

University of Wisconsin – Madison
Department of Chemical and Biological Engineering
Report of the Visiting Committee

Meeting: February 21-22, 2006

Introduction

The Visiting Committee met from 5:30 PM, February 21 to 4:00 PM, February 22, 2006. Eight of the 10 members of the committee attended the meeting as shown at the end of this report. The agenda for the meeting is attached as Appendix A. Handouts of most of the presentations and other extensive supporting materials were provided to the committee at the beginning of the meeting.

During the meeting the committee met with the junior faculty as well as representative groups of undergraduate and graduate students. The students represented a good cross section of those in the department. The Committee divided into three groups to meet simultaneously with these three groups. These meetings were held without the Department leadership present. During the last 30 minutes of the meeting, an oral report of our findings was made to Dean Paul Percy.

Overview

The Department of Chemical and Biological Engineering is very strong and well positioned to remain one of the preeminent departments during the twenty-first century. In prominent surveys of chemical engineering departments it is typically ranked among the top few departments. Thomas Kuech, the Chair, has strong support from the faculty, students, and staff. During his tenure the department has excelled within the College of Engineering at UW in many metrics as well. The department has an outstanding group of young faculty, and the faculty as a whole is distinguished and continues to receive significant external recognition.

Since the last meeting of the Committee in the spring of 2004, all of the recommendations from that meeting have been addressed at least in part. However, new issues that were a focus of this Visiting Committee included a review of the department's undergraduate program and upcoming ABET review and a review of the impacts of College of Engineering budget cuts and restructuring on the health of Chemical and Biological Engineering.

ABET and Undergraduate Program

This fall the department will undergo its next ABET accreditation visit. A major agenda item for this meeting was the review, evaluation, and feedback by the Visiting Committee of the department's undergraduate program. In particular we focused on the undergraduate program objectives and goals and their connection to the curriculum and

on processes that the department has implemented for closing the loop between outcomes and objectives.

Thatcher Root led a presentation and discussion on the department's ABET processes beginning with the four objectives of the CBE program and the (a)-(k) outcomes. The department has done a careful mapping of these outcomes onto the curriculum in order to demonstrate achievement of outcomes. They have also instituted an approach whereby they differentiate certain aspects of a subject, e.g., oral reporting, and keep grades on these in addition to the overall (averaged) subject grade. This allows more accuracy in assessing specific ABET objectives. Extensive use has been made of the EBI surveys to track achievement of program outcomes and to measure progress in these outcomes from year to year. Since our last review, the department has also added systematic instructor evaluation for subjects, which we endorse as a good idea. Finally the department uses three and five year alumni surveys and is working to implement a survey of interviewers.

The Visiting Committee fully endorsed the set of objectives and the system for evaluation that the department has put in place, and we were very impressed with the assessment and feedback processes in place for the specific program outcomes. We had two minor comments on the objectives and outcomes: In objective number 2, "that they will use these skills to contribute to their communities," we were a little concerned that the term "community" might be perceived as too local. Some graduates will do work to solve problems at a global scale. Perhaps this objective could be rephrased to use "society, locally and globally" in place of "their community." It is important to emphasize local, national, and global possibilities.

When ABET extended the wording of outcome (c) from "an ability to design a system, component, or process to meet desired needs" to "an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability," the department reviewed this change and, after discussion, chose to add the words "within realistic constraints" to the existing outcome (c), interpreting this as implicitly including many types of constraints. The Committee agrees that the needs around which one designs includes constraints and that the extra wording giving examples of types of constraints was unnecessary. Other suggestions to the department for future consideration included getting information from employers about where chemical and biological engineers can work and asking alumni in the surveys if they are satisfied with job opportunities available to them.

It was clear to the Committee that the Department has devoted an enormous amount of thought, time, and effort to developing a responsive ABET program. While we applaud this, we feel that it is probably not justified for the department to continue to spend this amount of effort on ABET issues.

We also heard a very interesting presentation by Regina Murphy on new developments in the undergraduate program. The undergraduate program continues to be a popular one at UW-Madison with 280 students in the sophomore through senior years. The department

teaches core subjects every semester, making the program accessible to co-op students. Highlights of the past two years include the new introduction to CBE, CBE 250, which uses the new text book by Regina Murphy, *Introduction to Chemical Processes*; new laboratory space for a remodeled and expanded polymers laboratory; the introduction of Chemical Engineering Connections, which provides a venue for senior students to make oral presentations and lead group discussions relating current issues affecting society to the chemical engineering fundamentals and background that allow them to have informed opinions; new summer laboratory experiments made possible by funds from the College of Engineering; the extension of enhanced presentation skill development across the curriculum; and several initiatives in mathematics and computation in the curriculum.

In response to the name change of the department several years ago, the department has been examining the biology content of its curriculum. About 25% of CBE undergraduates end up in industries that use biology. The department has therefore added six credits of biology; to make room for this the department has deleted six credits of advanced chemistry / chemistry laboratory elective. The department has also responded to the observation that a large number of students were doing poorly in Biochem 501 and Zoology 570, which are now required. Students believe that an introductory biology class or AP high school biology course is a de facto prerequisite for these subjects, though not formally listed as such. The department is working with the Zoology department to come up with a suitable introductory biology class for the CBE students.

Non-faculty advising was ranked high in satisfaction by the students. Satisfaction with faculty advising was lower, ranking only in the middle of the peer institution comparison group. As a result, improving faculty advising has been identified as another area for attention. A suggestion for improving faculty advising, which is used at the University of Texas, is the use of an advising survey every semester, with the results publicized to students and faculty. If this is implemented as a web based survey, it should not be too demanding of resources.

College of Engineering Restructuring and Fiscal Issues

A second major concern for the department is the impact of budgets cuts and restructuring of the College of Engineering on the department's ability to carry out its mission. Because of budget cuts at the state legislature level, the College of Engineering has been mandated to cut 8-10 FTE's from its administrative staff, representing approximately a five percent reduction. The College has developed plans for staff reorganization, which involve combining the financial services for departments into collective business units that report to the Dean rather than to department chairs. Savings would be realized by reducing oversight staff at the College level, made possible by hiring higher level personnel at the cluster level than is currently possible at the department level. A proposed set of groupings for these fiscal clusters is CEE-CBE, ME-BME-IE, and MSE-EP-ECE.

An additional issue is that while Tom Kuech was away in India, the College of Engineering hired away his fiscal officer with no notice. This exacerbated an already tight support situation driven by the loss of three FTE's in the department during the past

five years. The current staff level in the department is six FTE's, and in order to handle the work load within the budget constraints, undergraduates are used to do much of the accounting work. The Visiting Committee questioned whether or not it is appropriate to use undergraduates for critical fiscal management functions, and our meeting with the junior faculty reinforces this concern. Particularly given the uncertainties with the new system, this loss is causing significant anxiety and perhaps will produce a broken system. The previous financial management system was working very well for the department, and they are anxious not to degrade this important support function.

Clearly the Visiting Committee cannot insert itself into internal budgeting issues. However, we do offer a number of suggestions that we think could help with this difficult process:

- Make the processes involved as transparent as possible. This includes being open about how decisions are made concerning where FTE cuts are made, how decisions are made regarding obtaining additional resources, and clarity about the strategic appropriateness of allocation of reductions across the College. It is also important to provide a clear, long-range plan as well as the short term implementation steps.
- Some of the difficulties at the College level could be greatly ameliorated by improving the research financial management system at the University level. Cooperation with the Deans of other colleges and the Senior Administration of UW is important in this effort.
- A coupling of use of overhead funds at the College and University levels to research volume at the Departmental level is important. This is clearly critical for administrative functions needed in support of the research.

Infrastructure

To address issues of safety and infrastructure improvement that were raised at the last Visiting Committee meeting, John Yin gave an update on progress in these areas. We were please to hear that considerable progress on infrastructure has been made. The laboratory space for Assistant Professor Dave Lynn has now been redone and is fully functional. Progress is also being made in better utilization of the basement, by building corridors and student offices; the area involved has now been cleaned up, but the offices are not yet complete. We also learned of renovations planned for the Nealey lab and polymer instruction labs beginning this year and that Harmon Ray's old lab is scheduled for major renovation beginning 2007-8. We are pleased that the department is working with the College to optimize its use of space. It is important for the College to continue to support these renovations.

Safety

Since our last visit, we feel that significant progress has been made in ensuring safe operation of the laboratories and the safety of the department's personnel. John Yin is taking the lead in establishing regular routine of chemical and biological safety courses/quizzes, lab safety managers have been appointed for each CBE research group, the chemical hygiene plan and MSDS books for chemicals in the labs are updated

annually, written self audits are conducted on chemical, biological, and radiation safety; and the Campus Safety Department is providing inspections of CBE labs and supplying recommendations based on these inspections. John Yin would like to move the supervision of these new initiatives to a staff function.

Among the recommendations made by the Visiting Committee during this discussion were

- Although self inspections are useful and valuable, periodic inspections, announced and unannounced, by different groups should also be used. It was suggested that department consider engaging industrial representatives in these “out-of-group” inspections.
- A more systematic process is needed for hazard review of new laboratory experiments and systems.
- A formal check-out process is needed to ensure that old chemicals do not accumulate as students graduate.

Faculty and Research

Overall the faculty members in the department are excellent and are viewed as leaders in their fields, as evidenced by significant external awards. Research in the department is very healthy as gauged by several metrics: The ten-year average production of doctoral graduates per faculty in the department is 0.85, which is the highest in the College of Engineering (average of 0.51). The research funding per faculty is over \$500,000 / year, which is also substantially larger than the College average. Perhaps more revealing is the central role of the department in two large NSF centers on campus:

1. A new Nanoscale Science and Engineering Center on Templated Synthesis and Assembly at the Nanoscale has just been funded by NSF for a five year period at approximately \$12M. This center is directed by Paul Nealey.
2. The Materials Research Science and Engineering Center (MRSEC) on Nanostructured Interfaces has just been successfully renewed by NSF for 6 years at approximately \$12M. The director of this center is Juan de Pablo.

Roughly half of the department’s faculty members are involved in these centers; and about 30 graduate students, nearly one-third of the graduate students in CBE, and four post doctoral researchers are supported in whole or in part by these centers.

The department is to be commended for these successful competitions, as landing large centers is extremely competitive nationally. If UW is to compete successfully for large government funded centers in the future, better support from the University will be needed. Particularly crucial are matching funds, which are required by the government and which are beyond the means of an individual department or faculty member. Given the benefit and recognition these centers bring to the university as a whole, we believe such support is fully justified.

Undergraduate Students

The undergraduate students clearly have a great deal of pride in the CBE department, and they appreciate the fact that the high reputation of the department helps them greatly in getting good jobs and in getting into the best graduate schools. Among many positives about the department, the students cited the nice balance between theoretical and practical content in the curriculum, the move from broad to specialized knowledge as they move through the program, the fact that “really good professors” teach and care about students, and that core courses are taught every semester, which is very helpful to co-op students.

Among concerns raised by the undergraduate students were

- Inadequate preparation for biology courses they are required to take. Some chemistry (the Krebs’s cycle) is not correct in one of the required biology courses. They felt that a prerequisite is needed to prepare them for these courses. The department is clearly aware of this and is working on a resolution as described above.
- Some students would like to see the biology requirement framed as an option so that they could specialize in an area of choice. For example, CBE 560, biochemical engineering, that is taught every other year could be a good substitute for Zoo 570.
- Advising is still quite variable. Some faculty members are excellent advisors (e.g. Thatcher Root), but apparently some are quite poor.
- Students were frustrated that some appointments were not kept by professors.
- It would be good for faculty to update their homework and exams, because of inequity of access to old homework/exams. Alternatively, old homework and exams could be posted on private, course-only web sites to make access available to all students equally.
- The students thought a web-based FAQ on advising would be helpful. This seems like a reasonable idea to us, and we recommend the department investigate doing this.
- The undergraduates wondered “Why aren’t there more Hispanic and African-American students?” The next Visiting Committee meeting should address the issue of student diversity.

Graduate Students

Relationships between graduate students and the faculty are generally good and there seems to be a good esprit de corps among the graduate students. The graduate students appreciate the sense of friendliness and community that results from faculty attendance at graduate student events and outings. The students report that there is a great deal of variability from advisor to advisor in terms of accessibility and residence time for the PhD degree; it was generally felt that accessibility of the faculty was a strong point of the department. In one case a student having difficulty with the thesis advisor did not know where to go for conflict resolution. Apparently the student even tried unsuccessfully to get help from the Dean’s office. We recommend that the department set up and

communicate to the students a clear path and set of resources for conflict resolution, be this a thesis committee, Graduate Officer, or Department Chair.

There appeared to be confusion among the graduate students as to the precise requirements for the PhD. For example, there was uncertainty about the specific course requirements. If there is not already one, we recommend a graduate student handbook that spells out requirements. If this already exists, then it needs to be publicized more clearly to the students.

Students expressed some frustration with the qualifying exams. Concerns included the fact that a lot of students fail one of the tests and have to study and retake it, the exams are not returned so that students cannot see what they did wrong, there is significant variability in the difficulty of individual tests from year to year, the process does not seem fair or transparent to some, it does not seem to be a predictor of subsequent performance in research, and the exams cover graduate material even though they are advertised as covering only undergraduate material. At least one student reported that preparing and taking the qualifiers was a good experience, as the review served to solidify prior learning. We understand that the qualifier system and course work requirements will be under review when Nick Abbott returns from sabbatical.

Junior Faculty

Junior faculty are generally very happy with the department. Junior faculty space concerns were raised at the previous Visiting Committee, and we were pleased to learn that they felt that space resources are sufficient and space needs are being addressed in a timely way.

A number of concerns were raised:

- There are too many required courses for doctoral students and these take away from research. Some students are still taking courses into the fourth year. As a consequence, the junior faculty are frustrated that they have to pay for students when they are not productive in research at a time in their career when fiscal resources are particularly scarce and valuable.
- Mentoring is a concern, as a formal review committee meets once/year but mostly for evaluation. Mentoring is all informal. The department should consider a more structured mentoring process, with specific senior faculty assigned to each junior faculty member.
- Particularly worrisome was the concern expressed that junior faculty did not feel able to speak freely for fear that what they said could negatively affect their career.
- Grant financial management was cited as a problem. This concerns us in view of the plans to reduce and/or restructure financial support services in the College discussed above. Particular issues include inaccuracy of data needed to manage research funds and lack of timeliness in receiving data. The junior faculty clearly do not have confidence in the capabilities of undergraduates doing administrative tasks as is currently mandated by fiscal constraints.

Recommendations

1. Proceed with the systems in place for ABET program objectives and outcomes evaluation. We fully endorse the objectives, outcomes, and feedback processes that the department has put in place.
2. The department should work to improve faculty advising of undergraduates. The use of publicly available faculty advising evaluations at the end of each semester has helped elsewhere. Implementation of a web-based FAQ may also help.
3. We recommend that the department set up and communicate to the graduate students a clear path and set of resources for conflict resolution, be it a thesis committee, Graduate Officer, or Department Chair.
4. If there is not already one, we recommend the department publish a graduate student handbook that spells out degree requirements. If this already exists, then it needs to be publicized more clearly to the graduate students.
5. The department should consider a more structured mentoring process for junior faculty, with specific senior faculty assigned to each junior faculty member upon arrival in the department.
6. The department should consider benchmarking research and Ph.D. production against other top 10 departments of chemical engineering in addition to the benchmarking that is done within the College of Engineering at the University of Wisconsin-Madison.

Respectfully submitted by:

Robert C. Armstrong
Massachusetts Institute of Technology
2006 Visiting Committee Chair

Mr. Jeffrey H. Curler, Bemis Company, Inc.
Prof. Thomas F. Edgar, University of Texas at Austin
Dr. Carlos E. Garcia, Shell Global Solutions (US) Inc.
Mr. J. Michael Jensen, The Procter & Gamble Company
Prof. Deborah E. Leckband, University of Illinois, Urbana-Champaign *
Prof. Babatunde Ogunnaike, University of Delaware *
Mr. John J. Schmid, Kimberly Clark Corporation
Dr. Timothy C. Scott, Provectus Pharmaceuticals, Inc.
Dr. David Yarusso, 3M Company

* Unable to attend

Appendix A. Agenda for 2006 Visiting Committee Meeting

Tuesday, February 21, 2006

- 5:30 P.M. - 6:30 P.M. Poster session and social hour with faculty, students, and guests (The Edgewater)
- 6:30 P.M. - 7:30 P.M. Dinner (The Edgewater)
- 7:30 P.M. - 8:00 P.M. State of the Department
Prof. Thomas F. Kuech, Chairman

Wednesday, February 22, 2006

- 7:45 A.M. - 8:30 A.M. Visiting Committee Executive Meeting & Breakfast (Executive Dining Room, Fluno Center)
- 8:45 A.M. - 9:00 A.M. Meeting Overview – Thomas F. Kuech (Auditorium, Fluno Center)
- 9:00 A.M. - 10:10 A.M. Departmental Issues
- 9:00 - 9:30 · ABET Planning and Issues – Thatcher W. Root
 - 9:30 - 9:50 · Undergraduate Program Development – Regina M. Murphy
 - 9:50 - 10:10 · Infrastructure and Safety Update – John Yin
- 10:10 A.M. - 10:30 A.M. Break (Second Floor, Fluno Center)
- 10:30 A.M. - 11:30 A.M. Research and Faculty Activities
- 10:30 - 10:50 · New Research and Graduate Program – Paul F. Nealey
 - 10:50 - 11:00 · Novel Catalysis Related to the Hydrogen Fuel Initiative – Manos M. Mavrikakis
 - 11:10 - 11:30 · Process Systems Engineering and Optimization – Christos T. Maravelias
- 11:30 A.M. - 12:15 P.M. Lunch (Fluno Center Executive Dining Room)

| | |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12:15 P.M. - 1:30 P.M. | Subcommittee Meetings (Room 212/214/216/218, Fluno Center) <ul style="list-style-type: none">· Discussions with Undergraduate Students· Discussions with Graduate Students· Discussions with Junior Faculty |
| 1:30 P.M. - 2:30 P.M. | Visiting Committee Executive Session (Auditorium, Fluno Center) |
| 2:30 P.M. - 3:15 P.M. | Draft Report of Findings to Department and Discussions (Auditorium, Fluno Center) |
| 3:15 P.M. - 3:30 P.M. | Break (Second Floor, Fluno Center) |
| 3:30 P.M. - 4:00 P.M. | Meet with Dean Paul Percy (Auditorium, Fluno Center) |
| 4:00 P.M. | Adjourn |