

Student-Faculty Conference 2009
Chemical Engineering
Final Report
May 25, 2009

COMMITTEE MEMBERS

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- Karthik Narsimhan – Sophomore, biomolecular track
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- Dr. Julia Kornfield – Professor
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SUMMARY

This report details the findings of the Student-Faculty Conference on chemical engineering. These conclusions and recommendations were developed throughout the year and discussed at the Student-Faculty Conference on April 6, 2009.

- Industry opportunities – The department should invest more resources to facilitate a growing number of students pursuing summer and post-graduation plans in industry.
- Physical chemistry curriculum – This aspect of the curriculum has been an ongoing concern.
- Senior thesis – The students request more structure and clarity to the senior thesis program.
- Improving the track system – More guidance and course availability is desired for certain tracks.
- Miscellaneous course issues

INTRODUCTION

The Student-Faculty Conference (SFC) is a biennial meeting between undergraduates, faculty, and the administration with the common goal of improving education and student life at Caltech. The topics of the meeting span various issues including the Honor Code, the Core Curriculum, and the various options available to the students. This year the Chemical Engineering option held its own session on April 6, 2009. Throughout the year the members of the committee have reviewed the current chemical engineering program and identified specific

areas of improvement. These findings were presented at the Student-Faculty Conference and then discussed at length. This report summarizes the presentation and subsequent discussion.

The committee was composed of unique individuals that selflessly dedicated their time and effort for the improvement of chemical engineering undergraduate life at and beyond Caltech. They were selfless because many of the members will not have the opportunity to benefit from the changes implemented. The committee also brought in a diverse range of interest and experience, with members from all available tracks and varying seniority in the department. We especially hope that this tradition of selfless dedication will be carried on by the youngest members of the committee in the future.

REVIEW OF SFC 2007

In the previous Student-Faculty Conference held in 2007, the Chemistry and Chemical Engineering options were combined into a single session. The main issues that were pertinent to chemical engineers are listed below. The actual 2007 report can be found at <<http://www.ugcs.caltech.edu/~arc/sfc2007.php>>.

Recommendation	Status
Update course catalog	Finished
Switch ChE63ab/64, expand size of Ch3b, improve ChE91	Finished
Improve student-faculty interactions	Done, but could improve
Hire more undergrad TAs, find a stable funding source	Partially done
Improve physical chemistry curriculum (Ch21)	Has not been addressed
Appoint career advisor for growing industry interest	Has not been addressed

As shown, improvements within the department in the past two years have been considerable. Academic issues such as the catalog or course scheduling and logistics were addressed immediately after the previous SFC. Student-faculty interactions were improved through more in-class communications, research mentoring, and an AIChE-organized social event. More undergrad TAs were hired in the past two years, but a stable funding source has been expectedly unavailable. The final two recommendations have not been adequately addressed in the past two years; they will be central issues in this year's SFC report.

INDUSTRY OPPORTUNITIES

Data from the registrar indicates that student enrollment in chemical engineering has recently increased dramatically. The reason for this trend is not well understood, but we surmise that successful improvements to the curriculum and general interest in energy and biotechnology have made chemical engineering a more attractive field.

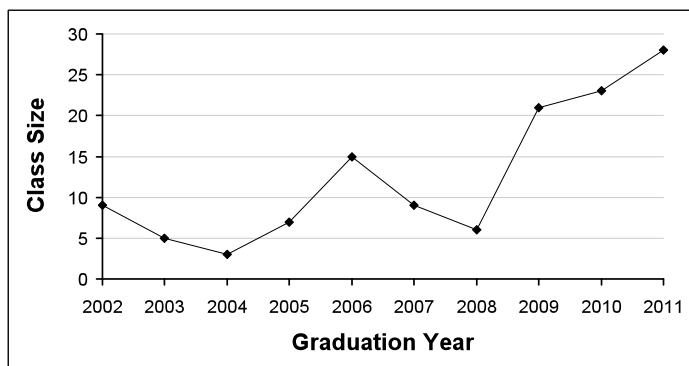


Figure 1: Class sizes have recently increased.

Consistent with the small class sizes before 2009, the undergraduate program has always had a focus towards rigor and academia, with most students pursuing graduate studies immediately after Caltech. In the recent SFC survey (conducted in February, 2009) we asked the students about their immediate and long term plans after graduation.

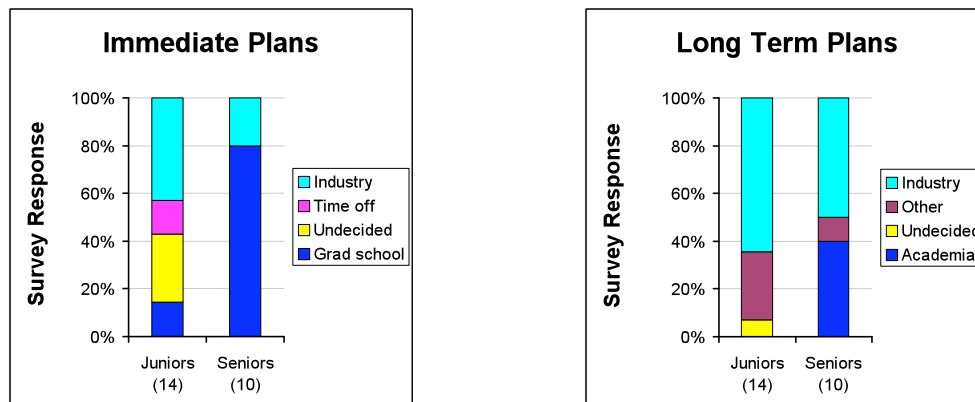


Figure 2: Results from the SFC survey conducted in February, 2009. 14 juniors and 10 seniors responded, as shown in the graphs. This corresponds to a ~50% response rate.

As shown in Figure 2, 8 out of 10 respondent seniors plan to attend graduate school. This is consistent with post-graduation plans of pre-2009 chemical engineering students. However, out of the 14 respondent juniors only 2 plan to attend graduate school and 6 wish to pursue industry jobs immediately after graduation. This shift in student goals is evident in the long term plans, where juniors are showing much less interest in academic careers. Unfortunately it is evident that the department has not responded quickly enough to this shift. For the statement “The ChE department provides adequate connections for internships,” only 10% of respondents agreed while 60% disagreed or strongly disagreed. In order to meet the changing needs of the students, the department should better prepare its undergraduates for industry careers. It is especially worth noting that many students simply want the experience of industrial internships before making the industry vs. graduate school decision at the end of Caltech studies. Indeed, almost all students present at the Conference were excited at possible summer internship possibilities, but only a handful would be interested in an extended co-op program. Students were also open to a wide range of opportunities from plant operation to research and development.

The committee recommends a more proactive approach from within the department for getting industrial internship and career opportunities for its students. Specifically, the department must effectively gather clear information on future plans of current students and current locations of past students. We hypothesize that the most efficient way to meet this goal is to designate an “Internship Coordinator” who arranges contacts with companies, manages internship opportunities, etc. This position may be held by any long-term member of the department, i.e. faculty or staff. To start up a web of connections for prospective interns, we recommend using department records or the Alumni Association to contact Caltech graduates in the industrial sector. Furthermore, many faculty members already have contacts in industry – these contacts would be documented and collected by the Internship Coordinator. Consultation with our sister programs at USC and UCLA could further expand this web of connections while allowing Caltech students access to other career recruitment events. Finally, we recommend a partnership

between the Internship Coordinator and the AIChE student association in order to ensure that the department is meeting student needs.

The committee has already made initial progress in this area. We have collected a list of students interested in career/internship opportunities. We have made contact with USC and UCLA through AIChE chapters or through prior connections. While we have asked for help at the Caltech Career Development Center, recent cuts to staff necessitate internal department action. Finally, we hope that we have effectively notified the department of the student need in this area, and we hope that the department will act swiftly.

PHYSICAL CHEMISTRY CURRICULUM

As stated in the review of SFC 2007, the physical chemistry curriculum has been identified as an ongoing concern. The previous SFC committee felt that the focus and direction of the material should be reviewed. While some progress has been made in the past two years, there is still much room for improvement.

Students continue to not understand the place of physical chemistry within the chemical engineering curriculum. When allowed to freely comment about Ch21a (Physical Chemistry) in the SFC survey, seven out of 25 respondents thought the course was either useless or should not be a requirement. Nevertheless, the faculty maintain that spectroscopy is an important tool for chemical engineers, and that an understanding of chemical interactions at the molecular level is vital to all aspects of the field. Since SFC 2007, the chemistry department has modified Ch24ab (Introduction to Biophysical Chemistry) in order to allow chemical engineers to take Ch24a in place of Ch21b. This additional flexibility is welcome and is easily integrated into the track system. For example, materials and environmental students should take Ch21b with its stronger focus on the physical and theoretical basis of spectroscopy. Students in the biomolecular track can now take advantage of the biological emphasis in Ch24a.

The committee has continued to receive urgent concerns about Ch21a. When allowed to freely comment about Ch21a in the SFC survey, twelve out of 25 students felt that the course was poorly taught to some degree. Common complaints included unclear lectures, poor board work, and irrelevant homeworks. Given the importance of physical chemistry to chemical engineering students, it is not acceptable that Ch21a continues to be poorly taught. The committee recommends the addition of online notes or PowerPoint lecture slides as partial remedies to these problems. However, the committee feels that action must be taken at the faculty level in order to fully address these issues regarding Ch21a. The department has been aware of the problems concerning Ch21a and has been working with the chemistry department to try and find a solution.

SENIOR THESIS

Chemical engineering students have the option of completing a senior thesis in place of their second senior lab requirement. This opportunity is beneficial especially to those who have previously performed research with one of the faculty, and/or those who wish to pursue research in graduate school. Historically the department has given much flexibility to students and their mentors in deciding the project, setting expectations, planning work schedules, etc. This freedom

has facilitated creativity in the students' research projects. In response to external factors, recently the department has required the projects to contain a design component. Fortunately this request has barely limited the students since design can include anything from building an experimental apparatus to selecting the proper chemical compound for a specific task.

The unprecedented freedom given to students and mentors has created a few drawbacks. In general, the students are unclear about expectations and how their work will be evaluated. Many of the current seniors actually have no idea what sort of grade they will receive, and they simply assume that pursuing a senior thesis is tantamount to extending the SURF period into the academic year. Both the faculty and students are busy, and it requires proactive effort from at least one party to define the project goals and to maintain correspondence throughout the thesis terms.

While the committee (and especially its faculty) understands that project requirements and advising styles vary dramatically between different students and mentors, we recommend more structure to the senior thesis program. The department should require written documentation of goals and expectations before projects begin, optimally in the form of a research proposal. Meetings between advisors and students should occur at least monthly and preferably biweekly. Finally, the students should be required to submit progress reports at the end of each academic term. All of these documents should be submitted to the department, which can admire not only the students' finished products but also their means of attaining it. With these measures, hopefully students will understand their expectations more clearly and be encouraged to maintain productivity.

IMPROVING THE TRACK SYSTEM

The track system has been a welcome addition to the chemical engineering curriculum, allowing students to further specialize within the field based on individual needs or interests. Regarding the process track, we are excited that the department will offer ChE110ab in 2009-2010 and we expect the class will be a great asset to the process track. The committee has found few issues with the environmental track. However, we have discovered some discontent from the materials and bio-molecular students about the structure and courses required or offered for their tracks.

Students in the materials track feel that catalog requirements are unclear and do not convey a general structure of the curriculum. As a result students are selecting sets of classes that simply satisfy the requirements rather than giving the best overall picture of a certain focus within material science. Currently, the materials track curriculum offers classes in the subfields of polymers, structural/crystals and electronics. Students often mix and choose classes from all of these subfields and as a result, they lack a sense of relevance that would ideally connect all of their classes. The committee recommends setting up suggested course schedules and creating publications (such as a webpage) that articulate the aims and goals of the materials track. These measures will help the students get a better sense of the big picture. A sample course outline that one might suggest for a structural/crystals material focus is as follows:

- MS115a – general overview of concepts in material science
- MS115b – properties, processing, performance of different materials
- MS131 – crystal structures
- MS132 – TEM characterization

- MS133 – transport, diffusion and performance of materials

Most importantly, students will learn the curriculum most effectively if they understand why they should take their classes.

Students in the bio-molecular track feel that courses do not have a sufficient emphasis on the molecular aspects of the field. For example, we have received many complaints about BE152 and BE153 because both are required classes that cover animal/human physiology, which is incompatible with students' research interests. Students feel that the best representative classes for the bio-molecular track are ChE163 and ChE169; accordingly, we recommend that ChE169 should be offered every year so that students can take it as seniors, after exposure to kinetics and transport. Students also recommend offering courses in metabolic engineering and systems biology, both crucial areas in bio-molecular engineering research.

Finally, to further discuss general issues with each track we recommend the department organize track-specific meetings with the faculty.

MISCELLANEOUS COURSE ISSUES

ChE63/64: Chemical Engineering Thermodynamics and Principles of Chemical Engineering

As a result of SFC 2007, the sophomore curriculum has been recently modified (2007) to have ChE64 taught before ChE63ab. After two academic years of this new ordering, opinions on the experiment are generally mixed. Proponents of ChE64 before ChE63ab maintain that the department should ease students into chemical engineering with the conceptually easier material of ChE64. Proponents of ChE63ab before ChE64 argue that many concepts in ChE64 require the thermodynamics knowledge learned in ChE63ab, so teaching ChE64 first does not make logical sense. Additionally, some students have proposed a restructuring of ChE64, focusing more on an introduction to chemical engineering and less on mass balances and separations.

Survey responses for this issue were mixed. 9 out of 13 juniors think ChE64 should be first, while 6 out of 8 sophomores think ChE63ab should be first. Note that only the juniors and sophomores have experienced ChE64 before ChE63ab, and the survey was conducted while the sophomores were taking ChE63a. Accordingly, the committee makes no recommendation on which class should come first, instead deferring to the faculty and further student opinion.

ACM95: Introductory Methods of Applied Mathematics

The catalog recommends ACM95 to be taken in the junior year. However, recently many students have taken this class as sophomores in order to mathematically prepare themselves for the material covered in ChE103 in the following year. Indeed, concurrent registration of ACM95 and ChE103 has often created issues with synchronization of material. For example, boundary value problems are currently introduced in ChE103a but covered only in ACM95c. Furthermore, moving a major class to the sophomore year gives more flexibility to students planning their track classes for the following years. The opposing viewpoint is that ACM95 makes the sophomore courseload unnecessarily hard. The faculty have mentioned that they prefer a difficult junior year instead of sophomore year, but they have acknowledged that the class may be taken either time.

28 out of 31 survey respondents recommended taking ACM95 as sophomores. However, the committee acknowledges that early burnout from difficult sophomore coursework is not beneficial to the department's future. Therefore, we recommend that the catalog at least

introduce the possibility of ACM95 as sophomores. For example, in the typical course schedule the catalog could list ACM95 in the second year, with a footnote “could also be taken junior year.”

ChE103: Transport Phenomena

Beginning this academic year (2008), ChE103ab was restructured to teach heat transfer before momentum transfer. This was done to introduce transport of scalar quantities before vector quantities, delaying the difficult tensor mathematics until students are familiar with basic transport concepts. The instructor has requested another year to continue this experiment. Additionally, students have suggested designating ChE103 as 12 units in order to reflect the unreasonably high workload. The committee welcomes this change.

ChE110: Optimal Design of Chemical Systems

The committee is excited that ChE110ab will be offered starting in 2009-2010. Both to encourage the class for all undergraduates and also in response to the increasing number of students with plans in industry, the committee suggests that ChE110ab be included as an elective in all tracks.

Science/engineering electives

The committee also proposes allowing 3 science/engineering electives to be taken pass/fail. ChE majors have to fulfill the most requirements of any majors at the school, and having the option to take some electives pass-fail will give them more room to focus more on the core ChE courses, which have to be taken on grades by institute requirements.