Chemistry Academic Plan; submitted October 7 2008

Mission and Aspirations

The Department of Chemistry continues to face challenges as a result of the magnitudes of our teaching and research missions. We are simultaneously responsible for one of the largest service teaching loads at the University and historically we have also had one of the largest and most successful graduate programs. Chemistry is an interdisciplinary program as a result of its unique approach to the study of nature by examining its fundamental building blocks, the molecules. Consequently, chemical expertise spans both the biological and physical sciences. The Department is acutely aware that most of the important technological challenges confronting scientists and engineers requires an interdisciplinary approach. Therefore, our major goal in the next few years is to remove barriers, and as a result "foster excellence" in our interdisciplinary contributions to the campus-wide bioscience and energy/material science efforts that are of importance to the citizens of Wyoming. In order to reach these goals of "reinforcing and refining areas of distinction the department's highest priority is to recover the infrastructural support that was lost during the 1990s.

Previous Planning Accomplishments

In the last 5-year planning cycle we have implemented assessment procedures for both our undergraduate and graduate level programs. Other efforts have focused on rebuilding our program after suffering through a series of retirements and resignations.

Relevant Institutional Issues

The Departments aspirations are consistent with the institutional goals as outlined in "Creation of the Future 3". In particular our overarching goal to increase the Universities infrastructural support of the Chemistry Department to a level commensurate with the support Chemistry Departments at comparator institutions such as Utah State University enjoy will help reverse the University's drive for breadth rather than depth (Motif 1). With these resources we plan to foster excellence (Motif 4) in both our undergraduate and graduate programs and seamlessly interweave our teaching and research missions. Reinforcing and refining energy and life science areas of distinction (Motif 2) will create a Departmental educational culture that will lead to production of health and energy science professionals that will be the future leaders in the State (Motif 5). Critical to achieving our goal of fostering excellence and producing health and science professional leaders is a partnership with Wyoming community colleges and high schools to promote access to higher education (Motif 3) by working to improve student preparation and their smooth integration into the Chemistry academic community.

CHEM-1 *Build a nationally and internationally competitive research department in the target areas of Chemical Biology and Energy. This will require an increase in the number of tenure/tenure-track faculty to the critical mass of 16-20.*

The Department of Chemistry believes that 16-18 tenure/tenure-track faculty, 4 academic professionals and one or two SER professors will provide the minimum necessary manpower to build a small but nationally competitive program. (Chart A2) We also believe that this size of a faculty is achievable and sustainable at a higher institution like the University of Wyoming. This assertion is supported by data that shows that Chemistry Departments at Utah State University, Montana State University, and the University of New Mexico all have 16 or more tenure/tenure-track faculty. (Chart A3) With 16-18 tenure/tenure-track faculty, 4 APLs and two SER professors we will be able to offer the breadth of courses at the graduate level that will enhance the research efforts of our graduate

students and simultaneously offer the undergraduate courses necessary to maintain our American Chemical Society accreditation. This size of faculty will also provide us with the breadth of expertise that will foster synergistic interactions both in the department and across campus that will lead to an intersdisciplinary output greater than the sum of the parts. This action item is consistent with Motif 1 (Building depth versus adding breadth) and Motif 2 (Reinforcing and refining areas of distinction) in Creation of the Future 2.

CHEM-2 *Prepare our graduate students for a competitive job market. This will require increasing the number of state and grant supported GA's up to between the critical mass of 60 and 70.*

The critical mass of 60 to 70 graduate students is necessary in order to offer the spectrum of graduate level courses necessary to prepare our students for the modern workplace where they must interact with engineers and scientists from diverse disciplines. This number of graduate students will foster synergistic relationships in laboratory and group meeting settings necessary for passing on of knowledge from senior to junior graduate students. Finally, this critical mass of students is necessary to provide the manpower to the research groups in the department to acquire and maintain funding from granting agencies to purchase modern equipment for training of students. On average our department has supported ~42 graduate students a year since 1971. By the end of Summer 2008 we will have under 20 graduate students in the department. (Chart A1) We believe that 23 state supported GAs and 37-47 grant supported graduate students is the correct make-up of our graduate student body. The current unacceptable number of state supported GAs (17) in the department reflects a deplorable decreased from 25-27 in the early 1980s. On the other hand the unacceptable number of grant supported GAs reflects inattention to the demographic make-up of the department. This academic year more than one-half of the department is assistant professors who are still struggling with getting funding for their programs.

CHEM-3 *Provide a laboratory educational experience for our undergraduates commensurate with comparator institutions. This will require establishing a reasonable, fair, and sustainable Laboratory Fee system to help pay for teaching laboratory consumables and for upgrades/replacements of undergraduate teaching equipment. It will also require increasing the number of state supported GAs to 23-25 from our current level of 15-17.*

With one of the largest service teaching loads, the chemistry department is faced with having to pay large laboratory bills each year. In a recent departmental audit (fall 2006), we found that the approximate costs to the department were in excess of $40,000 in an average year. Less than 25% of this is incurred by running the majors-only upper division courses, which means the department is paying more than $30,000 a year to help educate the general population of UW students. This cost estimation has most likely increased since the time of the audit, and is likely to increase further as the number of students enrolled at UW increases (this is an expected outcome of the Hathaway scholarships). Furthermore, costs of laboratory "consumables" (e.g. chemicals, disposable items, glassware) are not stagnant, and inflation will keep these costs rising. Additionally, these cost estimates did not directly consider the need to upgrade and update the existing laboratories and equipment. In many cases, these updates have not been done in many years, which is putting the department and university at a disadvantage in comparison to competing schools. These additional considerations could amount to much larger lab costs for the department.

In an effort to help defray the yearly costs to the department, and as a way of accruing revenue to start the updating/upgrading process, the department would like to establish a Laboratory Fee system for all of its undergraduate labs. Based in part on the audit mentioned earlier and on a faculty survey, a list of equipment costs and a replacement schedule/timeline has been generated. Using this as a guide, we have determined that a flat-rate lab fee of $40 per student per lab would cover the costs of 100% of

the yearly lab consumable costs, as well as provided monies that could over a number of years, pay for many necessary repairs and replacements that have, thus far, been unreasonable due to cost constraints. The choice of a flat rate is consistent with other universities in the area, and allows some of the lab courses that are more expensive to run to be subsidized by the less expensive ones. As the more expensive labs tend to be upper division (i.e. non-service) courses, we justify the added fee by recognizing that many of the students who are in the upper division labs are also teaching assistants (TA's) in the lower division labs. Therefore, we consider the extra amount added to lower division fee a reasonable request as it is used to educate the TA's.

Increasing the number of state supported GAs to between 23 and 25 will also allow placement of TAs in 80-90% of our undergraduate laboratories. Our best undergraduates will fill the remaining TA positions. Currently only 55-60% of our teaching assistants are graduate students. Although experience as a TA is invaluable to undergraduates, the qualified pool is smaller than our demand and as a result we are placing undergraduates with questionable qualifications into TA positions. This is a disservice to students taking the laboratory and provides an unacceptable safety risk.

CHEM-4 *Upgrade and acquire more Departmental/University shared instrumentation. This will require: (1) An increase the Department support budget to a level commensurate with the buying power of the mid-1980 levels and (2) initiation of a program to submit proposals to granting agencies on a yearly basis.*

Chemistry as the molecular science requires sophisticated instrumentation to characterize, detect and quantify molecules. Surveys of employers suggest that the most desirable characteristic of potential employees is experience with modern instrumentation. Consequently, it is imperative that we keep our instrumentation holdings at an acceptable level. Undergraduate instrumentation in the $10,000 to $50,000 range will have to be acquired with a combination of support budget funds and laboratory fees (**CHEM-3A**). More expensive undergraduate and research grade instrumentation such as NMRs and X-Ray diffractometers, however, can be obtained by faculty submission of instrumentation proposals to granting agencies. We will partner with other scientists in other departments on campus to acquire this instrumentation and we will work with these colleagues to provide housing/locations for these instruments that will provide campus-wide access and efficient operation and maintenance.

CHEM-5 *Promote the Undergraduate Laboratory Teaching facility.*

A new Undergraduate Laboratory Teaching Facility would dramatically enhance our laboratory instruction. We hope that the building will be equipped with shared undergraduate instrumentation such as UV-Visible, NMR, and IR spectrometers, gas chromatographs, high pressure liquid chromatographs, rotary evaporators, electronic balances polarimeters, and GC-mass spectrometers. The current undergraduate instrumentation in the Chemistry Department is in very bad shape of lower quality and quantity than that available to most if not all the community college and many high school students in the State of Wyoming. In addition, improvements in laboratory construction in the past 40 years, including fume hood technology, will provide a safer environment for the students. The decreased undergraduate traffic in areas devoted to research in the physical science building will also alleviate safety concerns.

CHEM-6 *Begin the process of expanding our divisions from the traditional Analytical, Inorganic Organic, and Physical to include both Energy Science and Chemical Biology divisions.*

The most important problems faced by society are extremely complex and require an interdisciplinary approach. Chemists are an essential part of any interdisciplinary team needed to address life science and energy issues that are of central importance to the State of Wyoming. Creation of the Future 2 also recommends in Motif 2 reinforcing and refining areas of distinction and list both

life sciences and critical areas of science and technology as areas of distinction. In addition, the importance of energy research to the State of Wyoming is amply documented in their creation of the School of Energy Resources. Bringing in faculty in the departmental target areas of Chemical Biology and Energy Science (**CHEM-1A**) is only the first step in strengthening our interdisciplinary contributions to these important areas. We must also put in place the framework necessary to train graduate students in these critical areas. A large number of curriculum issues need to be addressed. The need to train students in interdisciplinary areas may require having our students take courses outside of the department and college. We are in the process of identifying and developing these courses with our colleagues across the wider campus community. We have begun to make incremental changes to the curriculum within the department (refer to **CHEM-2B**, **CHEM-3B**, and **CHEM-4B**). We are also slowly developing consensus among the faculty members to implement changes to the cumulative examination system. At this point we believe we are exploring whether or not changes to the number of external members on our M.S. and Ph.D. graduate committees will be required. We are exploring whether the historical divisions (analytical, inorganic, organic, physical) should be dissolved at the graduate level and replaced with loosely knit associations of faculty members focused on equipping students with the interdisciplinary skill sets to think about problems broadly and lend their problem solving skills to address societal needs.

CHEM-7 *With the Departments of Physics, Geology and Geophysics, and Chemical and Petroleum Engineering design a team taught course called "Introduction to the Fundamental Physical and Earth Science Aspects of Energy Science." This course will be targeted to serve upper division undergraduate students and first year graduate students.*

Successful interdisciplinary research requires effective communication between the research partners. Consequently, it is imperative that our Energy Science students are familiar with the language used by Energy Scientists in other physical science and engineering disciplines. We envision as a critical element of our Energy Science curriculum a team-taught introductory course that provides the students with an overview of physical science and earth science aspects of Energy Science.

CHEM-8 *Develop a new course "Chemistry of Biological Systems."*

In order to broaden the interdisciplinary projects in chemical biology and biomaterials, a course entitled 'Chemistry of Biological Systems' is being developed. This course addresses many of the fundamental chemical principles behind biological processes. Furthermore, it also fulfills many of the points recommended by the American Chemical Society for a biochemistry certification.

CHEM-9 *Develop and implement a new applied course "Mathematical Methods in Physical Chemistry I and II.*

One of the long-standing problems in teaching undergraduate chemistry is the lack of mathematical background among the chemistry students. To alleviate this problem, integration of an applied mathematics course into the undergraduate chemistry curriculum is proposed. This course will emphasize applications of mathematics to problems in chemistry, including practical, computer-based numerical solutions and analyses of experimental data. The new applied mathematics course is expected to improve the undergraduate chemistry education and better prepare the students for their future scientific and technical careers.

CHEM-10 *Continue to apply for a Departmental National Science Foundation (NSF) funded Research Experience for Undergraduates (REU) program.*

This program has proven to be one of the best tools for recruitment of new graduate students. Through an unfortunate set of circumstances the department lost its REU program several years ago and it is imperative that we keep trying for its reinstatement.

CHEM-11 *Use lower division graduate level courses for upper division undergraduate electives and advise more of our undergraduates into these courses.*

More than 90% of the Ph.D. granting Chemistry Departments in the United States and Canada have more faculty than the Chemistry Department at the University of Wyoming. Our small size precludes offering the breadth of undergraduate and graduate level courses found at most universities. Encouraging undergraduates to take our lower level graduate level course will serve the dual purpose of providing electives to our undergraduates and increasing the population in these often under-subscribed courses.

CHEM-12 *Promote student involvement in the American Chemical Society Student Affiliate.*

This is our student professional organization. Historically the student affiliate has sponsored a variety of events on campus and trips to regional or national meetings of the American Chemical Society. It provides an excellent experience for our students. Unfortunately, participation has dropped off in the past few years and we will take a more active role in promoting this organization to our students.

CHEM-13 *Increase and update library chemistry holdings.*

For many years we have neglected our book holdings in favor of our serials. This was a very wise decision, however, with increased funding for the library we must now concentrate on our books.

CHEM-14 *Expand our website in order to provide a location for the description of ongoing energy related research projects in the department. We also plan to request a link to the School of Energy Resources faculty web page at http://uwacadweb.uwyo.edu/ser/facultypages.asp. This will provide Energy Scientists who might want more information on chemistry equipment, projects, and opportunities for collaboration easy access to this information.*

This action item complements the plans described in action items **CHEM-1B** and **CHEM-2B**.

CHEM-15 *Enhance recruitment of undergraduate majors by advertising in undergraduate classes or by holding a departmental "Open House"*

Our upper division undergraduate laboratories are a bottleneck defining the maximum number of majors in the department. With help from a reasonable Laboratory Fee (**CHEM-3A**) and additional faculty (**CHEM-1A**) we will be able to begin seriously addressing recruitment of undergraduate majors to increase our numbers beyond the current resource limited number of 60-75 students.

Implementation

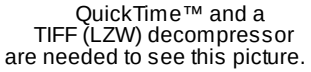
Rebuilding of a Chemistry Department will take many years. These action items are designed to achieve that goal. Action Item **4** (item 2) will be implemented early (E) in this new 5-year plan. Implementations of Action Items **6**, **8**, **9**, **10**, **11**, and **12** are already underway and should be completed successfully early (E) or midway (M) in this 5-year planning cycle. We will also begin early in this planning cycle to begin to argue for the resources necessary to implement the other action items including the efforts at increasing the number of majors in the department.

Department of Chemistry
Academic Plan III

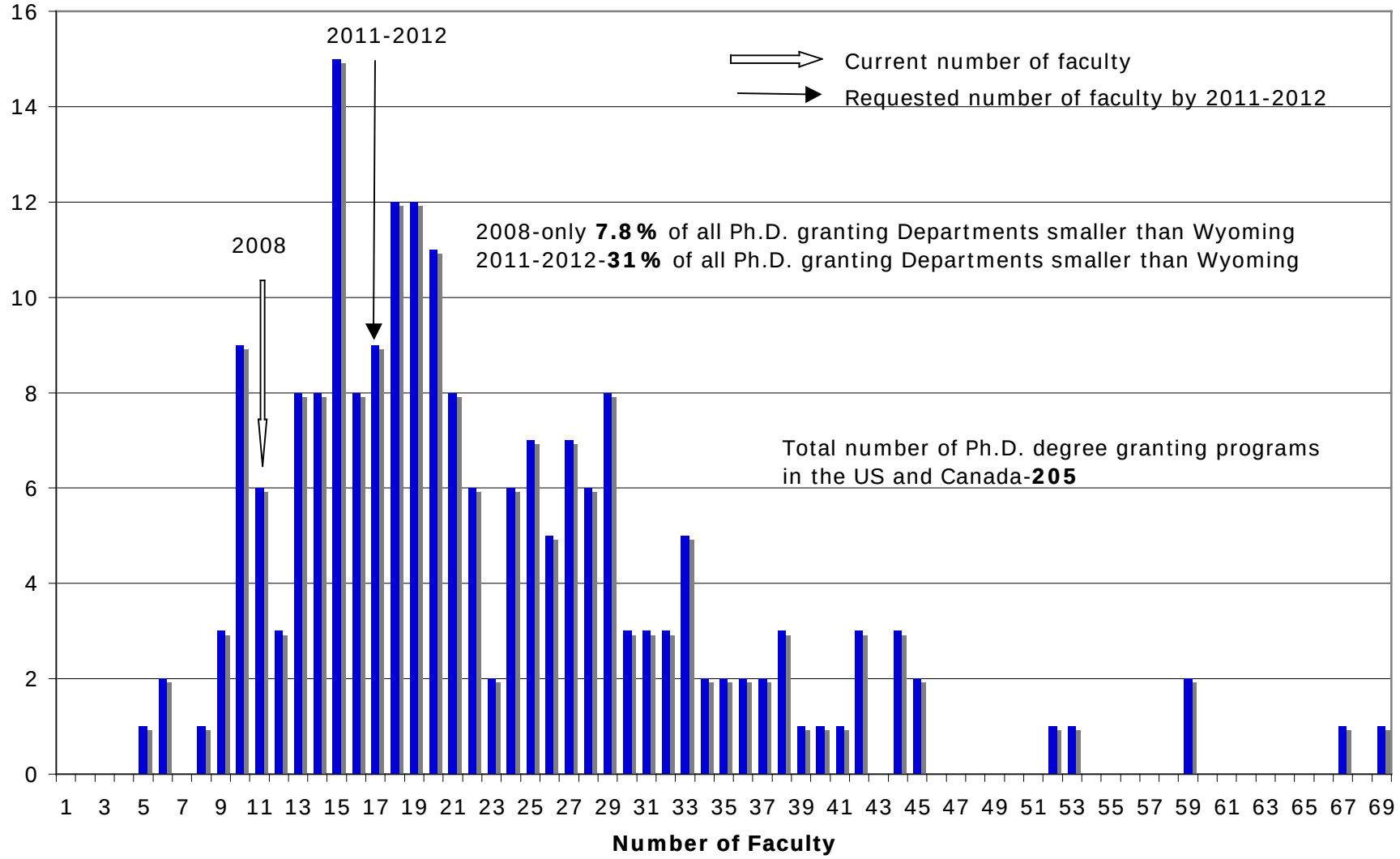
2009-2014

Appendix

A1. Historical Graduate Student Enrollment in the Department of Chemistry (1971-2007).



A2. Faculty Sizes in US and Canadian Ph.D. Granting Chemistry Departments



A3. Chemistry Department Faculty Size 1966-2008