted the students to think of their careers and their lives after graduation in terms of their objectives rather than in terms of fitting into their perceptions of a recruiter's needs. This was reinforced by a class discussion on criteria to be used in choosing an "ideal" job. The instructors served primarily as moderators and recorders of suggestions put forth by the students, and concluded the exercise by requesting that students give us their top ten criteria for selecting a job. The results were compiled in the same way that NCAA (basketball or football) teams are ranked, and this compilation (shown in Table 3) was returned to the students.

On the third day of class, a discussion was initiated in which the students were asked to consider the criteria they would use in selecting the best candidate for a job. We were now asking our students to put themselves in the position of corporate recruiters; our goal was to help students consider how to put their best foot forward. Note that throughout these discussions and, indeed, throughout this class, we avoided lecturing the students on what their criteria *should* be. Rather, we served as moderators and brought up for consideration topics and ideas that were not brought up by the students themselves.

We used the second homework assignment (Table 2) to encourage students to become familiar with the Career Resource Center (CRC) at the University of Florida. This is the university agency that handles on-campus job interviews, and our students who were looking for industrial jobs were already somewhat familiar with it. The CRC offers one-hour courses on various aspects of interviewing and professional prep-

TABLE 2
Homework Assignments

Assignment I	Write a (five-page) autobiographical paper addressing questions such as: Who am I? What is important to me? What would I like to achieve? What have I learned in college about myself?
Assignment II	Learn to use the Career Resource Center: A. Attend CRC minischool session of your choice and write a one-page outline of its content and usefulness. B. Interview role-playing.
Assignment III	Ethical Dilemmas: A. List three different technological innovations of the last fifty years which are "mixed blessings," and give at least three "good" and "bad" aspects of each development. B. Ethical problem questionnaire.
Assignment IV	Any time before the 16th session, attend a nontechnical cultural event (*e.g.*, lecture, concert, demonstration, art exhibit). Write a one-page paper describing the activity and what you got out of it.
Individual talk	Develop and deliver a ten-minute talk on some technical topic of general (non-ChE) interest. Submit a 200-word abstract for the talk. Visual aids must be used. See handouts for more information and for a list of suggested topics.
Others	**(At beginning of semester)** Write a list of your top ten criteria for choosing a job or company. **(Toward the end of the semester)** Given the compilation of top criteria you (as a class) chose in September, list the top ten criteria you would choose now. Please indicate how, if at all, the class influenced your thinking on this.

TABLE 3
Top Twenty-Five Criteria for Choosing a Company
(Selections made at beginning of course)

This list is compiled from the top ten criteria turned in for our second class assignment. The list was obtained by allocating 10 points to the first choice for each student, 9 to the second, etc. The number in parentheses is the total for the class (16 students). Students were not given a list of alternatives; they came up with these criteria independently, and all the selections that were turned in are included here.

1. Location (113)
2. Salary level (95)
3. Type of job (93)
4. Advancement opportunities (89)
5. Management structure and style (67)
6. Values and ethics of company management and coworkers (50)
7. Benefits (47)
8. Working environment (42)
8. Job security (42)
10. Future growth potential (37)
11. Support and/or opportunity for continuing education (33)
12. Flexibility (32)
13. Mobility within company (28)
14. Male/female ratio (including upper management) (24)
15. Lifestyle (21)
16. Company reputation (15)
17. Safety (14)
18. Size of company (13)
19. Emphasis on research and development (10)
20. Sales and/or production position of company (9)
20. Educational opportunities for children (9)
22. Travel opportunities (6)
23. Employee satisfaction and retention (2)
24. Facilities (1)
24. Feeling that the job is worth doing (1)

aration. Our students were required to take at least one of these courses (in addition to a general introductory course) and to write a brief report on its usefulness. The topics selected by the students included interviewing skills, the mechanics of computerized-interview sign-up, cover letters, job correspondence, government jobs, and resume preparation.

A large portion of class time was devoted to practice interviews. Each team consisted of two students who selected a company to represent. We asked that each group select a different company, and we tried to get a balanced representation of petrochemical, petroleum, semiconductor, and biochemical or pharmaceutical firms. The companies are listed in Table 1. The students could use any resource at their disposal (*e.g.*, the CRC, personal contacts, and talks by company representatives at student chapter AIChE meetings) to become informed about the company, and on the day of the interview a coin-toss would determine which student would be the interviewer and which the interviewee. We requested that the two students study independently to avoid a "canned presentation." We allocated ten minutes for each interview (two pairs per day) after which the class would discuss the strengths and weaknesses of each participant. The class was asked to fill out a worksheet on the participants (Table 4) which was returned to the interviewing pair.

TABLE 4
Questionnaire for Evaluation of Mock Interviews

• ROLE PLAYING INTERVIEWS •

Use the following questions to generate discussion of the mock interviews. After the instructor sees them, these sheets will be given to the interview team. Please make constructive comments.

Date _____ **Company** _____

Interviewer: _____

- ☐ 10 How well was the company represented?
- ☐ 10 Poise?
- ☐ 10 Knowledgeable about the company?
- ☐ 10 Project enthusiasm for the company?
- ☐ 10 Did the questions asked help distinguish among candidates? What qualities was the interviewer looking for?

Interviewee: _____

- ☐ 10 How well did the student represent him or herself?
- ☐ 10 Poise?
- ☐ 10 Knowledgeable about the company?
- ☐ 10 Positive impression as employee?
- ☐ 10 Answered questions well?

• Name two positive characteristics that came out most clearly in the interview and two that came out least clearly.

We do plan one modification to the mock interviews. Contrary to our initial expectations, we now believe that five minutes per interview is sufficient. By the third day of interviews, the exercise became quite tedious for the spectators. In spite of this, the students (particularly those who had not interviewed before) placed great value on the experience. Some even requested a second go at it! We feel that a shorter time limit would not interfere with the amount the students learn since, inevitably, the richest interaction took place very early in the mock interview. This change will allow more time for constructive criticism and may allow us to schedule three groups per day instead of two.

A discussion of graduate education rounded out the portion of this class dedicated to career selection. While this class is required for all seniors, about twenty-five percent of our seniors choose to continue their education, and this course provided a more balanced picture of the opportunities available to them.

• To develop an awareness of ethical choices.

Our main source in this exercise was a series of articles published in *Chemical Engineering* [1-4] asking its readership to respond to a variety of real-life ethical dilemmas. We asked the students to fill out this questionnaire and then used it for two days of occasionally vehement discussions. The AIChE code of ethics was also presented, but the students were more interested in the complex problems posed by the articles. In total, the students were asked to respond on paper to eighteen different dilemmas, and the topics discussed in class were selected by the students from this list. The class discussion was augmented by examples of ethical dilemmas that the teacher had faced, and the class was encouraged to provide alternative solutions to the ones he had chosen.

It may be worth noting that the most hotly debated topic in this section was the question of who owns the knowledge of an employee. The scenario was an engineer leaving the employ of a plastics company to join a fudge-making company. Even though he had signed a secrecy agreement with the previous firm, he decides that a proprietary modification to a mixer used for plastics could be employed equally well for fudge. The question is whether divulging this new mixer design to the new company is or is not ethical. The class was evenly divided on this issue. Students on the "pro side" argued that an employee's obligation to suggest any improvements (*i.e.*, to contribute *all* his knowledge) to his current employer overrides his responsibility to his previous employer. They acknowledged that his action was illegal, but (correctly)

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pointed out that the object of the exercise was to discuss ethics, not law. Students on the "con side" held that an employee has a legal *and* an ethical obligation to a former employer not to divulge proprietary information. When the problem was changed so that the modification was the invention of the employee, three-quarters of the class believed that employing the invention at the new place of employment was ethical. The students who felt that even under these circumstances, passing the knowledge on to the new employer was not ethical (as well as being illegal), suggested that the employee who invented the mixer could certainly make improvements to the design and thus ethically pass this improvement on to his new employer.

We spent quite a bit of time on delineating which part of our knowledge is generic and which part can be considered proprietary. Since one of the instructors (MEO) had recently come to the University of Florida after filing a patent disclosure at his previous institution, we were able to discuss how the rights of both the individual faculty member and the previous university were protected. A discussion of the legal aspects of the ownership of knowledge was led in a separate class by a lawyer from the patent division of the University of Florida.

This was a very effective and very important part of the class. We feel it is crucial to expose students to the types of ethical or moral decisions that they may face as professional engineers. Many of the problems have more to do with management than with technology, and the personal choice of a pathway through a dilemma can be supported by development of a keen sense of professionalism. In other words, ethical engineers see themselves as individuals with responsibilities to themselves, to their society, and to their profession—not as drones or cogs in a machine. Some of the comments made by our students (listed in the section "Student Comments") indicate that, through this course, they have developed a greater sense of professionalism.

An emphasis in this area has been made even more important by the recent development of the field of ethics and value studies in science and engineering which is being carried out in departments of philosophy and/or social sciences (see, *e.g.*, reference 5). This development is, in part, a response to the vacuum caused by the reluctance of technical people to get involved in matters of public policy. We believe that it is important that leadership in this area be provided by engineers and scientists who can be knowledgeable in *both* the technical and the managerial aspects of the problem. The treatment of ethical questions in this course represents a small contribution to this essential area.

TABLE 5
Topics Chosen by Students for Individual Talks

What is a Semiconductor and How is it Used?
Earthquake Prediction
Technology Involved with the Sail Design of the Stars and Stripes
Gene-Splicing Using Recombinant DNA
The Greenhouse Effect
Supernovas and Life
The Difference Between Stocks and Bonds
Solar Energy
The Role of Government in Scientific Research and Education
Plastics Pollution
How Foreign Nationals Can Stay in the United States
Black Holes
The Mechanism of Vision
Radon Gas: What It Is and What Can Be Done About It
Bhopal: Role of Government/Industry in the Aftermath of a Disaster

The major change we recommend in the way this material was handled is the reduction of the number of problems covered in order to allow for more depth. The students could be asked to consider about nine dilemmas, and to examine perhaps four in depth. We plan to include an additional assignment requiring the students to write a workable code of ethics for engineers.

• To develop an awareness of professional concerns.

The two topics covered under this heading were chemical toxicity and patent law. Guest speakers from within the university were found for both topics. As mentioned above, a portion of the attorney's talk was devoted to the legal ramifications of the problem posed on ownership of knowledge.

• To develop skills in presenting technical information in a short talk.

The final portion of the class was devoted to ten-minute presentations by the students. The topics were to be of a technical nature, but not directly related to chemical engineering. A list of the topics chosen is

presented in Table 5. Students were required to provide a one-page abstract at least a day in advance, and the instructor went over the abstract with the student. This was meant to be a constructive and very interactive enterprise, and no formal grade was given.

The first presentation, given by the instructor, was entitled "Tips for Technical Presentations." It covered the basic elements of successful presentations and concluded with the following:

- **Give your message three times in three different ways.**
- **Know your audience and be prepared to modify your presentation.**
- **Use visual aids to help your audience follow (not to help you remember) your presentation. Two minutes per slide provides a reasonable guide for the number of slides needed for a talk.**
- **Write your abstract to help attract listeners.**
- **This is your audience, and they are here to listen to you. Enjoy it!**
- **Do not abuse the last item!**

Presentations were critiqued by the audience, and a copy of all comments was given to each speaker.

STUDENT ATTITUDES ON JOB CRITERIA

Perhaps the results of the final exercise provide the best indication of the value of this course. On the last day of class, students were given the compilation of criteria given in Table 3 and were asked to mark, at this point, their preferences. The results are given as Table 6. We noticed a number of interesting results:

- *Location was the dominant criteria in September. The desire to stay near family or in Florida was a prominent reason. But in December, the type of job became overwhelmingly more important than salary or location. This could be attributed to other experiences (such as plant visits) as well as to the influence of the course.*
- *Ethics of the company made it into the top ten in both September and December. We were pleasantly surprised by the importance the students placed on this even before our discussion of ethics in engineering.*
- *The importance of job security fell from September to December. Students simply do not see job security as a major issue.*
- *Importance of the male/female ratio fell from 14 (with 24 points) to 23 (with only one point). This was an overriding concern of several of our female students in September, but by December, they did not include male/female ratio as a criterion at all. Some had received very significant job offers by December, and perhaps this influenced their thinking.*
- *Item number 24 in Table 3 (feeling that the job is worth doing) was the tenth choice of only one student in September (who, perhaps, was struggling to come up with ten solid criteria). The rise in popularity to number 7 in December is due, in part, to the inclusion of this criterion for consideration by all students.*

A number of students commented that, in their view, some of the categories overlapped. Modification of Table 6 to incorporate this overlap made only minor changes in the top five.:

1. **Type of Job + Feeling that the Job is Worth Doing (184)**
2. **Working Environment + Values and Ethics of Company Management and Coworkers (128)**
3. **Salary Level + Benefits (110)**
4. **Location (106)**
5. **Advancement Opportunities + Mobility within Company (93)**

A similar grouping of the results in September yielded:

1. **Salary Level + Benefits (142);**
2. **Advancement Opportunities + Mobility within Company (117);**
3. **Location (113);**

TABLE 6
Top Twenty-Five Criteria for Choosing a Company
(Selections made at end of course)

1.	Type of job (135) [previous ranking was 3 with 93 points, or 3:93]
2.	Location (106) [1:113]
3.	Salary level (87) [2:95]
4.	Working environment (73) [8:42]
5.	Advancement opportunities (72) [5:89]
6.	Values/ethics of company management/coworkers (55) [6:50]
7.	Feeling that the job is worth doing (49) [24:1]
8.	Safety (39) [17:14]
9.	Management structure and style (38) [5:67]
10.	Job security (27) [8:42]
11.	Support and/or opportunity for continuing education (26) [11:33]
11.	Flexibility (26) [12:32]
13.	Benefits (23) [7:47]
14.	Emphasis on research and development (21) [19:10]
14.	Mobility within company (21) [13:28]
16.	Travel opportunities (18) [22:6]
17.	Lifestyle (17) [15:21]
18.	Employee satisfaction and retention (15) [23:2]
19.	Size of company (13) [18:13]
20.	Future growth potential (11) [10:37]
21.	Company reputation (10) [16:15]
22.	Facilities (3) [24:1]
23.	Male/female ratio (including upper management) (1) [14:24]
24.	Sales and/or production position of company (0) [20:9]
24.	Educational opportunities for children (0) [20:9]

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4. Type of Job + Feeling that the Job is Worth Doing (94);
5. Working Environment + Values and Ethics of Company Management and Coworkers (92).

The most significant change here is the increased importance of the categories corresponding to the type of work the students envision doing and the atmosphere in which they will be working.

GRADING SCHEME

It is difficult to assign grades in a largely non-technical course. In previous years, the grades were assigned on the basis of class attendance and homework assignments by a strict numerical formula (*i.e.*, subtract 1/2 letter grade for each unexcused absence). We found that class attendance was very good, and all students participated in the assignments. As a result, we assigned 'A's to all students. We, of course, do not guarantee this for future classes.

STUDENT COMMENTS

Students were asked to comment on how this class influenced their decisions on the criteria they would use to select a job. Most used this as an opportunity to comment on the class as a whole. Some of their responses are

- *Before I took this class I didn't think too much about these points to choose a job. Now, I'm looking at interviewing with a lot of companies, and I do look for these points.*

- *This class has certainly influenced my thinking. It has developed in me a more professional attitude in choosing a job. Yes, I still think that location and salary level should be the most determining criteria since they are so necessary in ensuring a happy life to a human and consequently affecting his ability to be efficient. But topics like hazards in industries opened my eyes to the importance of safety in a company, how serious it should be and how dangerous the consequences of lack of it could be for a company and the workers. One thing that really struck me is the criteria about ethics and values. Before this class, I always thought of an engineer as an individual that should apply his intellectual skills in the work field without any deep involvement. At the end of this class, I know that I have to develop my sense of judgement when it comes to people, and my ability to make good decisions that will allow me to be honest to myself, to my career and to the company where I will be hired.*

- *I think this course has enabled me to see that I shouldn't have a preconceived notion of "the perfect job" before I go hunting. Although I only redefined a few things in my ratings, I've become a little more open-minded when I look at a potential job opportunity.*

- *I think that this course has influenced my criteria for choosing a company. It increased my consideration of a company's values and ethics as well as consideration of general categories other than salary, type of job, and location.*

- *The ethics exercise influenced me quite a bit – it is a topic not often stressed.*

- *This course motivated me to think about the relation of my future profession with my life style.*

- *The most helpful topic was the interview preparation. I have never had an opportunity to have an actual interview and after having the in-class (practice) interviews and listening to the criticism, I tried to correct the problems which were pointed out....I believe that I will see the benefit of this course, even more, in my personal and professional life.*

CONCLUSIONS

We believe that a one-hour course devoted to the professional development of our students is a worthwhile enterprise, and, as such, should be considered by other departments. A course of this nature provides a capstone for the professional development of our students that complements the usual capstone courses for their technical development. We have suggested some minor changes to the syllabus which we plan to implement in the next session.

ACKNOWLEDGEMENT

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