Department of Chemistry  
Program Review Committee Report

The Department of Chemistry prepared a self-study following program review guidelines. An external review team visited the campus, reviewed the self-study documents, interviewed unit personnel and university administrators, and submitted an external review. The Program Review Committee (PRC) read the self-study and the external review, and met with program faculty. This document reflects the PRC’s findings and recommendations.

**SUMMARY OF THE SELF-STUDY**

**Mission and History**

*Mission.* The Department mission focuses on the application of chemistry to advance society, through the preparation of students and research by faculty. Specifically, the Department strives: (1) to provide high-quality instruction for a broad spectrum of students, (2) to create a vibrant and demanding research environment, and (3) to stimulate regional economic development through industrial partnerships.

*Relationship to the College and University Mission.* The Department’s mission is closely related to that of the University through the synergism of teaching and research. The Department itself strives to become a premier learning community.

*Recent History.* The self-study highlights two developments in the recent history of the Department. One is a period of transition in the mid-1980’s that saw the founding of the Center for Photochemical Sciences and the creation of the Ph.D. program in Photochemical Sciences. The second is the decrease in the number of tenured and tenure-track faculty over the past seven years, from 19 to 13 (not counting Drs. Midden and Snively, whose primary responsibilities lie outside the Department). This decline is discussed further under faculty resources.

**Description of the Unit**

*Program Identification.* The Department offers an undergraduate major in chemistry and a specialization in biochemistry. The biochemistry specialization and an optional chemistry track are certified by the American Chemical Society. Undergraduate involvement in research has been provided each summer for the past 15 years through the National Science Foundation Research Experience for Undergraduates program.
The Department offers an M.S. degree in chemistry and a Ph.D. in photochemical sciences. The Ph.D. program was one of only three chemistry programs statewide to receive a Category I ranking in the 1995 OBOR review of Ph.D. programs.

The Center for Photochemical Sciences is interdisciplinary, comprised of eight faculty from the Department of Chemistry (including Dr. Snavely), two from the Department of Biological Sciences, and one from the Department of Physics and Astronomy. Members meet weekly to discuss Center issues, including research, external funding, and the selection and supervision of graduate students. The Center meets annually with its Scientific Advisory Board to discuss long-range goals.

**Faculty Resources.** The faculty consists of nine full professors, one associate professor, and three assistant professors. Three additional full professors (Drs. Dalton, Midden, and Snavely) have other appointments at the University outside the Department. The number of instructors was not given, although Table A includes teaching by additional faculty in 2001-2003. In the past seven years, four new faculty have been hired, but 10 were lost by death (1), retirement (4), resignation (3), and reassignment (2), leaving a net reduction from 19 to 13 (32%). Of the present faculty, five are age 65 or older and another is 62; multiple retirements are anticipated in the next few years. The Department maintains high research expectations for new faculty, especially for external funding. They receive a reduced teaching load during the first two years to provide extra time for establishing their research programs, with some senior faculty taking higher teaching loads. Nevertheless, the Department has reduced somewhat the number of graduate courses it offers.

**Graduate Assistant Resources.** The Department currently supports 14 M.S. and 50 Ph.D. students, somewhat above the seven-year average of 53. Most (42) have teaching assistantships through the Graduate College, and the rest (22) are supported by faculty research grants or research fellowships. Typically about 40% of the graduate students are women and about 85% are international students. Teaching assistants have in-class responsibilities in undergraduate labs, but selectively expanding that role to recitation classes is being considered.

**Staff Resources.** The Department has 11 staff, including four secretarial/administrative staff (one secretary is half time), a stockroom manager, an instructional lab supervisor, two electronics technicians, a machinist, and two instrument managers. Based on Table C, the number of staff appears to have increased from 7 or 8 a decade ago.

**Students.** There are currently 73 undergraduate majors, down from 117 eight years ago. There was a noticeable drop 3-4 years ago. Ten of the students counted eight years ago were education majors with an emphasis in chemistry, an option that is no longer offered. The number of chemistry minors has remained essentially constant, typically 45-50. The fraction of female majors has risen a few percentage points, to just over 40%. Advising is shared by five faculty, with one person advising the students with the biochemistry
specialization (roughly one third). The number of M.S. students has remained roughly constant (at about 15) over the last eight years. The number of Ph.D. students averaged about 36 during most of that period, but has averaged 47 the past three years. Two faculty members handle graduate advising, one for M.S. students and one for Ph.D. students.

**Student Credit Hour Production.** Student credit hour production data are presented without comment or comparison. The data show a decline in total SCH’s of about 21% over the past eight years, with a decline of 25% in undergraduate SCH’s slightly offset by a 10% increase in graduate SCH’s. The SCH/FTE faculty ratio declined about 10% over the same period.

**Recruitment and Retention.** Undergraduate recruiting relies on the Preview Day and President’s Day events. The Department of Chemistry and the Department of Physics and Astronomy sponsor a ScienceFest event each spring, inviting high school students to campus for laboratory tours and demonstrations. Recruitment efforts for graduate students include relationships with international universities, the Department’s REU program, invitations to campus, and advertising.

In order to improve the retention of students in several keys courses, graduate student teaching assistants provide one-on-one help every day; additional help sessions are held by faculty.

**Instructional Service to other Units.** General chemistry courses are required by a number of majors and minors at the University, although the chemistry faculty are concerned that students do not usually take these courses early enough in their curricula. The Department also offers several 300-level courses in support of other programs, as well as two 100-level general education sequences. A separate 100-level course is being developed for nursing students. A handful of 500- and 600-level courses in biochemistry are taken by Biological Sciences students.

**Facilities and Equipment/Instrumentation.** The Department is housed in two buildings: Overman Hall and the Physical Sciences Laboratory Building. The faculty use a variety of major equipment, and two of the instruments have full-time staff devoted to their operation and maintenance. The Ohio Laboratory for Kinetic Spectrometry, established in October 2002 with OBOR and University funds, will eventually occupy a separate facility.

**Information Resources and Services.** The Department relies heavily on the University libraries, especially the Science Library, and electronic access to journals and databases through OhioLink.

**Financial Resources.** Department expenditure data are presented without comment. Total operating expenditures have remained essentially constant since 1996 at slightly under $300,000 per year.
Self-evaluation

Quality. The faculty published 189 peer-reviewed journal articles from 1996-97 through 2002-03, at a nearly constant rate of about 27 papers per year. Except for the first year of that period, the number of faculty was nearly constant at about 15, which gives an average of about 1.8 papers per faculty member per year.

External funding has shown a dramatic increase since 1999, rising from $609,000 then to almost $3.2M last year (18% of the University's total external awards in FY 2003). Even apart from two large grants ($1.3M Hayes Investment Fund in 2002 and $2M Wright Capital Fund in 2003), the external funding has risen steadily and constitutes 6-8% of the University's external funding. About two thirds of the faculty currently have external funding. Faculty members have received a number of local, national, and international awards recognizing their research.

The quality of incoming students is indicated by their high school GPA's (averages in the range 3.4-3.5 since 1995) and ACT scores (averages approximately in the range 24-25). There is a slight downward trend in ACT scores. Of 171 recent graduates, three were national Goldwater Scholars, 35 were Phi Beta Kappa inductees, and 60 graduated with honors.

Tenured and tenure-track faculty have continued to teach at all levels of the curriculum, including recitation sections of the general chemistry sequence. The Department recognizes challenges in the undergraduate curriculum of maintaining high quality instruction in large-lecture classes and maintaining up-to-date laboratories. The major program is reviewed every five years by the American Chemical Society and has been continuously accredited for over 30 years. The Ph.D. curriculum is enhanced by prominent guest lecturers in classes and weekly department seminars, as well as the W. Heinlen Hall lectures given each summer.

The incoming M.S. students have average GRE scores in the 62nd percentile for quantitative and 36th percentile for verbal. The scores of Ph.D. students rank in the 66th percentile for quantitative, the 30th percentile for verbal, and the 80th percentile for the chemistry subject test. The lower verbal scores probably reflect the "diverse backgrounds of our predominantly international student body." The research of students from the Department has been recognized by various on-campus awards.

The self-study states that graduates have received high-paying jobs in various places in the chemical industry, academia, and national laboratories. Recent graduates are currently postdoctoral fellows at a handful of prestigious universities. M.S. graduates have enrolled in leading Ph.D. programs, and found jobs in the chemical industry and as university faculty.

The Department is currently developing a method for assessing student achievement across the curriculum. In the past it has relied on American Chemical Society certification.
The faculty have provided service to the University, notably including Dr. Newman as a long-time member of Faculty Senate, serving twice as chair, and Dr. Leontis, who is the current (03-04) chair of Faculty Senate. The faculty also serve the larger academic community, especially through reviewing research grants and manuscripts and organizing meetings.

The Center for Photochemical Sciences has served the region and state through forming cooperative research initiatives and industrial partnerships. The Center helped to develop three new businesses based on photoscience. Two new laboratories to be established with recent funding are expected to further such partnerships.

Demand. Table 11 shows that over the past three years the graduate enrollment has increased, while undergraduate enrollment has remained approximately steady. The data in Table F of SCH production since 1994 show a decline, then rise in graduate SCHs, and a steady decline in undergraduate SCHs.

The self-study reports that last year the median salary of all American Chemical Society members with full-time jobs is $76,500 and that the unemployment rate of chemists (3.3%) is roughly half the overall U.S. unemployment rate (near 6%).

The self-study cites significant demand for the Department's undergraduate service courses.

Centrality to the University Mission. The Department supports the University mission by challenging its faculty to function as both active scholars and good teachers.

A number of 400-level chemistry courses can be taken by chemistry, biology, and neurobiology graduate students. Faculty research activities involve teams of graduate, undergraduate, and postdoctoral students. The Department maintains ties to other departments through the Center for Photochemical Sciences and through participation in the Center for Biomolecular Sciences.

The Department is committed to improving scientific literacy; it commits a significant portion of its classroom activities to introductory service courses. The self-study also states that chemistry faculty are engaged with colleagues in the College of Education and Human Development to better prepare pre-service teachers.

The Department's upper-level undergraduate and graduate courses reflect the research interests of the faculty; for instance, classes include discussions of research topics and papers. Curriculum in bioinformatics has grown out of a research interest in that area.

The Department's service efforts in regional economic development are grounded in its research programs.

Comparative Advantage/Uniqueness. The self-study states that the distinctiveness of its undergraduate programs stems from the personal attention of faculty to students—through
recitation classes and research opportunities—to help students adjust to the culture of higher education. The stand-alone M.S. program is fairly unusual in the country, and provides an opportunity for "late bloomers" to develop research expertise. The Department also provides experience for international students to state-of-the-art instrumentation.

In terms of interrelationships with other programs at the University, the Center for Photochemical Sciences and the Center for Biomolecular Sciences provide distinctiveness.

The Photochemical Sciences Ph.D. program is focused and interdisciplinary, and is unique in the country.

The Department is concerned about the duplication of general chemistry, organic chemistry, and biochemistry material in biology courses to compensate for students not taking Chemistry courses early in their curricula.

Financial Considerations. Instructional supplies and equipment are covered by lab fees, but major upgrades in instructional labs require additional funds. Table H presents expenditures per SCH.

The Department operating budget was not increased when the Ph.D. program began in the mid-1980's. The Department is heavily dependent on external funding to pay research expenses and graduate stipends. Faculty share instrumentation and supplies to limit expenses.

The self-study reports a serious concern that physical space, especially for research laboratories, is inadequate. Although current financial resources are adequate, the research efforts are dependent on external funding and additional funds will be needed to modernize the instructional labs. The rising cost of maintaining instruments is a concern.

Planning

The self-study lists four goals:

Hire a second eminent scholar. The Department is in the process of searching for a second Ohio Eminent Scholar in Photochemical Sciences.

Increase faculty resources. The Department specifically requests four replacement and three new faculty positions in the next five years. The justification includes the decrease in tenured and tenure-track faculty from 19 to 13 in the past seven years, the impending retirement of 5-6 of its faculty, and the time demands on research-active faculty. In order to meet curricular demands, the new faculty would be photoscientists, covering the areas of biochemistry, physical chemistry, organic chemistry, and analytical chemistry.

Increase available research space. The existing space was designed before the creation of the Ph.D. program and is virtually exhausted. New faculty will require new
laboratory space and offices for themselves and additional graduate students.

*Review and revise the undergraduate curriculum and develop an assessment plan.*
The Department plans to study the curriculum at other institutions, investigate modernizing instructional labs, more closely integrate research into the curriculum, reorganize the service courses, and develop an assessment plan.

**SUMMARY OF THE EXTERNAL REPORT**

The external reviewers identified one pivotal issue for the Department, that of faculty resources. They judge that there is a "window of opportunity" to pursue an "aggressive schedule" of acquiring new research-active faculty and new research space or almost certainly face "serious consequences" to the program. They regard this as one of the University's "premiere programs", but note the decline in number of faculty, the impending retirements, and the higher teaching loads of some of the senior faculty. They make four specific recommendations:

1. The Department and administration should develop a plan for adding research faculty lines and research space. In light of imminent retirements, the reviewers say "the urgency of creating this plan cannot be overstated."

2. The administration should "acknowledge a research model for the Department, with a clear statement for teaching loads and research productivity." A research model involves "excellence and innovations in teaching" by research faculty, with non-tenured teaching faculty in "more limited, but important and well specified roles." This model "requires meaningful projections of total faculty size and composition (faculty/lecturers)."

3. Attention should be given to "keeping the existing faculty active and productive."

4. The Department should "evaluate critically the undergraduate curriculum." The issues include making the curriculum more effective, enhancing the quality of chemistry students, involving students in research, and modifying the teaching strategies for the service courses. They discuss an alternate model for faculty effort in service teaching.

The reviewers offered positive comments and constructive suggestions in support of all four stated Department goals, which align closely with the reviewers’ own recommendations.

**Strengths**

The external reviewers cite a number of strengths in research, teaching, and leadership, including:

- A unique Ph.D. program in photochemical sciences
- A continuing production of quality research with international visibility and good grant support
- Funded research by faculty in biochemistry not closely allied with photochemical
sciences—they recommend strengthening interactions with the Center for Biomolecular Sciences and a program in bioinformatics

- Excellent young faculty
- The Ohio Laboratory for Kinetic Spectrometry, which "established northwestern Ohio as the state center for the study of ultra-fast processes"
- A highly qualified staff that manages the instrument facilities
- The Center’s effectiveness at interfacing fundamental research and applied technology
- The major role chemistry plays in developing high-tech initiatives in northwest Ohio
- Innovative and significant special programs using endowed funds
- Recruitment of many excellent graduate students
- Good graduate student satisfaction
- Certification of the undergraduate program by the American Chemical Society
- Rigorous undergraduate offerings in biochemistry
- An extensive graduate course selection
- Good undergraduate satisfaction
- Excellent leadership provided by senior research faculty in developing the graduate research program
- The willingness of the senior teaching faculty to take on extra teaching loads in order to maintain the high quality of undergraduate courses

Concerns

The reviewers noted the following weaknesses:

- The size of the research faculty is not large enough; they note "the ultimate size of the faculty might better be in the 17-18 range"
- The Ph.D. student population is heavily foreign—they recommend developing new strategies for recruiting domestic students, including raising stipends
- They recommend regular communication with research staff to prevent retention problems
- The undergraduate courses have extensive service components—they recommend the Department consider ways to consolidate its service courses
- There appear to be difficulties creating an appropriate sequential science sequence at the University—they comment that not requiring freshman chemistry for science students lowers standards and undermines options for chemistry majors
- Likewise, organic chemistry should be a co-requisite or prerequisite for the core biology sequence
- Organic chemistry should be numbered as a 200-level rather than 300-level course
- Significant hours are invested in tutoring for freshman chemistry—they recommend developing other methods for improving students' experience in these courses.
- The faculty should examine if graduate courses might group into a common core, preferably as a capstone multi-disciplinary effort
- The University has not been able to provide sufficient faculty lines and space in recent years
The Department of Chemistry has developed a strong, focused research program centered on, although not limited to, photochemical sciences. External funding to the Department is especially noteworthy, showing a steady rise plus two recent large grants, and funding is spread over a comfortable majority of the faculty. The faculty have maintained overall research productivity over the last decade despite their decreasing numbers. The Ph.D. program in Photochemical Sciences has grown and attracts many well-qualified students. The undergraduate program also attracts some well-qualified students; the Department has long maintained an externally certified curriculum. The Department serves a substantial number of students in general education and general chemistry courses. Nevertheless, the number of students in these courses has been declining steadily, and the number of chemistry majors has also declined. The undergraduate curriculum is in some need of attention.

1. Faculty Resources

    Findings. Both the Department and the external reviewers cite the number of faculty as a critical issue. Given impending retirements, careful planning will be necessary simply to maintain the current number. The long-term health of the research program will almost certainly require additional faculty lines beyond the current number. Immediate action is needed to assure the continued success of the strong research program in photochemical sciences. Evaluation of faculty workloads should take into account existing and future support in the form of instructors, lecturers, scientific support staff, postdoctoral fellows, and graduate assistants who can work in conjunction with faculty to achieve the teaching and research goals. A continued faculty line in chemistry pedagogy would have significant benefits for strengthening ties to ongoing University efforts and providing expertise for Department curricular reform.

    Recommendation. Hiring new faculty should begin right away, without waiting for additional retirements to take place. A variety of lines across rank and tenure level appear necessary to maintain the program’s international standing. The Department, in conjunction with the Dean of Arts and Sciences, the Vice Provost for Research, and the Provost should develop a plan for making these additional faculty hires. The plan should be completed by the end of fall semester 2004. Whether or not the research model suggested by the external reviewers is adopted, the plan should address the issue of expectations for faculty in achieving the dual missions of teaching and research. The difficult issue of start-up funds should be realistically addressed. The Department should be expected to contribute its share of start-up costs, but opportunities for relief should be negotiated at the point the Department’s capacity is exceeded. The staff and financial resources of the Center for Photochemical Sciences should be considered in evaluating support that the Department has or needs. The implementation of the plan should be stepwise and contingent on the Department’s success in research and academic programs, as described in recommendations to follow.
2. Research Space

*Findings.* The existing space predates the Ph.D. program and is not adequate for present needs. The demand for space will increase with the addition of a second eminent scholar and as retirees who are less research active are replaced by new, research-active faculty.

*Recommendation.* The Department, in conjunction with the Dean of Arts and Sciences, the Vice Provost for Research, and the Provost should develop a plan for meeting space needs based on a realistic assessment of the needs and available alternatives. The plan should include efficient use of current space, alternatives for temporary space, and space in a proposed new science building, as well as possible new facilities built using the Wright Capital Project Fund grants as seed money. The plan should be completed by the end of fall semester 2004.

3. Research Productivity

*Findings.* The Department has maintained modest but steady growth in research productivity and external funding (beyond two recent large grants). As the University invests faculty and funding to support the Department’s research program, it may expect to see enhanced activity.

*Recommendation.* The Department, in conjunction with the Dean of Arts and Sciences, the Vice Provost for Research, and the Provost should develop benchmarks for research productivity and external funding, which should be included in the plan under item 1 above.

4. Undergraduate Curriculum

*Findings.* Both the Department and the external reviewers point to the need to review and revise the undergraduate curriculum. Issues and needs they raised include reorganizing the service courses to better serve the needs of both science and non-science students; the goal of developing science literacy; the difficulty of effective learning in large-lecture courses; modernizing the laboratories; integrating research into the curriculum; and developing better coordination of chemistry courses with courses in other departments. A faculty member in chemistry pedagogy could provide expertise on many of these issues, but could not be expected to bear the burden alone of designing or implementing changes.

*Recommendation.* The Department should undertake a comprehensive review of its undergraduate curriculum in light of the above issues. The review should address issues of both curriculum structure (course numbers and outlines) and appropriate teaching goals and strategies. Assessment provides an essential means to inform and evaluate curricular changes, so on-going assessment should be built into the curriculum at all levels. The review should address the need to provide extra support for general chemistry students, as discussed
in the self-study and by the external reviewers. The results of this review should be submitted to the Dean of Arts and Sciences no later than June 2006 with a brief interim progress report due June 2005. The Department should work with the College of Arts and Sciences to help assure that students throughout the College take chemistry and other science courses in an appropriate sequence. Both course prerequisites and appropriate academic advising should be addressed.

5. Assessment of Learning Outcomes

Findings. The Department has made disappointing progress toward developing an assessment plan. The need for assessment is clear, especially in light of the progress report required by NCA within two years. Clear progress must now be demonstrated for graduate programs as well.

The certification of two of its undergraduate programs by the American Chemical Society is a valuable component of an assessment plan, but should be complemented by significantly more assessment of student learning. Furthermore, the many students who do not follow an ACS-certified program should be specifically addressed.

Recommendation. The Department should diligently pursue developing an assessment plan for its undergraduate and graduate programs. Assessment of general education and service courses should also be developed. Progress should be reported through the Department’s annual reports to the Student Achievement Assessment Committee.

6. Undergraduate Recruiting

Findings. The number of chemistry majors at the University has declined significantly, especially over the past several years. Although numerous factors may play a role in this decline, and many if not most of these factors may be beyond Department control, it would seem unwise to ignore the decline. The ScienceFest event is a very positive step, but is not sufficient by itself.

Recommendation. The Department should develop additional strategies for recruiting undergraduate majors, from both on and off campus. The review of the undergraduate curriculum (item 3 above) may suggest some useful selling points for potential students. The Department should coordinate with college and other advisors to help assure that declared and potential chemistry majors are encouraged to adhere to a course schedule that will allow them to complete the required chemistry curriculum in four years. Taking general chemistry freshman year is an obvious example.

7. Graduate Recruiting

Findings. The external reviewers call attention to the heavily foreign Ph.D. student population. The connection to Mendeleyev University in particular has been very beneficial
and should certainly be maintained. The Department has also made efforts to establish ties to other international universities, such as the Middle East Technical University in Turkey. Nevertheless, increasing the number of qualified domestic students would clearly strengthen the program and provide some protection against future political shifts. If the NSF REU program is not continued, the need for additional recruiting tools for domestic students will increase even more.

**Recommendation.** The Department should develop additional strategies for recruiting graduate students, especially domestic graduate students. Creative strategies for increasing stipends should be investigated. One possible example might be to use McMaster Endowment funds to selectively supplement assistantship levels. The Department has done an admirable job of providing external support for graduate students. The responsibility for providing external funds should grow with the investment of the University in the Department’s research program, especially if a research model is adopted. Supporting graduate students should be included as part of the external funding expectations for young faculty.

*The Department of Chemistry should report annually to the Dean of Arts and Sciences, with a copy to the Provost, on the implementation of these recommendations.*