Department of Chemistry
Program Highlights

- Chemistry Department faculty generated over $7.5M in external funding. In addition, they are key contributors on virtually all major initiatives in the Natural Sciences, such as the Chemical Methodologies and Library Development Center of Excellence, the Bioengineering Research Center, the Higuichi Biosciences Center, the R.N. Adams Institute for Bioanalytical Chemistry, the Center for Environmentally Beneficial Catalysis, and the two COBRE programs; Protein Structure and function and Cancer Experimental Therapeutics.

- The BA and BS programs have been enhanced through the creation of two seminar courses for undergraduates to provide improved academic and career advising to students early in the program (Freshmen and Sophomores) and enhanced skills for both academic and industrial careers to advanced students (Juniors and Seniors).

- The PhD program has been revamped to provide a curriculum individualized to each graduate student. This provides students with the ability to explore the interdisciplinary nature of modern chemistry and interact with faculty across the University.

- The Department of Chemistry is in the top tier of Mid-America Statue University Association (MASUA) group as measured by research productivity.

- A General Chemistry for Engineers course was created to better serve students in the School of Engineering.
Chemistry Department Statement of Purpose: January 2007.

“The Chemistry Department makes significant contributions to learning and knowledge that benefit our students, the scholarly community and the population of our state and nation, because understanding the atomic and molecular nature of matter informs us about ourselves and our universe, and creating and finding applications for new and modified forms of matter helps to conserve and enhance our world.”

- **Introduction.** The Department of Chemistry strives to embody the key mission of a top-flight public research university: the synergy of teaching, research, and service. In the recent decades, the department has made significant progress toward this goal through increasing research funding, productivity, and scholarly visibility; curriculum changes and recognition of outstanding teaching in both major and “service” courses; and a commitment to university and national service at the highest levels. Chemistry has one of the best graduate programs among KU’s departments of mathematics, science, pharmacy and engineering. Chemistry has consistently hosted 90 or more graduate students over the past ten years. During the three years monitored by the recent NRC national ranking process, the Chemistry Department by a wide margin produced the largest number of Ph.D. graduates of any science and engineering discipline at KU. It also boasts one of the most productive and successful research programs among departments in the College. Annual research funding has exceeded $6 million over the past three years, and overall research funding has essentially quadrupled over the past ten years. Per-faculty research funding is the highest in the sciences at the University, being eclipsed only by Medicinal and Pharmaceutical Chemistry. No other science department at KU combines a per-faculty research portfolio of this magnitude with such a large load of undergraduate teaching. This past year, three chemistry faculty won the university’s Kemper Award for outstanding accomplishments in teaching, and one of our colleagues was the 2006 Hope Award winner (voted the outstanding educator by graduating seniors). Chemistry faculty have shouldered more than their share of service and administrative work on behalf of the university. Over the past fifteen years, chemists have served as President of the American Chemical Society (ACS), chaired ACS governance committees and served on several ACS Joint Board/Presidential task forces. At the university level, the Department has contributed leadership through various faculty with appointments as Associate Provost, Associate Vice Provost for Research, Chair of Faculty and University Senate Executive Committees, Directors of Kansas NSF EPSCoR Program and the KU Center for Science Education, and a Director of the University Honors Program.

This document outlines the Chemistry Department’s accomplishments and describes its priorities for continuing improvement and plans to achievement long-term aims. These plans include expanding the research profile consistent with the university priorities, increasing graduate student numbers and quality, enhancing undergraduate and graduate education, and areas in which the department can provide leadership within university initiatives and infrastructure. The
The self-study that follows is broken down into reviews of the following six basic areas of department operations:

- Chemistry Department research,
- Department space and infrastructure,
- Graduate studies in Chemistry,
- Undergraduate studies in Chemistry,
- Department governance, support staff and services, and
- Alumni relations.

Each of these sections summarizes the current accomplishments of the department and status of department programs, defines concerns and barriers that might affect the progress of the program, and outlines future goals and plans for improvement. Where appropriate, the Department poses questions for the visiting team.

In the context of these economically trying times, we recognize that these plans are ambitious. At the same time, we are reluctant to reduce expectations for our own achievement due to temporary economic challenges. We believe that the scope the expectations we set for our development will have an important influence on the scope of our future accomplishments. Since these aspirations are built upon the department’s genuine track record of success in combining scholarship, grantsmanship, teaching, and service, and we are convinced that these are achievable goals.
• **Research Facts and Trends.** The annual research funding for the department has exceeded $6 million over the past three years. In 2008, the total sponsored research expenditures were $6.6 million. As the figure below illustrates, research expenditures by our department have quadrupled over the past ten years. KU is consistently ranked second or third in research funding in the 12 university Chemistry Departments participating in the MASUA chemistry chairs forum.

![Comparison of OOE, GTA cost, Grant Expenditures and Faculty Salary](image)

*Figure 1:* expenditures: medium blue, GTA Salaries: yellow, faculty salaries: pink, other operating expenses: navy

The level of our research expenditures ranks us between the first and second quartile of NRC departments based on a recent Council for Chemical Research survey of research funding. Nationally KU was ranked 67 in the NSF 2006 survey of research and development expenditures in chemistry. It is important to note that this ranking would be significantly improved if chemistry related research in the departments of Medicinal Chemistry and Pharmaceutical Chemistry were included in the total Chemistry expenditures at KU; see Table 1. Many of the projects of the chemistry faculty are multidisciplinary and include faculty from these departments as co-PIs. If the chemistry related research for both of these departments was included, KU would rank #8 in overall chemistry funding nationally in the NSF survey. KU currently reports research projects from these departments to NSF under the Life Science heading. It is noteworthy that, contrary to this behavior by the university administration, the most recent NRC department ranking lists both Medicinal and Pharmaceutical Chemistry under the broad category of Chemistry.
Table 1: Total Chemistry related Research at KU

<table>
<thead>
<tr>
<th>KU Department</th>
<th>Total Chemistry Research Expenditures in 2006 (in millions)</th>
<th>Resulting National NSF CHEMISTRY Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>$6.840</td>
<td>67</td>
</tr>
<tr>
<td>Pharmaceutical Chemistry</td>
<td>$4.747</td>
<td>NR</td>
</tr>
<tr>
<td>Medicinal Chemistry</td>
<td>$11.675</td>
<td>NR</td>
</tr>
<tr>
<td>Chemistry &amp; Pharmaceutical Chemistry Aggregate</td>
<td>$11.587</td>
<td>41</td>
</tr>
<tr>
<td>Chemistry, Pharmaceutical Chemistry Aggregate</td>
<td>$23.262</td>
<td>8</td>
</tr>
</tbody>
</table>

The department currently has 29 tenure-track faculty consisting of 27 total faculty FTEs, not counting the addition of one junior faculty member in Physical Chemistry in Fall 2009. There are a slightly larger number of full professors (15) than junior faculty (12). Twenty five of the current faculty have active research programs. Twenty four have substantial funding for their research. Figure 2 shows a breakdown of the sources of research funding. Federal funding is equally split between NIH and NSF with about 10% of the budget coming from non-federal sources.

Eighteen of the faculty have research groups between 1-5 members in size. Seven faculty have groups of more than six members and only a couple of faculty have groups larger than 10. The publication record for the faculty has been steady over the past 15 years with the faculty producing approximately 150 publications per year. KU is especially active in undergraduate research with 18 undergraduate students participating in Chemistry department research groups last year.
Research Areas. The faculty in the department pursue research in nine research areas with many researchers belonging to more than one area (Table 2). In addition the department has 12 courtesy faculty from the departments of Medicinal Chemistry, Pharmaceutical Chemistry, Engineering, Molecular Biosciences and the Medical School. These courtesy faculty act as mentors and co-mentors, write cumulative exams and serve on exam committees. Many of the chemistry faculty have reciprocal courtesy appointments in these departments as well.

Table 2: General Research Areas in the Department of Chemistry

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Faculty Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical Chemistry</td>
<td>Cory Berkland¹, Cindy Berrie, Heather Desaire, Robert Dunn, Carey Johnson,</td>
</tr>
<tr>
<td></td>
<td>Michael Johnson, Craig Lunte, Sue Lunte, Russell Middaugh¹, Eric Munson¹, Ken</td>
</tr>
<tr>
<td></td>
<td>Ratzlaff³, Mario Rivera, Joel Schwartz³ Sitta Sittapalam³, John Stobaugh¹, Todd</td>
</tr>
<tr>
<td></td>
<td>Williams¹, David Weis, George Wilson</td>
</tr>
<tr>
<td>Chemical Education</td>
<td>Joseph Heppert</td>
</tr>
<tr>
<td>Inorganic Chemistry</td>
<td>Mikhail Barybin, Kristin Bowman-James, Daryle Busch, Joseph Heppert, Jon</td>
</tr>
<tr>
<td></td>
<td>Tunge</td>
</tr>
<tr>
<td>Organic Chemistry</td>
<td>Jeff Aube¹, David Benson, Robert Carlson, Rich Givens, Paul Hanson, Helena</td>
</tr>
<tr>
<td></td>
<td>Malinakova, Michael Rubin, Barbara Schowen², Richard Schowen², Jon Tunge,</td>
</tr>
<tr>
<td></td>
<td>Minae Mure</td>
</tr>
<tr>
<td>Physical Chemistry</td>
<td>Cindy Berrie, Shih-I Chu, Robert Dunn, Christopher Elles, Peter Hierl, Wonpil</td>
</tr>
<tr>
<td></td>
<td>Im¹, Carey Johnson, Krzysztof Kuczera, Brian Laird, Aaron Scurto¹, Ward</td>
</tr>
<tr>
<td></td>
<td>Thompson</td>
</tr>
<tr>
<td>Bioanalytical/Bioinorganic Chemistry</td>
<td>David Benson, Cindy Berrie, William Brooks³, Heather Desaire, Robert Dunn,</td>
</tr>
<tr>
<td></td>
<td>Wonpil Im¹, Timothy Jackson, Carey Johnson, Michael Johnson, Jennifer Laurence³,</td>
</tr>
<tr>
<td></td>
<td>Craig Lunte, Sue Lunte, Russell Middaugh¹, Mario Rivera, Christian Schoeneich³,</td>
</tr>
<tr>
<td></td>
<td>John Stobaugh¹, David Weis, George Wilson%3Ca%20href=</td>
</tr>
<tr>
<td>Bioorganic/Bioinorganic Chemistry</td>
<td>Mikhail Barybin, Andrew Borovik³, David Benson, Paul Hanson, Timothy Jackson,</td>
</tr>
<tr>
<td></td>
<td>Helena Malinakova, Minae Mure, Emily Scott³, Jon Tunge</td>
</tr>
<tr>
<td>Computational &amp; Theoretical Chemistry</td>
<td>Shih-I Chu, Wonpil Im¹, Krzysztof Kuczera, Brian Laird, Gerald Lushington¹,</td>
</tr>
<tr>
<td></td>
<td>Ward Thompson</td>
</tr>
<tr>
<td>Materials</td>
<td>Cindy Berrie, Andrew Borovik³, Daryle Busch, Brian Laird, Aaron Scurto¹, Ward</td>
</tr>
<tr>
<td></td>
<td>Thompson</td>
</tr>
</tbody>
</table>

¹Courtesy Faculty; ²Emeritus Faculty; ³Adjunct Faculty
• **Research Strengths.** The chemistry department has a very strong group of research faculty including junior and senior members. Five of the junior faculty received NSF CAREER awards in the past five years: (Barybin; Desaire; Malinakova; Mure and Tunge). A unique strength of the University of Kansas is the amount of interdisciplinary research that is performed on campus. Chemistry faculty collaborate with other faculty in engineering, pharmacy, molecular biology and bioinformatics. Current and future areas of research strength in the chemistry department are listed below:

**Bioanalysis/Detection.** The Ralph N. Adams Institute for Bioanalytical Chemistry is a clear leader in this area across the nation. Members of the institute are involved in the development of analytical methods to better understand cancer, AIDS and neurological disorders. Research areas of the chemistry faculty in the institute include sensors, *in vivo* monitoring (C.Lunte, S. Lunte, G. Wilson and M. Johnson), protein mass spectrometry (H. Desaire, D. Weis,), single molecule detection (R. Dunn and C. Johnson), clinical diagnostics (S. Lunte, C. Lunte), NMR (M. Rivera) and protein chemistry (M. Rivera, H. Desaire, D. Weis).

**Neuroscience.** Chemistry has both current and historical strengths in neuroscience starting with Ralph N. “Buzz” Adams in the early 70’s. KU has a neuroscience program. The current acting provost (J. Steinmetz) is the director of this program. Four of the faculty and three of the courtesy faculty in the analytical division have research projects concerned with the development of analytical methods for the investigation, detection and treatment of neurological disorders. These include using *in vivo* voltammetry to study the etiology of Huntington’s disease (M. Johnson), microdialysis based methods for monitoring neurotransmitters and neuropeptides in awake, freely moving animals (C. Lunte and S. Lunte) and sensors for monitoring glutamate and glucose in the brain (G. Wilson). Neuroscience will be a growing area of focus for the department and the Adams Institute. Last year the Adams Institute submitted a proposal for a graduate training grant in Analytical Neuroscience. The proposal is being revised for resubmission this May.

**Structural Biology and Protein-Protein Interactions.** Several of the faculty in Chemistry are involved in developing better methods and approaches to understanding protein-protein interactions and how these change during disease states. This includes understanding how bacteria sequester iron from their host in the pursuit of better antibiotics (M. Rivera), the understanding of how the glycosylation pattern of a protein used for an AIDS vaccine affects its immunogenicity (H. Desaire) and hydrogen-deuterium exchange mass spectrometry for looking at protein-protein interactions involved in diabetes and other diseases (M. Rivera).

**Drug discovery.** Drug discovery is an area of research at the university in which Chemistry is making major contributions. Drs. Hanson and Tunge are involved in the NIH sponsored Center for Excellence in Chemical Methodologies and Library Development (CMDL) that is located on West Campus. This is a $9.57 million multidisciplinary center sponsored by NIH. Jeff Aube, a courtesy faculty member in Chemistry is the director of the Center. On the bioanalytical side, the Adams Institute works closely with the Office of Drug Discovery and Experimental Therapeutics and the KU Cancer Center on the development of new analytical methods related to the detection of cancer, the efficacy of therapeutic agents and understanding of the etiology of
Huntington’s disease. A major goal of the university and the state of Kansas is to obtain NCI designation for the KU Cancer center by 2012.

**Nanoscience/Materials/Energy.** Nanotechnology is inherently interdisciplinary, requiring the collaboration of those who can synthesize new materials, characterize those materials, assemble components into devices, and test those devices. With few exceptions, the leading groups in the field are those who involve multiple principal investigators with complementary skill sets. Chemists play a central role in such projects since the aim – whether the application is molecular electronics, catalysis, sensors, or bioimplants – is to build nanoscale structure from the “bottom up” by assembling and arranging individual molecules. Nanotechnology will be a key element of the solution of many key problems in energy (fuel cell catalysts and membranes; hydrogen production and purification catalysts; hydrogen storage materials; biomass conversion catalysts), electronics (molecular switches, transistors, and wires; nonlinear optical materials; optoelectronic devices), and biology and medicine (lab-on-a-chip; biocompatibility; drug delivery; sensors; targeted therapies; nanobiodevices). KU Chemistry faculty working on nanotechnology projects include molecular electronics (Barybin, Berrie), molecular motors (Berrie with Richter from MB), nanostructured materials for catalysis (Barybin, Thompson), phase behavior in porous materials (Laird, Thompson), molecular recognition (Bowman-James), microfluidics (S. Lunte), biological/biomimetic membranes (Dunn), and nanoscale-patterned substrates (Berrie).

**Theoretical and Computational Chemistry.** The Department has a strong core of theoretical chemistry in both numbers of faculty members and overlapping research areas with four faculty members (Laird, Chu, Kuczera, and Thompson) and one permanent staff member (Gerry Lushington, Director of the KU Molecular Modeling and Graphics Laboratory and Courtesy Faculty Member in Chemistry). A significant proportion of the experimentally-focused faculty in the department also regularly utilize computational chemistry in support of their research in organic, inorganic, bioanalytical, pharmaceutical and biophysical chemistry. Areas of expertise in the department include: theory and simulation of materials, nanostructures, interfaces, and biomolecules, electronic structure calculations, chemical reaction dynamics, spectroscopy, algorithm development, quantum computation, quantum dynamics in extreme environments (space, high laser fields, etc.).

**Biofuels/Bio-feedstocks/Energy.** Biofuels/bio-feedstocks are viewed as one of the coming technologies that will replace a portion of the petroleum based energy and chemical feedstocks on which the economy is currently reliant. Conversion of cellulosic material into ethanol and other chemical precursors is viewed as a principle strategy for developing these resources. We have a number of faculty whose expertise in catalysis is being applied to these problems including Daryle Busch, Paul Hanson, John Tunge, Ward Thompson and Brian Laird.

The Chemistry faculty also have leadership roles in many of the major research initiatives on campus including the Center of Excellence in Chemical Methodologies and Library Development (CMLD), the Center for Environmentally Benign Catalysis (CEBC) and the Ralph N. Adams Institute of Bioanalytical Chemistry.
Center for Excellence in Chemical Methodologies and Library Development (CMLD): http://www.cmld.ku.edu/. Three of the organic chemistry faculty are key investigators in the Center for Excellence in Chemical Methodologies and Library Development. The Center has four project areas with organic chemistry faculty leading three of the four areas. These are Enhancement of Library Synthesis Using Microwave Flow Technology (Dr. Paul Hanson); Libraries Based on Natural Products and Privileged Structures (Dr. John Tunge) and Organometallic Reactions in Parallel Synthesis (Dr. Helena Malinakova). Paul Hanson is also the co-investigator in the fourth project area on the development of Lactam and Sulfoxamide Libraries. Jeff Aube from the department of Medicinal Chemistry is the project leader for this project as well as the director of the Center. The total award for the Center from NIH was $9.57 million. The budget for the four research projects is $1,657,557 per year.

Center for Environmentally Benign Catalysis (CEBC): https://rhodium.cebc.ku.edu/. Seven chemistry faculty are participants in the CEBC. Professor Daryle Busch is the deputy director of the Center with Bala Subramanian from CPE as the director. The mission of the Center for Environmentally Beneficial Catalysis is to develop and make available novel, leading-edge technologies that bring about economically- and environmentally-sustainable transformations in the chemical and energy industries. The expected long-term outcome of CEBC is a transformed set of industries wherein pollution prevention and environmental sustainability replace waste production, pollution, regulation and remediation.

Ralph N. Adams Institute for Bioanalytical Chemistry: http://www.adamsinstitute.ku.edu/. The Adams Institute for Bioanalytical Chemistry was established in fall of 2006 to foster education and research in Bioanalytical Chemistry at the University of Kansas. Members of the institute include eleven faculty from Chemistry, five from Pharmaceutical Chemistry, two from Engineering and one from Medicinal Chemistry. Susan Lunte is the Institute Director. The Institute fosters multidisciplinary research with in KU as well as international collaboration in Bioanalytical Chemistry. Currently, there are research and exchange programs with schools in Ireland, Brazil and the Netherlands. The Institute manages a microfabrication facility that is used by KU faculty as well as investigators outside KU (K-State, Saint Louis University, Creighton and NIH). Lastly, the Adams Institute also acts as a conduit between the Chemistry department, the KU Cancer Center and the Neuroscience Program.
**Figure 3:** Research funding of members of Adams Institute by Department

Some of the KU Chemistry faculty have benefitted from the two COBRE grants at the University. The NIH Center of Biomedical Excellence in Protein Structure and Function ([http://psf.cobre.ku.edu/](http://psf.cobre.ku.edu/)) conducts health-related basic research in protein structure and function. The main goal of this grant is to provide research support and mentoring to accelerate the career development of outstanding junior faculty researchers. Two chemistry faculty members, Drs. Heather Desaire and Julian Limburg were participants in this program. The COBRE also maintains core laboratory facilities that are available to researchers statewide. The NIH Center for Cancer Experimental Therapeutics ([http://ccet.cobre.ku.edu/index.php?page=newfolder:pi_page](http://ccet.cobre.ku.edu/index.php?page=newfolder:pi_page)) is involved in the development of new cancer drugs and methods of delivery. Drs. Paul Hanson and Minae Mure were participants in this program.

- **Action Items: Needs in Space, Personnel and Infrastructure.** The Chemistry Department has several areas where improvements or additional resources are needed. The most desperate of these is space. Figure 4 shows the breakdown of space for research in the Department of Chemistry. This includes both Malott (built in 1954) and MRB (built in 2005).

![Quality of Current Chemistry Research Space](image)

The top two categories—very good and excellent—are the standard we should aspire to in providing resources to support research mission of the university.

The quality of research space in Chemistry tends either to be very high or genuinely substandard. Spaces renovated for new faculty within the past 5 years and new spaces in MRB rival the quality of research space available to faculty anywhere in the country. Other space suffers from antiquated ventilation and climate control and potential water leaks that threaten the safety of expensive research instrumentation. Chemistry currently has the capacity to add up to three additional new research groups based on current and future available space. After that, the need
to expand and reconfigure existing research groups will account for the remaining available space.

There are problems caused by bifurcating chemistry space. For the first time in many years, a substantial fraction of the Chemistry faculty is physically separated from the main body of the department, with five Analytical faculty occupying new space in Multidisciplinary Research Building (MRB). This has raised several concerns: 1) there is understandable concern that the senior members of the Analytical division are all in MRB, while the two untenured members of the division remain in Malott. 2) Research and Graduate Studies has sited and shifted much of the major shared life science instrumentation to the Structural Biology Center on West Campus. This places these resources about a mile from life science research groups in Chemistry. 3) The housing of a substantial fraction of the department in excellent new space has raised some concerns about the differential benefits this imposes of one fraction of the department, especially with regard to recruiting graduate students into research groups in Malott. 4) Chemistry has always been noted for its cohesiveness and collegiality. Many members of the department are concerned that characteristics of the department will be diminished through the separation of the faculty across campus. In contrast, the concentration of many analytical service facilities—mass spectroscopy, bio-NMR instrumentation and protein crystallography—on KU’s west campus makes having laboratories near these resources attractive for many of our Chemical Biology researchers.

Virtually all of the major regional research institutions that we compete against for grants, graduate students and undergraduate students has had a new building for the basic sciences completed or a multimillion dollar renovation undertaken within the last 10 years. KU stands out in not having made this commitment to infrastructure.

**Figure 5** Distribution of Faculty FTE Service by Division

![Distribution of Faculty FTE Service by Division](image)

**Need for Faculty Additions.** New faculty hires in all divisions is also critical. The tenure-track faculty of Chemistry at KU currently numbers 29 members, comprising 27 total faculty FTEs. We will also add one junior faculty member in Physical Chemistry to our ranks in fall 2009. Among these individuals, 25 currently have active research programs, and 24 have substantial funding for their research. The distribution of these faculty among disciplinary areas, and with respect to years of service and rank are outlined in Table 2 and the bar chart at left, respectively.

**Table 3: Distribution of Chemistry Department Faculty FTEs**

![Table 3: Distribution of Chemistry Department Faculty FTEs](image)
<table>
<thead>
<tr>
<th>DIVISION</th>
<th>A</th>
<th>I</th>
<th>O</th>
<th>P</th>
<th>E</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>4.5</td>
<td>2.5</td>
<td>3</td>
<td>4.5</td>
<td>0.5</td>
<td>15</td>
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<tr>
<td>Associate</td>
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<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Assistant</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>7.5</td>
<td>4.5</td>
<td>8</td>
<td>6.5</td>
<td>0.5</td>
<td>27</td>
</tr>
</tbody>
</table>

The average number of faculty in NRC 1st quartile chemistry departments is 37 (Figure 5). Our goal is to build the department to a critical mass of a total of 35 faculty. This would be consistent with the university’s plans for developing science and technology funding, the current growth in enrollment in all core undergraduate chemistry courses through the junior level and the need to create NCR 1st quartile science programs at KU.

An inspection of the data in Table 3 prompts several observations:

1) **Faculty rank:** On average, the Chemistry Department is a fairly young unit. With an average age of 40, over half of the department faculty hold either Assistant or Associate Professor rank. On the positive side, this means that the department is still coming into its own with respect funding potential. It does point out some ongoing issues in leadership.

2) **Leadership:** Some departmental divisions have relatively few senior faculty who can provide leadership for their younger colleagues. For example, following two impending retirements, Paul Hanson will be the most senior funded faculty member in the Organic Division. This is an unusual situation for a highly effective group of Organic faculty. Similarly, among the five distinguished professors in the department, only one is younger than 60 years of age and three are presumably within a few years of retirement. The loss
of these individuals would leave a substantial gap in the voice of the department in advocating for the chemical sciences and forming science policy at the university level.

3) **Clear areas of disciplinary need:** The organic division is clearly smaller than divisions at many top-quality schools. With two impending retirements, this will move the department into an at-risk status for a critical mass of researchers, and increase the probability that the division will struggle to meet its current load of service, undergraduate major and graduate course requirements. To address this critical situation, we will need to add at least three new faculty over the next few years, with one or more of these hires being at a senior level.

The experimental physical chemistry division has only two full time members. This is not considered to be a “critical mass” for attracting graduate students. Moreover, the Physical division is, on average, the division with the longest serving members in the department. This means that the Physical division can expect to be impacted most severely by retirements over the next five years. The department needs to add three physical chemistry faculty, including at least two experimentalists, over the next several years. The faculty additions outlined above have been approved as top priorities for the department.

The recent loss of colleague from the Inorganic division plus the fact that three senior members of the division have substantial administrative responsibilities has left the division in a dire situation. New faculty will be needed just to meet the typical teaching contributions of the unit.

**Future Retirements.** As many as six current senior faculty members have approached the department about the prospect of retirement sometime in the near future. These individuals fall into the following divisions: Analytical (1), Inorganic (1); Organic (2); Physical (2). Naturally, the current economic situation has the potential to modify some of these plans, though there is good confidence that two of these individuals plan to complete their retirements by the end of fall 2009. Among these faculty, four out of the six have active research programs. Given the existing needs in the physical and organic divisions, these retirements would have a disproportionate impact. The department would also lose 3 of its 5 distinguished professors if all of these retirements materialize over the next five years.

Based on these expected personnel changes, adding a single faculty member each year over the next five years will not even be sufficient to sustain the teaching capacity and research productivity of the department. It certainly will not be sufficient to serve the expanding numbers of undergraduates focusing on science, engineering and pharmacy degree programs. The two potential Organic retirements would directly impact our capacity to provide high-quality introductory service courses that the university depends on for all of its science, engineering and pharmacy majors. The two potential Physical retirements will contribute to similar issues in the “freshman” chemistry service courses, as the physical chemists frequently adopt leadership roles in teaching these courses. In order to sustain current activities and continue to build the contributions of the department, the college and university need to plan for at least searches
every year in Chemistry over the next five years, with multiple searches in the first, third and fifth years of this period.

**Departmental Leadership: Distinguished professorships.** Within the past 20 years, the Department has been the simultaneous home to seven distinguished professors: Dick Schowen, bioorganic chemistry, Ralph Adams, Ted Kuwana and George Wilson, bioanalytical chemistry; Paul Giles, physical chemistry; Daryle Busch, inorganic chemistry; and Shih-I Chu, theoretical and computational chemistry. These numbers have now shrunk to five, and at least three of these individuals are eligible to retire at any time. The loss of these positions is not a positive trend for the Department or for the College of Liberal Arts and Sciences. The leadership that many of these individuals have brought to the Department is also sorely missed. Their efforts have spawned major Centers, endowment efforts and mentored countless junior faculty. It is essential that the institution move on behalf of the College to reclaim a substantial share of this leadership.

Candidates to fill these positions need not all come from outside the university. It is clear that Chemistry has four or five mid-career faculty whose career trajectories are clearly consistent with distinguished professor rank. Arguably, if the positions existed, we could currently field three candidates who would easily pass muster for appointment to chaired or distinguished professorships. Part of the solution to this problem is to fight to ensure that once current chairs are vacated that they are reassigned to faculty in our department. Another strategy is to target the creation of new chaired professorships named for some of the current luminaries in our department. This is one of the priorities of the department and we are working with the alumni and friends with the help of the KU Endowment Association to identify resources.

**Challenges and Expectations for Faculty.** Over the past 15 years, standards for promotion and tenure in the sciences have increasingly favored major external funding (from a federal agency such as NSF or NIH) along with a continuous and developing record of quality publications. The recent flattening of the NIH budget and accompanying shrinking of percentile scores for successful grants has made it much more difficult for both junior and senior faculty to obtain and maintain federal funding. Up to the present, junior faculty in Chemistry have an exemplary record of achieving these goals. However it is still critically important for the department and the university to regularly examine hiring practices, the level of support provided for all faculty seeking external funding, and our institutional expectations for the development of an independent, well funded research program. We believe that part of the reason our junior faculty have fared so well in the past despite substantial funding challenges relates to the outstanding quality and experience of the individuals we have hired.

The coming years are not a time to backtrack on hiring young scientists of the *highest quality* and hiring them *when they are needed*. In times of extraordinary stress, faculty at all levels need the highest degree of support in preparing and submitting proposals and in administering grants once they are received. Maximizing faculty efficiency by continuing to support these, as well as the teaching and service components of a faculty member’s effort minimizes the stress placed on them by the many demands of a modern academic career. The department needs to continuously examine its faculty mentoring policies to ensure that evaluations continue to focus on providing feedback, support and direction that maximize our colleague’s opportunities to achieve professional success.
**Mid-career faculty retention.** We believe that the department’s top priority must be to retain our department’s highly successful cohort of mid-career faculty. The outstanding scholars and leaders of tomorrow are in the ranks of our Department today. In order to accomplish this, the Department must partner with the university administration to ensure that:

- Mid-career faculty are provided with leadership responsibility within Chemistry and have a significant voice in developing long-term policy for the growth of research emphases and commitment of resources within the Department,
- Additional mentoring is provided for mid-career faculty in grant development and management, and resources are developed to support individuals seeking funding for major multi-investigator programmatic projects,
- Common and personal working spaces in Malott Hall and other Chemistry research venues are upgraded so that KU is a pleasant, satisfying working environment,
- Sufficient staff support exists to assist faculty in the development, preparation, and management of programmatic grants.
- Research space is enhanced and expanded to the extent that no faculty member ever considers the availability of adequate space a barrier to their professional growth, and
- Real rewards (e.g. salary increases, enhanced overhead return, enhanced space and access to facilities) are provided to faculty who sustain research programs funded through multiple grant sources.

It seems possible, in light of our anticipated retirements and opportunities defined by the areas of strength described above to refine this priority list. The following is a rank-ordered list of potential candidates that the department hopes to recruit:

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Research Area</th>
<th>Experience Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-2011</td>
<td>1. Bioanalytical chemistry</td>
<td>junior*</td>
</tr>
<tr>
<td></td>
<td>2. Bioinorganic chemistry</td>
<td>junior</td>
</tr>
<tr>
<td></td>
<td>3. Organic synthesis / drug discovery</td>
<td>senior</td>
</tr>
<tr>
<td></td>
<td>4. Experimental Physical Chemistry</td>
<td>senior</td>
</tr>
<tr>
<td>2011-2012</td>
<td>5. Organic or bio-carbohydrate chemistry, glycopeptide synthesis, catalysis in the preparation of glycans, polysaccharides as chemical feedstocks</td>
<td>junior or senior level</td>
</tr>
<tr>
<td></td>
<td>6. Theoretical Chemistry, electronic structure and/or materials</td>
<td>junior</td>
</tr>
<tr>
<td></td>
<td>7. Organic synthesis/drug discovery</td>
<td>junior</td>
</tr>
<tr>
<td>2012-2013</td>
<td>8. Neuroscience/molecular biology</td>
<td>eminent scientist</td>
</tr>
<tr>
<td></td>
<td>9. Inorganic materials chemistry</td>
<td>junior</td>
</tr>
<tr>
<td>2013-2014</td>
<td>10. Experimental Biophysical Chemistry</td>
<td>junior</td>
</tr>
</tbody>
</table>
We project that these hires will take the department by the end of AY 14-15 to a total faculty population of 33, within range of the overall goal of achieving faculty populations at the NRC top quartile level. The members of the department understand that additions at this rate are highly unlikely to occur over the next several years, but we can demonstrate that there is need for these additions and the Department’s track record of productivity demonstrates that the university will accrue enormous benefits from investment in these personnel.

**Support for Research Administration within the Department.** Despite the increase in faculty productivity and, therefore, the number of grants being administered by the department (see Figure 1), the OOE budget has remained flat over the past ten years. The number of staff members within the department administer the grant budgets, hire postdoctoral associates, appoint graduate students and order instruments and supplies for Chemistry faculty have also remained constant. The increased amount of funding means that the current staff are working much harder to keep up with grant administration tasks along with taking care of the graduate and undergraduate teaching. *The University needs to increase the OOE budget to reflect the larger amount of overhead coming from grants directed by faculty in the department of chemistry.*

**Research Support at the University.** Over the past five years, KU has made major investments in buildings and instrumentation. Three new buildings have been constructed on West Campus that house an 800 mHz NMR, an FT-MS, MALDI, microfabrication facilities and a state of the art high throughput screening facility. An imaging facility has also been established in Haworth Hall with state of the art microscopy instrumentation. Although this is a start, there are many other pieces of instrumentation and infrastructure that are needed if KU is going to move into the top quartile of research universities. This includes state of the art mass spectrometry equipment (Orbitrap, walk-up triple quadruple mass spectrometer), instrumentation for materials characterization and increased computational capabilities. In addition, the one thing that is sorely lacking at KU is the funds for personnel to oversee and maintain the equipment once it is purchased. There are directors of many of these laboratories but the labs themselves are severely understaffed (or not staffed at all). This results in losses of productivity, missed research opportunities and overall faculty frustration.

**Recommendations.** The following actions must be undertaken as a partnership between the College and the Department to advance the success and growth of the chemistry department:

- Plan for two or more hires per year over the next five years, with faculty additions targeted to enhance strengths in key research areas;
- Enhance support for successful mid-career faculty;
- Enhance personal, public and research spaces so that faculty are consistently supported;
- Support and mentor mid-career faculty who sustain aggressive research growth and seek leadership in programmatic research endeavors;
- Identify new and existing chaired and distinguished professorships for worthy faculty in the Department;
Engage the Department’s alumni and friends to support the establishment of new chairs and distinguished professor positions, and create more flexible named professorships (i.e. professorships where the awardees retain the title indefinitely, but the monetary benefits of the professorship are shifted to another faculty member after a pre-defined term).

- **Questions for External Reviewers**
  1. How can the department work to enhance the quality of its scholarly productivity?
  2. Where do you perceive that the department has logical opportunities or needs to extend the scope of its research capacity?
Department Space and Infrastructure

This is a critical time for the future of science programs at major universities. It is paramount that states and universities invest resources in the future of science and engineering research programs or these programs run the risk of becoming non-competitive on a national level. KU and the State of Kansas must move now to modernize its basic infrastructure.

It is apparent that across the nation, many states are in the process of abrogating their responsibility for funding academic science infrastructure. This behavior is shifting the burden to universities to provide and maintain expensive facilities for education. As a result, the need for new research facilities at KU has been taken up by the research arm of KU Center for Research, Inc. (KUCR), which has borrowed against the future earnings from research grants. These facilities have been directed towards the needs of a few of the major contributing groups in the research community or narrowly focused to a single area of research. This focused approach has had the unintended consequence of bypassing a significant portion of the Chemistry faculty, a major contributing arm of the research enterprise.

Chemistry faculty members are participating and have always participated in major interdisciplinary research endeavors dating back to the Health Science Achievement Award (HSAA) in the early ‘70’s. There is a substantial representation of Chemistry faculty in many of the current Centers on campus. The participation of these individuals has been vital to the success of each Center. A partial list of these groups includes CEBC, CMLD, Higuchi, Adams, and COBRE Centers. Chemistry contributes some level of leadership in all of these endeavors: in particular, Chemistry faculty drive much of the innovation in basic science in these endeavors. These collaborative arrangements have drawn our faculty and students to new research venues and away from the central main campus facility.

The following recommendation is the goal of this document:

In order to maintain a strong integration of our research and teaching missions, we need a major expansion of research space on Main Campus, along with upgrades of existing science research space assigned to the College. The total cost for this plan might reach $100 million, which is certainly within the range of infrastructure commitments made to virtually every other chemistry department in a major research university throughout the region over the past ten years.

This section outlines a major 10-year plan to modernize and construct major chemistry buildings on the KU campus.

- Background;
- Quality of Existing Research and Teaching Spaces;
- Problems and Challenges Raised by Current Chemistry Department Space;
- Long-term Results of Space Concerns;
- Recommendations for Long- and Short-Term Solutions to these Critical Space Issues;
- Near-term remodeling with Stimulus Funds;
- Recommendations for University Leadership.
• **Background.** Malott Hall was built prior to the birth of the vast majority of Chemistry Department faculty and staff members. The current facility (55 years old) was built at a time when the student population was less than 12,000. Now there are nearly 30,000 students at KU. The construction of Malott Hall in 1954 prompted the move of the Department from its original home in Bailey Hall, which still stands at the crest of Jayhawk Boulevard. Malott Hall is an incredibly resilient structure. Aside from a skeleton of steel reinforced concrete beams, virtually none of the internal structure is load bearing. This means that the internal configuration of the building is highly plastic. Limitations on remodeling are introduced only by the availability of funding and approval of room layouts by the State of Kansas Fire Marshall’s Office.

The Chemistry Department currently occupies 71,358 net square feet (nsf), of Malott Hall, which is 38 percent of the available square footage of the building. Considering space occupied by chemistry faculty in the Multidisciplinary Research Building (MRB) on KU’s West Campus, and the small amount of space assigned to Professor Daryle Busch in the Oread Buildings at the corner of Wakarusa and 15th Streets in Lawrence, approximately 79 percent of the 87,746 nsf assigned to the Chemistry Department is in Malott Hall. All of the Department’s dedicated teaching, service laboratory and administrative space are in Malott Hall.

Currently, more than 3,000 students take laboratory courses in the 11 undergraduate teaching laboratories available in Malott. These laboratories are woefully out of date, under equipped with essential and required safety devices, and cannot be upgraded in the present building configuration. Moreover, no other major 4-year university in the State of Kansas has such antiquated teaching laboratory facilities for undergraduate chemistry.

Despite the malleability of its internal floor plan, Malott Hall has a number of critical problems that cripple its utility as a modern research building for the chemical sciences. These include:

- Fundamental elements of design and configuration,
- Long-term neglect of up-keep and renovation,
- A legacy of inadequate upgrades to building infrastructure, and
- Chronic overcrowding, given the functions it fulfills for its current and likely future occupants.

The quality and availability of space for research and teaching in Chemistry is one of the primary impediments to both the future growth of our research capacity and our ability to provide an education of the highest caliber for our undergraduate and graduate students. Ten years ago in an effort to address this need, the Department of Chemistry led the drive to upgrade the laboratory facilities and teaching facilities through a four-department initiative that had the support of the Endowment Association, the Provost, the CLAS Dean, and the Chancellor. There was, however, no funding commitment by the University at any level of the administration to provide financial support for any part of the proposed structure. The proposal for the new building was developed, vetted, and financed entirely by the Chemistry Department in a true collegial effort to improve the undergraduate and graduate educational experience.

A rigorous and state-of-the-art training in chemistry is demanded by the professional fields that our undergraduates enter, such as medicine, materials science, the health sciences including
pharmacy, biofuels, engineering, and the biosciences. Central to their training, then, is the exposure to expert training in first-rate facilities. We have such a facility for large classes with the three lecture halls in Budig, a facility that is now over 10 years old. However, such a showcase facility for laboratory and small lecture/classroom education has not followed. Over 3,000 pre-professionals matriculate each year, the future alumni should graduate with a sense that they have been afforded the best training possible. That is currently not the case. Return on investment for construction of a teaching and research facility is huge.

The following section will examine in detail limitations of the current infrastructure prior to providing the Chemistry Department’s vision for addressing these issues over the next ten years.

• **Quality of Existing Research and Teaching Spaces.** Space in the Chemistry Department can roughly be divided into four categories determined by function: (1) research space, (2) faculty and student office space, (3) teaching space and (4) administrative and infrastructure support space. The distribution of these spaces follows the pattern shown in the pie chart below. Clearly, research dominates the department’s space utilization. Considering components of the department’s administrative function and the use of office spaces to serve the research agenda, approximately 75 percent of the department’s space is dedicated to fulfilling its research mission. Since it is rare for departments or units at KU to have dedicated lecture space, this analysis does not reflect rooms ranging in capacity from 25 to 1,030 persons in Malott, Hoch-Budig and Wescoe Halls that are used throughout the week for chemistry lectures.

![Figure 1: Categories of Chemistry Department Space Utilization](image)

Assessing the quality of the dedicated space available to Chemistry provides a more complete picture of the space situation for the department. The quality of all of the spaces available to the department were recently evaluated by the department chair and business manager and placed into one of the following categories:

- **Excellent.** Excellent spaces are designed for and conform extremely well to the applications for which they are being used. Fixtures and surfaces are appropriate and in excellent repair. Utilities and other resources are appropriate and should allow expansion of current activities.
o **Very good.** Very good spaces are well suited for their current use. Though they may show some wear, fixtures and surfaces are in good condition. Utilities and other resources are adequate to support current activities.

o **Sub-standard.** Sub-standard spaces are not appropriately designed for their current use. Fixtures and surfaces are worn. Utilities and other resources are inadequate to support the primary usage of the space.

o **Poor.** Poor spaces have elements of design and construction that are deficient or inappropriate given their current use. Fixtures and surfaces show disrepair and/or decay. Utilities and resources contribute to the lack of utility of these spaces.

The top two categories—very good and excellent—are the standard we should aspire to in providing resources to support the education and research missions of the university. The bar graph below shows the distribution of research, office, teaching and administrative spaces under these four categories. Among these four types of spaces, only the department’s research space has barely more than half of the space in the very good and excellent category. The department’s research space in MRB, as well as recent remodeling projects in Malott, has made a noteworthy contribution to the quality of this category. Despite, some recent improvements, this reflection on the overall quality of Chemistry space is very alarming. As the summative pie chart below illustrates, only 40 percent of dedicated Chemistry space falls into the top two categories. Most striking of all is the extremely low quality of our dedicated teaching spaces. This latter point comes despite the “Crumbling Classroom Initiative” funds that were allocated in the late 1990s. This issue, like many of the other challenges created by the current state of space for basic sciences within the College, is outlined below.

**Figure 2: Quality of Current Chemistry Department Space**
Problems and Challenges Raised by Current Chemistry Department Space. Malott Hall is a sturdy 55-year old building. It is possible that the building would pose fewer serious problems were its primary use as office space or as space for humanities or social science research. The need for careful environmental controls and extensive technology makes it far more problematic to use Malott Hall for science teaching and research.

Problems with building design and configuration. At the time Malott Hall was designed, the utility space above each floor and ventilation ducts run through the building were sufficient to support scientific research. The number and efficiency of hoods required for some applications and the networking and power requirements have made it increasingly difficult to retrofit Malott Hall spaces for modern standards. An excellent example of these difficulties arose several years ago when one of Paul Hanson’s laboratories became unaccountably hot during one particularly harsh month of winter. After being called in to consult on what was causing this problem, Facilities Operations isolated the problem to a very old heating unit responsible for climate control in that particular laboratory. The unit was sticking in the full-on mode. When asked why that laboratory was not on the multi-million dollar air handling system that had been installed to handle environmental control on that side of the building a few years earlier, the managers responded that the chase space above the ceiling was already too crowded with ducts to take the new air source all the way down the hall to that laboratory. As a consequence, the progress of the ductwork down the hall was simply dead ended, no one was informed of the change, and the old climate control system was left in place.

A second example can be seen in many of the classrooms and seminar facilities in Malott Hall. At the time the building was constructed, overhead, slide projectors and movie projectors were the only technologies that could be used for augmenting black boards in seminars and course lectures. In these circumstances, a fairly flat configuration for lecture rooms posed few problems. Today, with the extensive use of ceiling mounted projectors for instruction and seminars, the relatively flat configuration of lecture rooms causes obstructions from both the floor and ceiling to restrict
the projection space at the front of the room. This plus poor lighting significantly restricts the use of these spaces for modern presentations and instruction.

**Chronically inadequate teaching, administrative and research spaces.** Current teaching space is inadequate in quality and square footage to support the teaching mission of the department. Current administrative space is inadequate to ensure the orderly operation of the Chemistry Department. The quality of current research spaces forms a bimodal distribution, and the space is rapidly becoming inadequate to support the full complement of scholarly activity in the department.

Though opportunities to modify some of the department’s advanced teaching laboratories over the past ten years has improved the learning environment for a few classes, the department is essentially teaching in the same spaces we did the last time we were reviewed 15 years ago. Of greater concern is the fact that the laboratory spaces that serve our first and second year science and engineering students are characteristic of designs that were prevalent in the 1950’s, based on teaching practice standardized in the early part of the 20th century. These spaces are not compatible with the teaching methods or safety practices we expect from teaching laboratories today. Organic laboratories have no line of sight across the laboratory, are inadequately wired to support the modern micro-organic techniques used in today’s instruction and are ill equipped to support circulating water baths, which save vast amounts of cooling water and reduce the likelihood of devastating floods. Worst of all, the organic laboratories have virtually no hood space in an era when conducting the majority of organic experiments in hoods is common practice. The freshman chemistry laboratories suffer from similar issues. Computers, which are used for data collection and delivery of experimental procedures, are placed approximately 2 feet above the bench tops. Aisles are too narrow to allow students to conveniently move around their workstations or collaboratively work on procedures and reports. Line of sight throughout the laboratory is completely interrupted, making discussion and data analysis difficult.

The teaching laboratories for introductory courses and lectures have also largely reached capacity. With enrollments of approximately 1,000 students, fall sections of CHEM 184 (Foundations of Chemistry I) would need to be permanently split into two sections to accommodate more students. Introductory chemistry laboratories in the spring semester are scheduled from Monday through Saturday afternoon, leaving only evening laboratory spaces to increase enrollment. The past two years, there has been a waiting list of 50 – 60 students for CHEM 625 (Organic Chemistry I), the first semester introductory organic laboratory course. This leaves only evening laboratories, from 6 to 11 pm, as an option for meeting the needs of prospective science, pharmacy and engineering students. During the next four years, while both pharmacy and engineering are seeking to double the numbers of students matriculating in their programs, there is no prospect of an expansion of introductory undergraduate space to accommodate these additional students.

Current departmental administrative space is among the poorest quality space in the department. There is a lack of storage space to secure, convenient access to confidential personnel files. Workspaces for the business manager, administrative assistant, bookkeepers and purchasing personnel are small and extremely overcrowded with paperwork and records. The scarcity of conference room space, currently shared with physics, causes continuing conflicts among researchers in the two departments. The condition of current conference and seminar rooms is highly embarrassing to the university. There is no place in Chemistry that distinguished lecturers
from other institutions can present a lecture without line of sight problems, equipment clanking and pressure relief valves going off, 50 year old benches intruding in the space, pianos sitting next to the chalk boards, and 75 year old renditions of the periodic table overseeing the proceedings. The current state of our administrative spaces is embarrassing.

The quality of research spaces in Chemistry tends either to be very high or genuinely substandard. Spaces renovated for new faculty within the past 5 years and new spaces in MRB rival the quality of research space available to faculty anywhere in the country. Other spaces suffer from antiquated ventilation and climate control and potential water leaks that threaten the safety of expensive research instrumentation. Chemistry currently has the capacity to add up to three additional new research groups based on current and future available space. After that, the need to expand and reconfigure existing research groups will account for the remaining available space.

**Problems with long-term neglect of up-keep and renovation.** The hallways, restrooms, windows and stairwells in most of Malott are in dire need of renovation and repair. Several recent occurrences illustrate the long-term neglect that plagues College of Liberal Arts spaces in Malott Hall. The first was the rupture of a 50 year-old clay sewage drainpipe that resulted in a sewage leak in a classroom during a graduate Chemistry course. A portion of this drain system had evidently been blocked for some time, leading to the back-up and failure of another portion of this antiquated drain system. Paint continues to peel in large sections off of the plaster walls in Malott Hall. It is unclear whether this is due to the quality of the paint, the number of coats that have been applied to the walls or some underlying problem with moisture that is compromising the plaster.

**Inadequate upgrades to building infrastructure.** The nightmare of Heather Desaire’s space on the sixth floor of Malott Hall was a perfect example of inadequate and misguided upgrades to the building’s infrastructure. Prior to renovation for use by Professor Desaire, the target space on sixth floor was known to leak. The space was located directly under an equipment room, which holds a range of antiquated air handling equipment. These climate control systems have condensation drains that regularly plug and overflow onto the floor, then down into the laboratory below. Fifteen years ago, water and ceiling tiles came down on top of a brand new protein synthesizer in this space. When this space was renovated, Chemistry was not consulted regarding the problems with environmental control in this area; consequently, no sealants were applied around floor drains and pipe chases and no water diverters were incorporated into the renovation. This was a disaster waiting to occur. After the fourth time that Professor Desaire’s laboratory had a water leak incident over a period of 8 months, the Provost’s office had to be called in to broker an emergency move of her research space to another building.

• **Long-term results of space concerns. Problems Caused by Bifurcating Chemistry Space.** For the first time in many years, a substantial fraction of the Chemistry faculty is physically separated from the main body of the department, with five Analytical faculty occupying new space in Multidisciplinary Research Building (MRB). This has raised several concerns: (1) Chemistry has been noted for its cohesiveness and collegiality. Many members of the department are concerned about the likelihood that these characteristics will be eroded by the separation of the faculty. (2) There is understandable concern that the senior members of the Analytical division are all in MRB,
while the two untenured members of the division remain in Malott. (3) The housing of a substantial fraction of the department in excellent new space has raised some concerns about the differential benefits this imposes of one fraction of the department. For example, faculty have been concerned about the impact on departmental recruiting, given the shabbiness of the spaces in Malott and the beautiful new spaces in MRB.

The further divisive and dispersal trends for the faculty members in Chemistry are apparent as collaborations in several fields noted earlier and below draw our research active faculty and students to newer, more functional facilities on west campus. The chemistry faculty members are and have always participated in major interdisciplinary research endeavors as noted above.

**Impact of Relegating Basic Chemical Sciences Research to Antiquated Laboratory and Office Spaces.** Since the development of a site plan for developing the research areas of West Campus, KU’s Research and Graduate Studies has sited and shifted much of the major shared life science instrumentation in the Structural Biology space on West Campus. This places these resources at some distance from life science research groups in Chemistry. For the past thirty years, Chemistry at KU has had an extremely collaborative approach to research. The department has established strong ties with Pharmaceutical Chemistry, Medicinal Chemistry and with various programs in Engineering. Physically separating much of our life science research from these traditional collaborations may tend to weaken these alliances, which have historically been points of strength for the institution. Proximity and intellectual interactions are still important elements of building such collaborations. If West Campus is to become a focal area for life science research on campus, Chemistry faculty members need to have a research presence. The College of Liberal Arts and Sciences has made a major investment in life science research in Chemistry and this investment needs to be cultivated by promoting effective collaborations. Separating researchers in Chemistry from Pharmacy and other life sciences research efforts on West Campus is an important issue that has to be balanced against the teaching mission of department, much of which naturally takes place on Main Campus. This apparent variance between research priorities and teaching priorities is an issue that leaves many faculty members conflicted about the institution’s continuing emphasis on building research space on West Campus.

**Impact of Early 20th Century Teaching Configurations on Undergraduate Education.** Science, engineering and pharmacy students at KU, along with the general student population, have every reason to be upset by the antiquated, inadequate laboratory and lecture facilities in which they are learning their core sciences at KU. Both laboratory and lecture space is outdated and is not conducive to modern instructional methods such as group learning and effective uses of technology. This situation should have been remedied ten years ago, and it must be an immediate priority for the university and the state to redress this situation.

**Retaining Quality Faculty.** We can all agree that KU is a special place that gives faculty an opportunity to establish their careers and raise their families in a community that offers a more comfortable, affordable and less stressful environment than is encountered in the cities where many major institutions are found. Environment alone is not going to retain the talented faculty who have begun their careers and flourished at KU. We take the attitude that our odds of retaining talented, successful faculty increase as we convince individuals that the infrastructure, resources and support provided for research and teaching at KU do not throw up barriers to their continued...
professional growth. The College and University administration have been sincere and effective partners in working to find the resources needed to retain researchers who are being courted by other institutions. This includes finding resources to renovate and upgrade existing laboratory spaces where this type of assistance is necessary.

The chemistry research laboratories are modestly better due to the demands of the individual research faculty members to be research competitive and to compete for national and international funding and recognition. These faculty account for over $6.5 million, or approximately 10% of the University’s external funding from NIH, NSF and DOE.

The institution has not been able to be as effective in creating quality teaching and research space that can sustain the future productivity of a large research department.

**Consequences of Extended Neglect of Support for Basic Support for Core Sciences on Prospects for Sustainability of State Technological Competitiveness and Economic Growth.** It is testament to the talent, ambition and loyalty of the KU Chemistry faculty that in spite of the clear, sustained and indefensible neglect of research infrastructure to support the Chemical Sciences, they have built one of the most successful, and highly externally acknowledged scientific research endeavors at the University of Kansas. The general state of Malott Hall is certainly a drag on the University’s ability to attract undergraduate students who want to focus in the sciences, a sorry sight for returning alumni of the university and a dramatic embarrassment for distinguished scientific visitors to the institution. Current strategies for addressing systemic problems in Malott Hall seem to migrate from one issue to the next: the ventilation and climate control, the computer networking system, the electrical system, the sewer drains and back to issues associated with ventilation and climate control. Faculty in most top flight research departments do not have to spend as much of their time contemplating damage to their research productivity due to a rapidly decaying infrastructure. Probably the most glaring issue that needs to be highlighted is the following: Every major regional institution that we compete against for grants, undergraduate students and graduate students has had a new stand-alone building for the basic sciences completed or a multimillion dollar renovation undertaken within the last 10 years. KU stands out alone in this regard.

Neglect of support for the basic sciences will have long-term consequences for the ability of the institution and the state to remain competitive in science and technology related fields. Quality programs in the basic sciences are essential for preparing the scientific and technological workforce needed to fuel economic growth. Robust research in all of the basic sciences, including Chemistry, is essential for addressing the problems encountered in creating cutting edge solutions to problems in energy, life science and human health. The basic sciences are also the engine for producing the molecules, materials and processes that eventually provide technological solutions to today’s problems.

**Anticipated Need for New Research Space.** Based on the existing space needs of the department and the outline of faculty additions above, we anticipate that the department’s need for added research space falls into the following categories:
### Table 1

<table>
<thead>
<tr>
<th>Space Type</th>
<th>nsf</th>
<th>Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office/collaborative</td>
<td>2,400</td>
<td>New spaces for computational chemistry, spaces outside of laboratories for all research students and professionals, spaces for new faculty</td>
</tr>
<tr>
<td>Synthetic/chemical biology</td>
<td>11,000</td>
<td>Expansion space for existing research groups, spaces for replacement hires in synthetic chemistry and biological chemistry, space for three new faculty in these areas.</td>
</tr>
<tr>
<td>Spectroscopy/analysis</td>
<td>11,500</td>
<td>Expansion space for existing research groups, spaces for replacement hires in spectroscopy and bioanalysis, space for two new faculty in this area</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24,500</strong></td>
<td></td>
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</table>

- **Future Long Term and Short Term Goals.** With the passage of the American Recovery and Revitalization Act of 2009, the Federal Government has accepted some responsibility for rebuilding the infrastructure and aiding higher education in this country. Furthermore, in an open letter in the New York Times (Dec. 16, 2008), the Carnegie Corporation of New York called upon then President-elect Barack Obama and his administration to rebuild the infrastructure of the public higher education facilities as part of the recovery program. The Chemistry Facilities at the University of Kansas must be among the timeliest candidates for such a rebuilding effort in the State and possibly elsewhere in the US.

**Long-term solution.** Build a major new 100,000 nsf Chemistry research building on Main Campus and remodel 30,000 nsf of current space in Malott Hall to accommodate Chemistry teaching. This approach provides a proactive, coherent solution to the problems of a crumbling, inadequate infrastructure, and a need to maintain the cohesiveness of one of the most successful science research and teaching programs at KU. Comprehensively remodeling substantially larger science teaching spaces in Malott Hall would provide KU students with the excellent, modern teaching resources they need to enhance science learning. Maintaining the major new building on Main Campus would help to sustain the integration of the research and teaching missions of the department, which needs to be one of the hallmarks of the University’s plans for enhancing two of its critical core missions. It appears that the leadership of the College favors the construction of a multidisciplinary science research building adjacent to the current science core (Malott and Haworth Halls) on the KU main campus. This could be an appropriate strategy to address the needs of the Chemistry program assuming that plans address the need for types of spaces that Malott Hall cannot currently accommodate, provide adequate space for the development of current research programs and the overall growth of the department.
The alternative long-term solution, which is currently not favored by the majority of the faculty in chemistry, would be to move the University’s entire science research enterprise to West Campus by building three large buildings (each several times the size of MRB), consolidating of the science research functions at one site. For example, one could site three major buildings on West Campus with equivalent square footage to the new teaching/research building envisioned for the main campus, label these buildings: (1) Drug Discovery, (2) Energy and Materials, and (3) Life Sciences. The College of Liberal Arts and Sciences research efforts in the sciences could occupy major portions of all three buildings. This would create a “science campus” west of Iowa Street and a “social sciences and humanities campus” on the Main Campus. By concentrating science and engineering faculty in one region of campus, the University would alleviate concerns about separating researchers in the sciences from their collaborators and key instrumentation infrastructure. Existing science buildings on Main Campus could be remodeled to accommodate high quality undergraduate instruction in science and growth in the humanities and social sciences. The total cost for this endeavor would approach $700 million, though the West Campus construction and renovation of vacated spaces could be completed in phases over an extended period.

**Short-term interventions.** Build a succession of smaller, MRB-sized buildings in the West Campus research area, and successively move components of the Chemistry Department over onto west campus. The natural progression would be to move the remaining junior bioanalytical faculty (two current and one prospective hire) over to West Campus first, followed by the synthetic organic faculty and bioorganic faculty. This would establish either a “drug discovery” or “cancer research” presence for the College on West Campus. Subsequent buildings should incorporate the physical and inorganic chemists in some logical progression of research foci.

This strategy seems like a more digestible approach to the current need, but it will progressively disconnect many chemistry faculty members from their teaching responsibilities and make it more difficult to incorporate undergraduate majors into the total intellectual life of the Chemistry Department. This approach will undoubtedly also exacerbate problems of departmental cohesion are already developing due to the current Chemistry space situation.

The most direct approach to the current challenge is to commit to an ambitious timetable to build the research and teaching spaces we really need now on the Main Campus and assemble all available resources—alumni, endowment, state, federal and private sector—to achieve them. Among the major needs for research and teaching spaces on the Lawrence campus, the needs of the Chemistry Department are the most obvious, defensible and immediate.

- **Near-term remodeling with stimulus funds.** In light of the aforementioned discussion, the following are recommendations for utilization of stimulus funding in the near term for much needed renovations of current space in Malott Hall.

**Renovation of research laboratories.** The laboratories throughout Malott are in dire need of repair. Major upgrades across the entire old part of Malott are requested. Extensive laboratory upgrades are requested for 6th floor, 5th floor, 3rd floor, 1st floor and basement laboratory spaces. This
includes new lighting, painting, benches, and epoxy flooring in all laboratories. Funds in the amount of roughly $400-450K per 1000 nsf of laboratory space are requested

- **Tunge 6th floor laboratory**
- **Former Desaire 6th floor laboratory**
- **Givens 5th floor laboratory**
- **Benson 5th floor laboratory**
- **Wilson 3rd floor laboratory**
- **M. Johnson 3rd floor laboratory**
- **Barybin 1st & 2nd floor laboratories**
- **Jackson 1st floor & Basement laboratory/student offices**
- **Bowman James 1st floor laboratory**
- **Hierl 1st floor laboratory**
- **Chu 1st floor laboratory/student offices**
- **C. Johnson Basement laboratory/student offices**
- **Berrie Basement laboratory/student offices**
- **Elles Basement laboratory/student offices**

**Renovation of All Undergraduate Laboratories.** Teaching laboratories for all of the undergraduate service courses offered by the department need a comprehensive renovation and expansion to accommodate the student populations we expect to see over the coming years. The priorities for renovation of these facilities include:

1) Organic chemistry laboratories on the 4th floor.
2) Freshman chemistry laboratories on the 2nd floor.
3) Analytical/physical laboratories on the 3rd floor.

**General repairs and renovations:**

- **New Windows in All Stairwells.** Single unit, Tinted windows are requested in all stairwells throughout Malott Hall. The improvements made to Bailey Hall can serve as a guide for implementing a vast window replacement strategy in Malott.

- **New Windows in Laboratories and Offices.** Funds are requested for replacement of the upper window board in all laboratories throughout Malott. This has already been successfully implemented in two laboratories (Malinakova, Hanson), greatly enhancing the natural light within each laboratory.

- **Upgrades and remodeling in all bathrooms.** The restrooms throughout Malott are in dire need of repair. Major upgrades across the entire old part of Malott are requested.

- **Upgrades to hallways.** Funds are requested to provide additional energy efficient light fixtures, paint and 8x8” wall tile throughout the building.
• **Recommendations for University Leadership. Form a long range planning task force.** The fact that Chemistry is not the only department facing such issues suggests that it is past time for the University to identify a target solution to address these needs. The next major (>$100 million) science building project for the College of Liberal Arts and Sciences will, for all intents and purposes, permanently define the future landscape of research spaces for the sciences. If it is placed on West Campus, we must begin to plan for the migration all scientific research west of Iowa Street. If it is placed on Main Campus, we must prepare for an ongoing schism among scientific researchers by providing unusually vigorous support for researchers who need to communicate between the two campuses and who require access to research resources on both campus.

We cannot afford to wait 10 years to develop a coherent long-range plan and implementation strategy for the upgrade of our science, engineering and technology teaching and research infrastructure. To do so would permanently leave our institution behind universities at the forefront of scientific and technological advancement. Moreover, planning and beginning construction of major new investments in science research and teaching spaces will *never again* be as cheap as it is today. Waiting until the end of the current economic situation will put us in direct competition with accumulating demand for new infrastructure on the part of developing countries. This strategy would telescope the time required to obtain facilities that we already needed 10 years ago and attach a multiplier of at least 4 or 5 to and already daunting figure. If we stand by without acting, we are likely to incur losses of talented mid career faculty that will enormously amplify the consequences of recent faculty defections. It will also permanently damage KU’s ability to garner research funding for scientific and engineering research and development.

It is essential that the University establish a long range planning task force charged to work with the Administration to develop an infrastructure plan and implementation strategy for addressing these needs. This task force must be composed of top flight mid career faculty, department chairs, and only few members of the “research elite” of the institution. This composition intentionally focuses input for long range planning on the younger, highly productive faculty who represent the research prowess of tomorrow. They are the individuals that KU needs to retain and foster in order to build its future in science, engineering and technology research.

**Change KU’s Relationship to KU Endowment Association.** The KU Endowment Association is a tremendous asset to KU. The support and assistance the KUEA provides for the university’s research and teaching efforts is difficult to overvalue.

Yet the policies of KUEA can also act as an unintentional governor, retarding the long-term growth and prosperity of the university. Three specific *apparent* attitudes or policies of KUEA bear consideration, given the current crisis in research space:

(a) **Increasing the size of the University Endowment is always a desirable goal.**

This is clearly true from one perspective. The size of the endowment is predictive of our ability to guarantee future support for teaching and research programs, and it is a hallmark of a well-run endowment program. However, this principle must always be viewed through the prism that the absolute goal of the university is the success of its education and research programs. The objective of growing the university endowment is not necessarily always synonymous with this absolute goal.

(b) **Creating permanent endowments is preferable to generating expendable funds.**
Again, from the perspective of generating future income this statement is prima facie truth. However, generating future income does not always serve the long term growth and prosperity of teaching and research programs. A KU alumnus who has been a distinguished professor at MIT and is now at The Scripps Research Institute in La Jolla, CA has a story that illustrates this reality. An endowment fundraiser approached him with a donation for $40M and told him, “I want you to spend this in the Chemical Sciences. Make things happen!” About halfway through this enormous gift, the faculty member had second thoughts. He approached the fundraiser and confided, “This is a lot of money! Wouldn’t it be better if we banked the rest of this and did things with the interest?” The fundraiser looked at him and said, “Listen Julius, there is at least another $40M out there, most likely in exactly the same place that the $40M you are worried about spending came from! The only way I am going to be able to convince the donor to part with that much money is if you show them that you have accomplished extraordinary things with the money you have. Spend the money and do extraordinary things!” We have to be willing to trust that gifts spent well are going to generate additional gifts from understanding alumni.

(c) There are some things that Endowment cannot fund, because those are the responsibility of the legislature, and we don’t want to give them an excuse for not meeting their responsibilities.

This would be a sensible attitude, were we dealing with an entirely sensible situation. Consider the recent cathartic process for achieving minimal funding for public schools in Kansas! Consider how, in the face of sewage raining on the heads of students at KU, the legislature was finally persuaded to provide funds to address over $600M in deferred maintenance, funds that amounted to only $8.8M for KU! It simply isn’t sensible to suggest that the legislature considers initiate major funding for new buildings on university campuses as an essential part of its responsibilities!

This is a critical time for the future of science programs at KU. In order for us to move forward, KU endowment must take a leadership role, becoming a major investor in a 10-year plan to construct the major science buildings on campus. We have to be willing to invest the dollars rather than bank them, because:

- It will never again be cheaper to build research infrastructure than it is today, and
- We cannot wait 10 years to begin to address this need; ten years from now, we will be too far behind to play catch up.

It is time for the KU administration to clearly articulate a new policy and set of operating paradigms to KUEA. We can acknowledge that a return to current practice is likely in the future, but that we must change our practice in the critical conditions of today.

- **Questions for External Reviewers**
  1. How can we convince the upper administration of the imperative to support a substantial expansion of existing research and teaching space?
2. Is the need for substantial upgrades of existing research and teaching space as apparent as we believe it is? If so, how can we better partner with the administration to accomplish these improvements?
Graduate Studies in Chemistry

The primary goal of the graduate program within the University of Kansas Department of Chemistry is to prepare students to become independent, creative practitioners of Chemistry. Two degrees are offered: an M.S. and a Ph.D.

Since progress through our degree programs begins with admissions and recruiting, critical aspects of recent recruiting activities are tabulated below. To begin, our department has 29 faculty, of which 25 are “research active.” During the period of 2004-present, an average of 50 students were accepted into our program and offered admission. An average of 20 students per year chose to enroll in our program. Thus, we have a 40% success rate in recruiting students to KU. The composition of the resulting graduate student body is 36% female, 24% international, and 5% students from underrepresented groups.

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<tr>
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<td>42</td>
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<td>58</td>
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<td>33</td>
<td>38</td>
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<tr>
<td>International Offers</td>
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<td>6</td>
<td>2</td>
<td>13</td>
<td>4</td>
<td>13</td>
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<tr>
<td>Total Offers</td>
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<td>48</td>
<td>46</td>
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<td>51</td>
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<td>51</td>
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<td>Enrolled</td>
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<td>23</td>
<td>19</td>
<td>21</td>
<td>21</td>
<td>13</td>
<td>31</td>
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<td>74%</td>
<td>90%</td>
<td>76%</td>
<td>69%</td>
<td>74%</td>
</tr>
</tbody>
</table>

Student Support. Student applicants are evaluated by the admissions committee and given one of 4 types of offers for admission. The first is a standard “TA offer” which carries a stipend of $21,992. Some students are offered Berger fellowships (TAF offer) that enhance this offer by $2,000 for each of their first two years and the top students are offered a Bailey Fellowship (BF offer) that enhances their stipend by $4,000 in the first year and $2,000 in their second year. Lastly, international students that have not passed the Test of Spoken English (past) or the TOEFL-iBT spoken section with a score of 26 are given a “GRF” offer which carries a stipend of $14,500; it is expected that these students will pass a test of spoken English at which time they receive a stipend equivalent to a TA offer. The department uses approximately $48,000 of state funding from KU’s “General Research Fund” to make these offers. Functionally, this only provides the flexibility to admit 4 or at most 5 foreign born students each year. The chart below shows the overall breakdown of these offers and those that chose to enroll in our program. We had a 51% success rate in recruiting students who received TA offers; these are generally our weakest applicants. In contrast, we had a 35% success rate in attracting those that received Berger fellowships (TAF) and a 38% success rate with our strongest applicants who generally receive Bailey Fellowships (BF). Lastly, we were much more successful with our offers to international students; 63% of those receiving offers chose to enroll in our program.
Despite our success rate in recruiting talented international students into our department, we are currently unable to admit substantial numbers of foreign students because of the very high standard for spoken English mandated by the University and the State of Kansas. Nearly all of our entering students serve as Teaching Assistants in the undergraduate laboratories for their first year. In order to perform these duties, students are required to pass a spoken English exam. Effectively, in order for foreign-born students who have not completed a degree at another U.S. university to receive an offer of support which is a prerequisite for obtaining a student visa, they need to pass the Test of Spoken English examination. In the past, students had to pass the Test of Spoken English with a score of 50. Not only was this a high standard of achievement, but the test was cost prohibitive for the vast majority of international students. Furthermore, the definition of duties for teaching assistants has, until this past year required that students be assigned duties in front of classes. This means that we have, until now, essentially been unable to offer foreign graduate students support unless they passed the TSE examination. Starting in 2008, entering international students must receive a score of 26 on the spoken section of the TOEFL-iBT. While this new standard makes the exam accessible to more of our applicants, very few of our applicants achieve a “passing” score, thus they can only be admitted with GRF offers which are rather paltry. Ultimately, one can compare the breakdown of our graduate students with those of other regional schools (Blue = domestic, Red = international). It is immediately obvious that we do quite well in attracting domestic students, however our ratio of domestic to international students is much higher than those of other schools. Perhaps most interestingly, the graduate student body of Kansas State University (KSU), which is subject to the same English requirements as KU, is made up almost entirely of international students.
The Department currently expects to receive support for 44 Graduate Teaching Assistants in the Fall 2009 and 46 in the Spring 2010. Every semester some of the allotted teaching budget is allocated to more cost-effective undergraduate teaching assistants, which allows us to cover more laboratory sections than would be possible otherwise. For the first time in many years, the 44 GTA’s amounts to a decrease in the number of TA’s allocated to our department by the College. The decrease has occurred despite the fact that our laboratory sections are typically oversubscribed even when larger numbers of GTA’s are allocated (see F2008, S2009). As can also be seen from the data in Table 2, roughly equal numbers of graduate students are supported as GTA’s

**Table 2: Numbers of graduate/undergraduate teaching assistants and graduate research assistants.**

<table>
<thead>
<tr>
<th></th>
<th>GTA’s</th>
<th>UGTA’s</th>
<th>GRA’s</th>
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<tbody>
<tr>
<td>F2004</td>
<td>35</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>S2005</td>
<td>43</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>F2005</td>
<td>42.5</td>
<td>2</td>
<td>44.5</td>
</tr>
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<td>S2006</td>
<td>34</td>
<td>14</td>
<td>39.5</td>
</tr>
<tr>
<td>F2006</td>
<td>45</td>
<td>3</td>
<td>48</td>
</tr>
<tr>
<td>S2007</td>
<td>44</td>
<td>8</td>
<td>36.5</td>
</tr>
<tr>
<td>F2007</td>
<td>44.5</td>
<td>4</td>
<td>45</td>
</tr>
<tr>
<td>S2008</td>
<td>40</td>
<td>20</td>
<td>48</td>
</tr>
<tr>
<td>F2008</td>
<td>48.5</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>S2009</td>
<td>48</td>
<td>10</td>
<td>41</td>
</tr>
</tbody>
</table>
and GRA’s. Thus, it is clear that, in order to increase our numbers of graduate students, we must a) increase the number of GTA’s allotted to the department to meet the teaching needs of ALL laboratory sections, b) raise more money for GRA salaries via successful grant applications, and c) find mechanisms to admit talented international graduate students that do not meet the English standards currently enforced by the University.

**Graduate Curriculum.** The awarding of a graduate degree is based not solely upon the completion of a definite number of credit hours, but rather upon the accomplishment of the student in research, in course work, and in individual examinations. Certain definite requirements concerning courses and examinations have been established by this Department or by the Graduate School, and are presented below.

Each graduate student must pass (with a B or better) three “distribution courses” from three of the five major areas of study (Analytical, Organic, Physical, Inorganic, Biological). The remaining courses that a student takes are dependent on their course of study and input from their advisors, however, each division does have specific recommendations.

In addition to their coursework our graduate students are required to accumulate 8 points from monthly cumulative examinations. The students are given 2 years to accomplish this requirement. A pass of any exam is worth 2 points. First-year students may receive a “half-pass” or 1 point for a performance that borders on passing. This is done to encourage students to begin taking the examinations at an early stage in their graduate careers.

After passing their cumulative examinations, the students in most divisions are required to give several oral presentations during divisional colloquia.

In a student’s third year, he or she is required to complete a Comprehensive Oral Examination. Here students are required to prepare and defend a 10 page NSF or NIH style original research proposal. After successful defense of their proposals, all that remains is for the student to perform research and write and defend their dissertation.

**Outcomes.** In the four year period from the Fall of 2004-Spring of 2008, the Chemistry Department granted 11 M.S. degrees and 58 Ph.D. degrees. At the same time, 79 new students joined the program (table 3). The difference in degrees awarded vs. students enrolled likely reflects some attrition as well as our attempts to expand of the program over the last several years. The average time to complete a Masters degree is 3.2 years while the most students complete their Ph.D. degree in 5 or 6 years, with an average time to a Ph.D. degree of 5.3 years (figure 3). Our graduates go on to a variety of positions; many pursue postdoctoral research positions while others go directly into industry or teaching. Overall, the placement of our graduates is high and a detailed list of employment can be found at: [http://www.chem.ku.edu/alumni/positions/index.shtml](http://www.chem.ku.edu/alumni/positions/index.shtml).
Table 3

<table>
<thead>
<tr>
<th></th>
<th>New students</th>
<th>M.S. degrees</th>
<th>Ph.D. degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2004-S2005</td>
<td>16</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>F2005-S2006</td>
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<td>8</td>
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<tr>
<td>F2006-S2007</td>
<td>19</td>
<td>3</td>
<td>17</td>
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<tr>
<td>F2007-S2008</td>
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<td>14</td>
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<tr>
<td>F2008-S2009</td>
<td>21</td>
<td>1*</td>
<td>5*</td>
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</tbody>
</table>

* Since summer 2008.

Figure 2: Time to complete a Ph.D. Aug. 19997-May 2008.

- **Recommendations.** Many recommendations relevant to recruitment of graduate students are related to policies and practices operating at the university level. KU’s ambition to be known as an international research university certainly provides strong impetus for increasing the number of international graduate students. Our need to attract a larger and better qualified cohort of graduate students also supports more targeted, affirmative recruitment of foreign-born students. The recognition by the current Dean and Provost that KU’s research productivity is largely bounded by the number of full-time graduate students is a further confirmation of our need to explore a range of methods for enhancing graduate enrollment, particularly in the sciences. We recommend the following actions to address some of the issues raised in this section:
  - At a faculty population of 30, reach a steady-state population of graduate students of 120.
  - If we are successful in expanding the faculty to 35 over the next five years, work to reach a steady state graduate student population of 140.
- Focus departmental development efforts on creating new graduate fellowships (either through the establishment of endowed fellowships or through faculty enhancement funds that are earmarked for support of graduate students),
- Increase funding for GTAs, both to enhance the number of GTA positions at KU and to enhance the monetary value of stipends offered to outstanding students,
- Work to develop reasonable spoken English requirements for GTAs that ensure both quality undergraduate instruction and adequate graduate student numbers and diversity,
- Continue current trends to liberalize the instructional roles in which graduate students are supported at KU, and
- Create multidisciplinary collaborative efforts led by the Graduate Studies Program to target recruitment of outstanding foreign-born graduate students from various regions around the world.

**Questions for External Reviewers**

1. Given the size and activity of our faculty, what would be an appropriate size for our graduate student body (i.e. what size should we strive to be)?

2. How can we increase our ability to attract to talented international students?

3. Given the size of our enrollment and student body, what would be an appropriate number of GTAs to support our instructional needs?
Undergraduate Studies in Chemistry

The KU Chemistry Department has always made considerable strides to develop and maintain a program having the rigor and relevance needed to remain competitive. Our success in generating highly-educated graduates possessing the knowledge, skills, and vision necessary for shaping the future of science and technology requires constant review, modernization, and adaptation of our curriculum, teaching practices, and research strategies. However, the path from “having potential” to attaining and surpassing expectations is a journey of many steps. In the last 20 years, the KU Chemistry Department has certainly progressed along a path paved by science education research. This journey, as pertaining to the undergraduate (UG) program, is detailed in this report. The current state of the UG chemistry program, the challenges that remain, and the Department’s future plans are emphasized.

• **KU Chemistry: The Current Program.** In the early 1990’s, an external evaluation of the KU Chemistry program characterized the department’s formal undergraduate coursework as traditional and unimaginative. This review prompted many curriculum initiatives. Honors courses and undergraduate special topics courses were developed and incorporated into the degree program. Inquiry-based laboratories, team-learning activities, and independent projects were introduced in introductory and advanced courses. These modifications served to broaden the undergraduate education beyond learning chemical concepts and laboratory techniques by helping students develop valuable skills in problem-solving, critical-thinking, teamwork, leadership, time management, intellectual initiative, personal responsibility, creativity, and independent scholarship. Laboratory curricula and instrumentation were updated in many of the undergraduate labs. Recent grants have led to significant improvements in the undergraduate physical chemistry and honors general chemistry laboratories. Experiments that explore environmental issues and alternative energies have been incorporated into the undergraduate laboratory repertoire. These investigations highlight the impact of society on science and vice versa. The department has also experimented with alternative strategies for preparing graduate (and undergraduate) students to teach in the UG laboratories.

The Chemistry program at KU provides a comprehensive, undergraduate chemistry education that promotes the development of students as research scientists by offering numerous opportunities for students to gain experience in independent research and scientific reporting. The fact that undergraduate alumni from KU populate some of the most elite chemical science graduate programs in the country (e.g., MIT, Cal Tech, and UC-Berkeley) speaks to the success of these efforts. The Department’s commitment to undergraduate research has a long and rewarding history. This dedication is reflected in many ways, including the current curriculum requirements, the ChemScholars program, and the summer undergraduate research program. These efforts give KU undergraduates and students from colleges and universities around the country an opportunity to conduct cutting-edge research in a department known for its academic excellence and diverse, multidisciplinary research.

The KU Chemistry degree options include:
- B.S. degree
- B.S. degree with biochemistry option
- B.A. degree
- B.A. degree with biological emphasis
• B.S. degree with chemical physics option • B.A. degree with environmental emphasis
• B.S. degree with an environmental emphasis • Chemistry minor
• B.S. or B.A. degree with UKanTeach secondary certification

A detailed list of the curriculum requirements for each of these degree options is given in the University of Kansas: Undergraduate Studies in Chemistry packet. This documentation reveals the caliber (all B.S. degrees meet ACS-certification requirements), rigor, and flexibility of each degree type. It also describes the KU ChemScholars program and highlights undergraduate research opportunities, Departmental scholarships and awards, and the Chemistry Honors program.

The Chemistry program at KU remains solid, but we feel that the number of chemistry majors is lower than expected given the caliber of the program and the wealth of opportunities available within the Department. Figure 1 shows the number of B.A. and B.S. degrees that have been awarded in the last 18 years. As this figure indicates, graduate levels have not surpassed 30 students per year since 1999, though there are recent indications that the number of majors in the degree pipeline has been increasing. In order to better attract and retain chemistry majors, the department plans to diversify its undergraduate course offerings, build a stronger sense of community among students interested in chemistry, and provide stronger support for students enrolled in the large, introductory chemistry courses. Increased faculty numbers and improved laboratory facilities would also have a positive impact on the undergraduate educational experience at KU.

Figure 1

A general overview of the undergraduate curriculum is given in the subsequent sections. Significant changes that were made to the curriculum since the last Departmental review are highlighted. The success of these efforts and the challenges that remain are also discussed.
**Honors Courses and Research (Chem 185/189, Chem 628/630, Chem 699).** Since the last review process, the department has implemented honors versions of both the general (Chem 185/189) and organic chemistry (Chem 628/630) sequences. These courses have been well-received, and they are quite popular with the students enrolled in the honors program. Students find these courses to be challenging, but worth the effort considering the level of competence that is gained from the educational experience. These advanced classes are ideal for undergraduates having a strong interest in chemistry and the appropriate background, motivation, and ability. Students in the Chemistry Honors program are also required to enroll in undergraduate honors research (Chem 699), where they conduct independent research studies under the supervision of a faculty member (or members). At the completion of the project, students must submit a written thesis to an advisory committee and present their results at a seminar and/or conference.

Enrollment in these honors courses varies from semester to semester, but the overall numbers could be improved. Figure 2 shows the enrollment in the honors general chemistry courses from 1997 to 2008. Figure 3 compares the enrollment in the honors undergraduate research course (Chem 699) to that in the non-honors equivalent (Chem 698). The Department acknowledges that stronger efforts are needed to guide students towards these honors courses, especially those undergraduates that meet the previously-described criteria. Improved advising and the development of mechanisms that would allow earlier recognition of suitable honors candidates would also help alleviate issues related to overcrowding and intellectual frustration that manifest in the non-honor analogs.

**Figure 2**

<table>
<thead>
<tr>
<th>Year</th>
<th>CHEM 185 (Fall)</th>
<th>CHEM 189 (Spring)</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>1998</td>
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<td>2011</td>
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</table>
General Chemistry (Chem 124/125, Chem 184/188, and Chem 185/189). KU currently offers three versions of freshman chemistry: Chem 124/125, Chem 184/188, and Chem 185/189. Chem 124/125 is a one-semester terminal course that serves non-science majors, mechanical engineers, and allied health professionals. This course can be taken either with or without an accompanying laboratory (corresponding to Chem 125 and Chem 124, respectively). Chem 184/188 is a two-semester course for science majors, pre-health professionals, and engineering majors that choose not to take Chem 125 as their one-semester chemistry course or that require the full two-semester freshman sequence as a foundation for their future study. Chem 185/189 is the two-semester honors sequence that should be taken by all students having a strong interest in the chemical sciences and a sufficient background in mathematics and chemistry.

Introduction of Inquiry-Based Laboratories in Chem 184/188 and Chem 185/189. Recent efforts to improve the freshman laboratory curriculum and increase student engagement have led to significant changes in the laboratory portions of Chem 184/188 and Chem 185/189. Intrinsically, the laboratory provides a unique opportunity for an educational experience beyond that afforded by teacher-directed lectures and non-interactive homework assignments. Laboratory investigation involves experiential learning through hands-on activities that promote self-driven, conceptual development and intellectual autonomy via collaborative, guided, and/or independent investigation. Laboratory instruction strategies often emphasize active learning, which engages students and promotes critical thinking. In an effort to improve the educational experience in the undergraduate chemistry laboratories, the traditional, step-by-step, investigations that were once used in these large introductory chemistry courses were replaced with inquiry-based labs that highlight student-centered, exploratory learning. Because inquiry-based laboratories are less prescriptive than traditional “cookbook” laboratories, these types of investigations readily accommodate collaborative work, challenge students’ problem solving
abilities, and bring an important element of creativity and individuality into the study of science. Investigations of this type also more closely simulate the research environment encountered by real practicing scientists and engineers, which provides students with a better understanding of the nature of modern scientific inquiry. The pedagogical benefits of this instructional approach have been well-documented in the literature.

The switch from “cookbook” labs to inquiry-based investigations was initiated in the late 1990’s. Efforts to evaluate the inquiry labs for caliber, content, and clarity are currently ongoing. This assessment has already led to some recent improvements in the Chem 184/188 and Chem 185/189 laboratory curriculum. These enhancements include the addition of new, higher-caliber investigations in Chem 185/189 and the introduction of TA-facilitated, team-learning exercises in Chem 184/188. Improved alignment and coordination between the lecture and lab components of these courses have also been a priority. These new curriculum initiatives are discussed below in more detail.

Introduction of New Experiments in Chem 185/189. During the Fall 2007 and Spring 2008 semesters, the curriculum in the Chem 185/189 laboratory was updated to include new experiments that were more sophisticated and better aligned with the lecture portion of the course. Investigations usually reserved for the undergraduate physical chemistry and inorganic laboratories are now offered in honors general chemistry. One of the new investigations is a one-week spectroscopy experiment and computational exercise involving the visible spectra of conjugated, organic dyes. A two-week lab exploring the kinetics related to the iodine clock reaction and various oscillating reactions (e.g., the Briggs-Rauscher reaction and different versions of the Belousov-Zhabotinsky (BZ) reaction) was added as well. A green chemistry lab that allows students to create titanium dioxide raspberry solar cells was also developed. Furthermore, theoretical investigations using Chem 3D have been added to the laboratory curriculum to augment several of the experimental studies.

The student response to these new experiments has been quite positive, especially in the case of the solar cell laboratory. Some students expressed having difficulties understanding the kinetics involved in the oscillating reactions, suggesting lab revision or increased TA involvement. Review of these new experiments and their effectiveness will continue as more students are exposed to the new laboratory curriculum.

Introduction of Team-Learning Exercises and Improved Lecture/Lab Alignment. During the Summer/Fall 2008 and Spring 2009 semesters, TA-facilitated, team-learning exercises were added to the Chem 184/188 laboratory curriculum. These activities were implemented in the undergraduate laboratories to facilitate the development of problem solving and critical thinking skills through collaborative learning and interactive application. Improved student engagement, motivation, and achievement were additional objectives. Other project goals included: enhancing the student learning experience; augmenting the instruction of large introductory chemistry courses; promoting an environment for active, student-centered learning of fundamental chemistry concepts; improving the alignment and coordination between the lecture and lab components of the course; helping students develop a better sense of course connectivity via increased one-on-one and small-group interaction; improving student recognition of the available course resources; and increasing student retention and success rates.
The team-learning project involved replacing or augmenting some of the existing laboratory experiments with active, group exercises that were implemented using POGIL (Process Orientated Guided Inquiry Learning) instructional strategies. Only those experiments considered low-caliber, redundant, and/or poorly aligned with lecture material were removed from the curriculum and replaced with team-based learning exercises. These group activities were specifically designed to give students additional instruction and practice on concepts that have been historically difficult for students to master on their own. Some of the exercises also highlighted concepts that were to be investigated in a laboratory experiment scheduled for later in the same period. Peer collaboration was emphasized to encourage active discussion and discovery. The presence of a facilitator/content expert ensured that these interactions remained productive and meaningful. The TA also helped to dispel or correct any misconceptions or misunderstandings that arose during the team-learning activities.

TAs were surveyed about these changes and agreed that these activities helped students understand the course material, but some expressed concern over the loss of hands-on, wet-lab experience. TAs overwhelmingly agreed that group exercises helped their students learn the material covered in the course. They also agreed (although to a slightly lesser extent), that the group exercises should continue to be incorporated into the general chemistry lab curriculum. Student response to the group exercises was surprisingly favorable. When asked if the group exercises helped them understand the material covered in class, just over 88% of the students surveyed replied that they strongly agreed (43.16%) or agreed (44.92%) that they were beneficial. Almost 86% of the students surveyed strongly agreed (53.32%) or agreed (32.62%) that the group exercises should continue to be incorporated into the general chemistry curriculum. Students also felt that their TAs were prepared and knowledgeable about the material covered on the group exercises (54.08% strongly agreed and 32.62% agreed).

**Organic Chemistry Sequence (Chem 622, Chem 624/626, and Chem 628/630).** Our organic chemistry sequence offers both a traditional two semester sequence (Chem 624/626) and a one semester terminal course (Chem 622). In addition, we have implemented an honors version of the two semester sequence (Chem 628/630). The organic chemistry course is a large service course and the laboratory is required by many disciplines. Consequently, there is a large waiting list to enroll in the organic chemistry lab courses. The severity of this situation rivals the enrollment problems that currently plague Chem 184 and Chem 188. In order to meet increasing enrollment demands, the Department has had to offer Saturday sections of both the organic and general chemistry labs. While this strategy has been palliative in the immediate, it is by no means curative.

**Support Staff for General and Organic Chemistry.** The recent addition of a general chemistry coordinator position has helped tremendously with the curriculum reform mentioned above as well as with the facilitation of lecture demonstrations. Since our general chemistry courses are taught by regular faculty on a rotating basis, having a support person who can help provide guidance on technology and curricular issues has been a real bonus. A vast repertoire of lecture demonstrations is now available for request by faculty members. These demonstrations are already making an impact on our students and our courses. The students appreciate and understand the concepts better when they can see them in practice. Having the ability to easily
put together and show these demonstrations is a key improvement that this position has provided. For a department of our size and with the kind of service load that we have, we have been traditionally understaffed in these types of support roles. The addition of the general chemistry coordinator position, as well as the addition of a similar position in organic chemistry was a critical improvement.

Upper-Division Undergraduate Courses. The upper division courses have undergone recent changes as well. The physical chemistry and analytical chemistry curriculum are highlighted below. In each case, the laboratory courses are emphasized.

Physical Chemistry. The physical chemistry sequence (Chem 646/648) is now offered with a microscopic to macroscopic ordering. The first course (Chem 646) in the 2-course sequence covers quantum mechanics, spectroscopy, and statistical mechanics. The second course (Chem 648) focuses on thermodynamics and kinetics. This revised curriculum appears to be more successful than the previous arrangement of topics.

As a result of NSF-CCLI funding, recent (2004/2005) curriculum reforms have also been implemented in the undergraduate physical chemistry laboratory. Computational exercises and experiments exploiting modern, laser-based techniques were developed and added to the curriculum. A list of the new laboratories is included in the table below. As indicated in this table, the new projects emphasize spectroscopy, photochemistry, kinetics, thermochemistry, and computational chemistry. These “non-black box,” interactive experiments provide the students with an experience not unlike what they might encounter in a typical university research laboratory.

An additional objective of the physical chemistry CCLI project was to emphasize the development of students as research scientists by helping them attain competencies in scientific communication, proposal-writing, and independent project design, development, and implementation. Hence, some of the written reports were replaced (or augmented) with oral presentations so students had an opportunity to practice and improve their verbal scientific communication skills. Independent projects were also incorporated into the laboratory repertoire in order to enhance students’ skills in project development, scientific reasoning, and problem solving. After completion of their independent research, students are required to present their results in a departmental poster session. This approach was devised to help reinforce fundamental physical chemistry concepts in a framework that stimulates critical thinking, independent exploratory learning, peer collaboration, and public scientific discussion.

<table>
<thead>
<tr>
<th>Concept Area</th>
<th>Experiment</th>
<th>Computational Supplement</th>
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<tr>
<td>Spectroscopy</td>
<td>Laser-Induced Fluorescence of Molecular Iodine</td>
<td>Calculating the Potential Energy Curves of the</td>
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<tr>
<td>Ground State and Several Excited States of I₂</td>
<td>The Infrared and FT-Raman Spectroscopy of Small, Polyatomic Molecules</td>
<td>Using HyperChem and Gaussian to Calculate the IR and Raman Spectra of CCl₄</td>
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<tr>
<td>Absorption Spectra of Conjugated Dyes*</td>
<td>Using HyperChem to Calculate the Electronic Spectra of a Series of Conjugated Dyes</td>
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<tr>
<td>Vibrational-Rotational Spectra of HCl and DCl*</td>
<td>Investigating HCl with HyperChem</td>
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<tr>
<th>Photochemistry, Photophysics, and Kinetics</th>
<th>Investigating Benzophenone Photochemistry with Laser Flash Photolysis</th>
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<tr>
<td></td>
<td>Using Flash Photolysis to Study Carbonmonoxmyoglobin (MbCO) Recombination Kinetics</td>
<td>Molecular Dynamic Simulations of MbCO</td>
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<tr>
<td></td>
<td>Excited State Lifetimes of Select Xanthene Dyes: Eosin Y and Erythrosin B</td>
<td>N/A</td>
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| Thermochemistry                         | Combustion Analysis of Naphthalene, Azulene, and Select Foods using a Semi-Micro Bomb Calorimeter | Using Gaussian and Isodesmic Reactions to Calculate △H° of Naphthalene |

*These experiments were part of the laboratory repertoire prior to the curriculum reform (CCLI project).
The curriculum reforms in physical chemistry prompted the Department to modify laboratory prerequisites. Students are now required to take Biological Physical Chemistry (Chem 640) or Physical Chemistry I (Chem 646) before they can enroll in the Biological Physical Chemistry Lab (Chem 641) or the Physical Chemistry I Lab (Chem 647). Before this change, students could take the laboratory concurrently with the lecture course. This situation posed a serious problem as lecture and lab alignment is quite poor. Thus, students rarely had the appropriate background to fully understand the scheduled experiments. The new curriculum exacerbated this situation and motivated the scheduling and requirement changes. Likewise, students must now take the Physical Chemistry II (Chem 648) course before they will be allowed to enroll in the Physical Chemistry II Lab (Chem 649). It is too early to know if these changes will result in improved comprehension in the laboratory, but it is hard to imagine how the effect will be anything but beneficial in the long run.

Analytical Chemistry: Instrumental Analysis Laboratory (Chem 636). The instrumental analysis laboratory also provides a unique experience for our undergraduate students. A detailed description of this course can be found at the following website: http://www2.chem.ku.edu/GWilsonGroup/Chem_636/Packet/default.asp.

In short, students begin this course by filling out a specialized job application that requires them to catalog their background in science and math and describe their research experience and career goals. They must provide academic references and relevant employment information as well. Group leaders use this information (and data collected during one-on-one interviews) to form teams that represent different mock companies. Each company is then tasked with formulating a plan to investigate a realistic “problem” having industrial, commercial, and/or academic significance. The experimental program and methods used to solve the “problem of interest” are proposed and implemented by the students. However, before students can start their laboratory study, they must submit a written project proposal for approval. These detailed project plans must include an approximate timeline and an estimated cost analysis. Once their proposals are approved, students can begin their proposed research. During these semester-long independent projects, students often meet and work with their instructor and TA. They are also encouraged to consult with outside experts. In week 11 or 12, students submit written progress reports. At the end of the course, students are required to submit a final written report and give oral and poster presentations of their findings. This undergraduate laboratory is clearly very different from traditional lab courses that rely on “canned” investigations. This course, which has been well-received, gives students a better appreciation for real-world issues and science investigation.

Special Topics Courses. Several new special topics courses have been recently added to the undergraduate curriculum, including Nanotechnology, Quantum Computing, and Biological Organic Chemistry. These special topics courses allow the students to explore current problems that are not covered in the traditional course sequence. Our ability to teach these courses depends strongly on whether or not there is sufficient faculty to cover all of our core undergraduate and graduate courses. The special topics courses are not taught every semester as current staffing levels restrict when they can be offered. Increasing the number of faculty would allow these and other advanced multidisciplinary courses to be offered on a more regular basis.
• The Challenges that Remain and Long-Range Plans. While a concerted effort has been made to improve the UG chemistry curriculum at KU, there are still many challenges that remain to be addressed. Most of these revolve around the need for new teaching facilities and additional faculty and support staff. The Department also recognizes that introductory freshman course offerings need to be restructured to better meet the diverse educational and intellectual needs of the college students taking these courses. Other priorities include establishing multidisciplinary undergraduate and graduate programs in progressive fields like chemical biology and developing a stronger community among our UG students to better attract, retain, and educate our chemistry majors.

General Chemistry Enrollments are Exceeding Facility Capacities. The Chem 184/188 general chemistry sequence is offered as a single, large-lecture course with laboratory sections of approximately 20 students per lab. As the figures below indicate, the enrollments in Chem 184 and Chem 188 are quite high in the Fall and Spring semesters, respectively. These high enrollment numbers are a source of concern for both students and the Department. The pedagogical and administrative consequences have already been felt. At the beginning of each semester, there is always a significant waiting list of students that are unable to enroll in these classes due to limited laboratory and classroom space. For months, the general chemistry laboratory director and the main-office staff are inundated with e-mails and walk-in requests for permission numbers and special enrollment accommodations. This demand has caused the Department to open extra laboratory sections which meet on Saturday mornings and afternoons. At present, the Chemistry Department is the only department on campus that has had to offer weekend labs to accommodate student enrollment demands. In the Spring semester, labs routinely run until 5:30 pm on Monday through Saturday. Opening any more laboratory sections will require hiring additional lab staff and TAs. This situation is only expected to worsen as increased student demand is anticipated.

Figure 4
CHEM 184 Enrollment
(Spring and Fall semesters only)

(*CHEM 150: Chemistry for Engineers began Fall 2010; enrollment of 243)

Figure 5

CHEM 188 Enrollment
(Spring and Summer Semesters)
Arguably, the best solution to this unfortunate situation is to add more undergraduate laboratory space since the existing facilities no longer meet the current educational or enrollment needs. Other avenues for addressing the continued escalation in student enrollment may be more feasible in the short-term due to fiscal constraints, but these “band-aid” approaches will only act to mask or lessen the symptoms rather than cure the “disease.” Some of the palliative approaches that have been discussed include:

(1) offer evening or Sunday labs, which will require the hiring of additional lab staff; (2) change the 5-hour Chem 188 lab to a 4-hour lab and offer MWF lab sections at 10 am and 2 pm (or 2:30 pm)...this would open up 12 new lab sections on MWF and only extend normal operating hours by an hour or less; or (3) increase the number of lecture sections that are offered and offset the times that these sections meet so that labs can be offered all day. Debate continues about how best to resolve this situation; however, all can agree that action must be taken immediately.

**The Modified Laboratory Curriculum Requires Laboratory Renovations.** Not only is additional undergraduate laboratory space needed, but the existing space is also in desperate need of renovation. The undergraduate general chemistry labs and organic labs are entirely too small and antiquated for modern teaching standards. The close proximity of the lab benches compromises easy maneuverability and safe transport of materials around the lab, as well as into and out of the balance rooms. The bench configuration is ill-suited for collaborative work and discussion. Furthermore, line of sight is restricted throughout much of the laboratory. The obstructed views and poor visibility impede instruction and compromise the ability of TAs to assess student adherence to safety standards. Inadequate bench space hinders experimentation and requires computers to be anchored well-above (~ 3 ft) the bench tops, which ultimately hinders data acquisition and analysis. Not surprisingly, comfortable viewing of the computer monitors is difficult for all but the tallest of students. Facilities such as these are hardly expected to inspire students, much less serve our educational mission.

**Current Freshman Chemistry Course Offerings are not Meeting the Needs of All Students.**

The current configuration of freshman chemistry course offerings raises serious issues for students, including many engineering and allied health majors, whose needs are not fully met by any existing course. Moreover, students in courses like Chem 124/125 and Chem 184/188, where there is such an incredible diversity of prior knowledge and motivation for taking the course, frequently find themselves poorly engaged and frustrated by the course content. A solution to this issue is to restructure our freshman chemistry offerings by developing specialized, introductory courses that target specific student groups or emphasize chemical concepts relating to specific subject areas (e.g., Chemistry for Engineers, Chemistry for the Health Sciences, and Chemistry for the Biological Sciences). This is certainly not a novel idea as many major chemistry programs offer freshman chemistry courses such as these.

One of the first courses of this type that we would like to implement is a Chemistry for Engineers course. At present, the approximately 220 engineering majors we serve annually are spread out amongst all of our freshman chemistry courses. Furthermore, the enrollment of engineering students is generally increasing from year to year. These statistics suggest that a single-semester, university-level chemistry course for engineers could have an initial enrollment of well over 225 students. These potential enrollment numbers and the fact that the educational needs of the
engineers are not being fully met by the current curriculum speak to the need for a specialized Chemistry for Engineers course that focuses on concepts more relevant to their fields of study. The following is a suggested course syllabus for the proposed single-semester, university-level Chemistry for Engineers course:

**Chem 135: College Chemistry for Engineers**

**Course Description:** This is a one-semester (5 credit hour), general chemistry course that is designed for engineering students and offered during the Fall term. The lecture is coupled with a 4-hour recitation/lab component. The one-hour recitation focuses on active-learning through discussion and problem solving. The three-hour laboratory session complements the lecture and emphasizes materials science applications when appropriate. **Prerequisites:** One year of high school chemistry and the appropriate math background.

**Potential Audience:** mechanical engineers, aerospace engineers, architectural engineers, electrical engineers, engineering physics, civil engineers (could also include: atmospheric science, astronomy, secondary education – earth & space science, and geology students)

**Tentative Course Syllabus and Laboratory Schedule:** The course curriculum is designed to cover many of the same topics that are discussed in Chem 184 and Chem 188. This will be done, however, in a single semester timeframe. Accomplishing this requires a more advanced pace. It also necessitates more stringent student prerequisites. Students will be expected to have had completed at least one chemistry course in high school since familiarity with topics such as unit conversions, the scientific method, the classification of matter, chemical nomenclature, and stoichiometry will be assumed. Students must also be proficient in the required math background. A tentative syllabus for this one-semester, chemistry course for engineering majors is given below.

**Proposed Schedule of Lecture Topics**

*Week 1* – Quantum Theory and Atomic Structure  
*Week 2* – Electron Configurations and the Periodic Table  
*Week 3* – Chemical Bonding: Basic Concepts  
*Week 4* – Chemical Bonding: Molecular Structure  
*Week 5* – Properties of Gases (Ideal and Real)  
*Week 6* – Liquids and Solids – Intermolecular Forces  
*Week 7* – Energy in Chemical Systems: First Law of Thermodynamics  
*Week 8* – Entropy and the Second Law of Thermodynamics  
*Week 9* – Equilibrium and Free Energy  
*Week 10* – Physical Equilibrium  
*Week 11* – Chemical Equilibrium  
*Week 12* – Acids and Bases  
*Week 13* – Aqueous Equilibrium and Solubility  
*Week 14* – Chemical Kinetics  
*Week 15* – Organic Chemistry and Polymers  
*Week 16* – Metallurgy and/or Nuclear Chemistry (or Instructor-Specific Special
We believe that implementing more targeted freshman chemistry courses of this type would positively affect student engagement in freshman chemistry. The accompanying decrease in class sizes is likely to dramatically enhance the quality of the learning environment, particularly for students in their first year at the university. Implementing this plan would require an increase in the number of faculty committed to teaching freshman chemistry. This is yet another justification for increasing total faculty numbers in the Department.

**Encouraging Greater Flexibility in the Chemistry Major.** As a department whose research lies on the growing edge of knowledge in many disciplines (e.g., life science research, alternative and efficient energies, and materials science), we are uniquely situated to provide our students with highly multidisciplinary experiences in the sciences. Establishing multidisciplinary undergraduate and graduate programs in fields such as chemical biology would formalize these types of experiences and help focus our efforts to enhance multidisciplinary studies within the Chemistry Department.

Graduate students who use molecular biology techniques in their research and/or whose research focuses on biological macromolecules are currently underserved by the existing Chemistry curriculum. They are required to take courses that are not related to their core focus, and they are not offered courses that they need in order to be effective researchers. For example, there are currently no graduate “biochemistry” courses or courses that specifically focus on protein expression, protein structure and function, post-translational modifications to proteins, enzymology, RNA/DNA, or glycobiology. However, the curriculum is filled with courses in small molecule synthesis and analysis that are only marginally relevant to such students. Moreover, undergraduate students, for whom biological chemistry will loom larger in the chemical profession than it has in the past, are not receiving an adequate introduction to the chemical basis of protein structure and function.

Additionally, there is no seminar program that combines the macromolecular research groups. The Mure, Rivera, Desaire, Benson and Jackson groups are spread across three different divisions and two campuses. As a result, students who are doing research involving molecular biology techniques and methods do not get a chance to interact and learn from each other. Expertise in protein expression, purification, and analysis is not being effectively shared and fostered in the department. One solution for this is to develop a new multidisciplinary graduate studies program in biological chemistry.

Students wishing to take part in a multidisciplinary program, such as biological chemistry, would need to petition in order to modify their course of study. For instance, a student might petition to use the Biophysical Methods course (currently co-taught between Chemistry and Biology) as a distribution course. All modifications to the regular degree program would require approval by the student’s home division and their research (or academic) advisor. If necessary, special topics courses could be developed to fulfill specific requirements. Alternatively, students could take courses from other departments, like Molecular Biosciences. Students would also be required to attend bi-weekly Macromolecular Biological Chemistry colloquia. During off-weeks, attendance
at seminars in other divisions (preferably the division of their mentor’s undergraduate teaching appointment) would be mandatory.

A by-product of this program could be the development of one or more special topics courses appropriate for undergraduate students. The ACS guidelines for approval of undergraduate programs have recently undergone a major change in recommendations related to chemistry curricula. The changes will allow more modern, interdisciplinary subject matter into ACS approved undergraduate chemistry programs. Developing one or more special topics courses in which synthesis, analysis, modeling, and spectroscopy are covered in the context of understanding structure and function problems in biomacromolecular chemistry could be an outstanding approach to building a more engaging and multidisciplinary undergraduate curriculum.

This program would offer students:
- an increased level of interaction between research groups addressing similar issues;
- more appropriate coursework that focuses on the interface between chemistry and biology.

This program would offer participating faculty members:
- an opportunity to teach courses more aligned with their research specialties (e.g., glycobiology, enzymology, protein structure and dynamics);
- a better curriculum for the graduate and undergraduate students working in their labs.

This program would offer the department:
- a new graduate recruiting tool and a new “focus of excellence” (Note: We may be the first department in our region with such a program.);
- a good reason to expand the faculty at the chemistry/biology interface. (Right now we can’t “fully staff” this as an independent division because we don’t have the personnel. With more people, we could develop this into an independent division and also offer chemical biology-related classes in the undergraduate curriculum.)

**Creating a Stronger Community Among our Undergraduate Students**. Building a sense of accomplishment, commitment, and community among our undergraduate majors is another step that we hope will enhance the number of students retained in the major. The department has asked the general chemistry laboratory supervisor, Dr. Roderick Black, to become more actively involved in mentoring the undergraduate student club. He has plans to hold regular club meetings that include talks given by faculty and visitors. The Department has committed some discretionary endowment funds to support Chemistry Club activities. We hope that this and other Departmental efforts will enable us to double the number of undergraduate majors over the next 5 years.

- **Research Experience for Undergraduates Program**. For the past twenty one years the Chemistry Department has had the privilege of being a site for the National Science Foundation sponsored Research Experience for Undergraduates program. The goal of our REU Program is to attract promising undergraduate students to careers in the chemical sciences by providing an
opportunity to engage in full-time research within the stimulating atmosphere of a large, active, interdisciplinary research community. Essentially all of the NSF-REU funded participants are recruited from primarily undergraduate institutions with substantially limited or no research infrastructures. Every year, in addition to ten NSF-funded participants, 10-25 non-KU (including international) and KU undergraduates funded through other means participate in the program, enhancing the experience through the diverse backgrounds of the cohort of young researchers. Participants select individual research projects from more than thirty problems at the forefront of the chemical sciences. These research projects are carefully planned to be appropriate for an undergraduate researcher. The cohort experiences include a variety of professional and social group activities that contribute to each participant’s personal and professional growth. The students benefit from the highly collaborative research environment at KU, state-of-the-art facilities, and an extensive orientation program to facilitate their acclimation to the University and initiation of research. A key REU component is career enhancement program addressing career opportunities and challenges in emerging interdisciplinary research. Close interaction of the participants with their faculty and graduate student and/or postdoctoral mentors provide guidance and feedback throughout the program and beyond. In addition, the students develop important skills for oral and written communication of their research accomplishments. The REU Program is currently directed by Professors Barybin and Heppert. More up-to-date information can be found at www.chem.ku.edu/reu.

**Recommendations.** The Department recommends that the following actions be implemented to enhance our graduate and undergraduate programs:

- Diversify freshman chemistry course offerings making them more relevant to majors in particular disciplines,
- Develop a new plan to staff current freshman chemistry teaching,
- Institute instructional enhancements designed to improve student engagement and learning in freshman chemistry and organic chemistry courses,
- Develop course offerings that encourage flexibility in both graduate and undergraduate degree programs,
- Work to create greater community among undergraduate chemistry majors, and
- Double the number of chemistry majors over the next five years.

**Anticipated Outcomes.** Over the past ten years, Chemistry has demonstrated its willingness and ability to provide enhanced course offerings and better learning experiences for its undergraduate students. These efforts have included updating and modifying the laboratory curriculum to reflect inquiry-based learning, introducing new honors courses at the introductory level, and developing more small-group learning opportunities for students in large lecture courses. We believe that focusing on the innovations outlined in this report over the next 10 years will:

- Significantly increase the number of undergraduate chemistry majors,
- Greatly enhance the number of students KU annually certifies to teach secondary chemistry,
Contribute to the retention of students in science and technology majors,
Enhance student satisfaction with our undergraduate degree programs, and
Substantially increase the diversity of our undergraduate and graduate student populations in Chemistry.

**Questions for External Reviewers**

1. Do you have any suggestions for what the Department can do to increase the number of chemistry majors?

2. Are there steps we can take to better serve our non-majors?

3. Based on what you have observed, how can we improve the undergraduate chemistry program in ways that will allow our students to receive the education and training they need to succeed in today’s workplace?

4. What thoughts do you have concerning the changes that we have made and future plans we have to modify the undergraduate chemistry curriculum?

5. Please suggest additional curricular modifications that we should pursue to improve the undergraduate program.

6. What steps can we take to continue to build a stronger community among our undergraduate chemistry majors?
Department Governance, Support Staff and Services

Like all major organizations the Chemistry Department has a variety of individuals to assist the faculty with the educational and research mission of the department and the university. Without the efforts of these individuals, student’s educations would suffer. No matter how small the task, someone must be responsible to see each task carried through. The entire staff, both unclassified and university support staff work as a cohesive team with the faculty to make this happen.

The Chemistry Department currently has seven unclassified professional staff and thirteen university support staff employees to assist in the daily operations of the department (see attached organizational chart). These individuals provide a wide range of services to both the educational and research mission of the Chemistry Department. Many of the individuals have been crossed trained on other position in order to alleviate work slow down or stoppage due to illness, vacation or increased activity. This is an overview of the positions and their duties.

The **Program Assistant** works exclusively for the chair of the department. The individual is responsible for managing the chair’s calendar, correspondence and other duties associated with his position. The individual takes minutes at meetings and transcribing them for the chair. This position is also the scheduling officer for all chemistry classes and works with Course and Room Scheduling to make sure that all of the chemistry classes have adequate rooms to teach in. The individual provides students with special permission numbers to enroll in classes that are either closed or require faculty permission. The individual also monitors the enrollment of all classes to ensure that classes are not being over crowded. The position writes and sends two Chemistry newsletters each year that are sent to Alumni. The individual maintains contact with Alumni and works with the chair to foster alumni relations through letters and dinners at regional and national meetings. This individual is responsible for gathering and maintaining the electronic files of Chemistry Department information. The position gathers data and maintains a spreadsheet to be used for surveys, external reviews and other reports. This position works closely with the faculty and business manager. This position is supervised by the chair of the department and is an unclassified position.

The **Business Manager** is responsible for the daily operations of the Chemistry Department. The position supervises thirteen university support staff individuals with a wide variety of job duties to help maintain the education and research mission of the department. The position is responsible for overseeing all of the state, grant, and endowment expenditures. Therefore the individual must be current on all rules and regulations associated with these expenditures. This position is also responsible for overseeing all chemistry remodeling projects for start to finish. The individual works with the faculty member, Design Construction Management, Facilities Operations, Networking and Telecommunications, and the College to insure that the project is finished correctly, in a timely manner and on budget. This individual also works with Environmental Health and Safety and is the Chemistry Safety Officer. The individual gives at least three safety seminars per year – two to the entire faculty, staff and student population and one to incoming graduates students. The individual in this position often does impromptu safety inspections of the undergraduate and research labs to ensure that proper safety guidelines are being followed. The individual is also an ad-hock member of the Chemistry Space Committee. The position keeps all information concerning teaching and research space on a data base and
provides that information to the committee. This individual also inputs that information in the University’s JaySpace program for use with the indirect cost proposals. The individual is cross trained on all of the university support staff positions so that if there is an absence, the business manager can fill in or at least provide needed information. The individual in this position works closely with the chair to provide figures for state and grant expenditures for reports such as the NRC, MASUA, CCR, etc; with faculty on remodeling or class problems and very closely with the university support staff on the daily operations of the department. This position is also the backup person for the Course and Room Scheduling officer. This position is currently responsible for all expenditures from endowment funds and is the Scholarship Coordinator. This position is also a Hiring Manager for PeopleAdmin. This position is an unclassified position supervised by the chair of the department.

The **Network Manager** works for the entire department and is responsible for the management of the servers and computers used by the faculty, staff, and students in the department. The department is divided between three different buildings and often the network manager must handle problems in each building. This position recommends what computer configurations should be ordered depending on if the system will be used for the educational or research mission of the department. Upon arrival of a new computer, the network manager configures it according to university standards before it is placed on the chemistry server. The position also works with the university on internet security issues within the department and on the departmental servers. The network manager also maintains several research servers and provides support for them. This position is supervised by the chair of the department and is an unclassified position.

**Director of Laboratories – General Chemistry** is a position that works exclusively with students who are taking all introductory chemistry classes. The individual in this position is responsible for meeting with faculty who teach these classes and coordinates the laboratory with the material being taught in class. This individual also assists the Program Assistant with class enrollment numbers for each semester. The individual in the position is often asked to teach, either as a substitute for one of the classes during the fall and summer, or to teach an entire class in the summer. During the fall and spring semesters there are five different chemistry laboratory classes being taught. There are a total of six classrooms with twenty students per class. Typically in the fall and spring semester there are 1500 students taking lab classes. This position also works closely with other the Lecturer Coordinator. This position works closely with other faculty members and is the chair of the Curriculum committee. This position often volunteers with the undergraduate Chem Club and works with the students on the Carnival of Chemistry. This position is supervised by the chair of the department and is an unclassified position.

**The General Chemistry Lecturer Coordinator** assists faculty who teach the undergraduate general chemistry classes. The individual in this position is responsible for assisting in the lecture classes with doing chemical demonstrations to enhance the lecture material presented to the students. The individual may be asked to substitute teach in one of the classes as well. Often the individual is asked to teach a class during the summer semester. This individual is responsible for finding new demonstrations to be used in the classroom setting. Although the primary function of this position is to the general chemistry area, the position often provides demonstrations to the undergraduate analytical and physical chemistry classes as well. The
individual works closely with the Director of Laboratories – General Chemistry as well as faculty. The individual is responsible for writing new lab experiments to be incorporated into the general chemistry laboratory setting. The position works closely with the Administrative Associate Sr. (1767) to place orders and purchase needed items for the demonstrations or lab experiments. The position also works closely with the Business Manager for funding of the projects. This is an unclassified position supervised by the chair of the department.

**Director of Laboratories – Instrumentation Laboratories** is responsible for the operations of the undergraduate analytical and physical chemistry labs. This individual works closely with faculty on implementation of laboratory experiments directly related to those courses. The individual is responsible for maintaining the equipment associated with those undergraduate classes as well. In addition this position maintains the equipment in the Instructional Instrumental Lab (IIL) that is used by analytical undergraduate and graduate students. The individual works closely with the Administrative Associate Sr (1767) to place orders for items needed and the Business Manager for budgetary considerations. This position works with all faculty and the two Laboratory Educational Technicians during the fall semester to compile a list of items the department would like to purchase from Instrumental Technology Funds. The position then works with the Chair and Business Manager to finalize the list before it is submitted to the College of Liberal Arts and Science. Upon approval of the items, this position works with the business manager to order the items for all divisions. This is an unclassified position supervised by the chair of the department.

**Organic Chemistry Laboratory Coordinator** – individual is an unclassified employee who is supervised by the chair of the department. This half time position is responsible for the daily operations of the undergraduate organic laboratories. The duties include assigning graduate teaching assistants to labs; supervision of teaching assistants; implementation of new lab experiments; working with organic faculty to ensure curriculum is being met. This individual works with Organic Lab Ed Tech (1763) to order items to be used in lab experiments and with the Business Manager on budgetary considerations.

**University Support Staff Supervised by the Business Manager.** The following staff support departmental activities, record keeping and grants administration.

- Administrative Associate Sr.—Undergraduate and Graduate Affairs Secretary
- Administrative Associate—Receptionist
- Laboratory Educational Technologist, General Chemistry
- Administrative Associate Sr.—Payroll
- Accountant—Grants and Stockroom
- Administrative Associate Sr.—Analytical
- Laboratory Educational Technologist—Organic Chemistry
- Administrative Associate Sr.—Exams and Grades
- Administrative Associate Sr.—Website and Orders
- Instrumentation Technologist—Machinist
- Accountant—State and Grants Funds
- Administrative Associate—Orders and Reception
- Administrative Associate Sr—Chemistry Stockroom
Special University Staff Positions Attached to the Chemistry Department

Director IDL – Instrumentation Design Laboratory is a position that works not only for chemistry but all of the campus. The IDL works with faculty members to design and build instrumentation used on research grants. Items range from simple to complex in nature. The director of the IDL is an unclassified position who reports to the chair of the department. However in normal operations, the IDL operates as an independent entity without having to consult the chair of the department. The director of the IDL supervises one employee who is also an unclassified employee:

- Electronic Design Engineer who works with faculty in the design phase of instrumentation for equipment.

The Research Instrument Operator (not listed on the organization chart) works directly for the director of the Mass Spectrometry Laboratory. Fifteen years ago the Mass Spec lab was part of the Chemistry Department but now is considered part of a larger service group entitled Molecular Structures Group (MSG). This position is still being funded through the College and is reported as salary only. This is a university support staff position and is supervised by the director of the Mass Spectrometry Laboratory.
## Standing Committees - Roles and Assignments

### General Functions of the Standing Committees

1. Each standing committee may receive communications from the faculty, the other standing committees, or the Chair.

2. Each standing committee may hold meetings, open to all members of the Faculty.

3. For matters that are the concern of more than one standing committee, a joint meeting of the relevant committees is encouraged.

4. Each standing committee shall provide the Departmental members with such information as it requests or, in its advisory and review capacity, present reports or make recommendations on other matters which, in the judgment of the committee, deserve faculty attention.

5. Each standing committee may, where appropriate, delegate to the Department office and/or staff the performance of specific functions on its behalf.

6. The Chair shall confer with the chairs of the standing committees for the purpose of coordinating standing committee activities, considering long-range planning, and establishing special committees to address specific long-range policies and goals.

### Standing Committee Responsibilities

#### A. Committees Reporting Directly to the Chair:

**CHAIR ADVISORY COMMITTEE**
Composition: Chair, Associate Chair for Graduate Programs, Associate Chair for Undergraduate Programs, and four faculty members, including distinguished professor, if appropriate.

- Advisors to and called into session by the Chair.
- Annually reviews the Department's progress relative to long-range planning.
- Reviews and proposes revisions to faculty/Departmental aims, goals, and needs.
- Reviews and provides input on major initiatives proposed by the Chair or other members of the faculty.
- Proposes priorities for program development and utilization of personnel and resources to the faculty.

**ALUMNI RELATIONS/ENDOWMENT COMMITTEE**
Composition: Chair, Associate Chair for Graduate Programs, Associate Chair for Undergraduate Programs, Academic Administrative Officer, and four faculty members, including an emeritus faculty member, if appropriate.

- Advisors to and called into session by the Chair.
• Annually reviews the Department's progress relative to long-range planning.
• Reviews and proposes revisions to faculty/Departmental aims, goals, and needs.
• Proposes priorities for program development and utilization of personnel and resources to the faculty.

FACULTY DEVELOPMENT COMMITTEE
Composition: Chair, Associate Chair for Graduate Programs, Associate Chair for Undergraduate Programs, and two faculty members, including distinguished professor, if appropriate.

SPACE AND FACILITIES COMMITTEE
Composition: Three faculty, Business Manager, and one Laboratory Director.
• Reviews and makes recommendations on space and instrument needs.
• Keeps a rank-ordered list of equipment and space needs that is updated on at least an annual basis.

CHEMICAL HYGIENE AND SAFETY
Composition: Chair, Business Manager, and one Laboratory Director.
Administers the departmental safety program and regulations.
• Conducts safety and hygiene seminars at least twice annually to introduce the rules, regulations, and procedures to new members of the Department and to review the same for continuing personnel.

WEBSITE COMMITTEE
Composition: Two faculty, Department Administrative Officer, and one Administrative Staff
• Reviews and makes recommendations with regard to the content of the Department website

NETWORK AND COMPUTER SECURITY COMMITTEE
Composition: Network Manager, One faculty, Business Manager, one Laboratory, and one Administrative Staff
• Reviews and makes recommendations with regard to the budgetary needs for computational hardware and software for the Department
• Oversees computer and network security measures for the Department

B. Committees Reporting to the Associate Chair for Undergraduate Studies:

UNDERGRADUATE AFFAIRS COMMITTEE
Composition: Associate Chair for Undergraduate Programs, two faculty members and one undergraduate student.
• Takes final action on petitions and applications for admission to the Honors Program.
• Acts as an appeal board on undergraduate student grievances.
• Acts on petitions for transfer credit and credit by examination for all courses except
general chemistry.

UNDERGRADUATE CURRICULUM COMMITTEE
Composition: Associate Chair for Undergraduate Programs, Director of General Chemistry Laboratories, General Chemistry Lecture Coordinator, three faculty members and one undergraduate student.
- Reviews and proposes revisions in the undergraduate curriculum to the Department.
- Makes recommendations on curriculum including addition and deletion of courses, and changes in credit hours, prerequisites, and course descriptions to the Department.
- Makes recommendations on changes in degree requirements to the Department.
- Takes final action on petitions and applications for admission to the Honors Program.
- Acts as an appeal board on undergraduate student grievances.

GENERAL CHEMISTRY COMMITTEE
Composition: Associate Chair for Undergraduate Programs Director of General Chemistry Laboratories, and three faculty.
- Coordinates staffing of General Chemistry courses - CHEM 125, 184, 188, and 189.
- Works in conjunction with the Undergraduate Curriculum Committee on review and recommendations for the General Chemistry curriculum including addition and deletion of courses, and changes in credit hours, prerequisites, and course descriptions.
- Acts on petitions for credit by examination and transfer of credit for general chemistry.

C. Committees Reporting to the Associate Chair for Graduate Studies:

GRADUATE AFFAIRS COMMITTEE
Composition: Associate Chair for Graduate Programs, three faculty, and one graduate student.
- Reviews current graduate curriculum.
- Makes recommendations on curriculum including addition and deletion of courses, and changes in credit hours, prerequisites, and course descriptions.
- Makes recommendations on changes in advanced degree requirements.
- Takes final action on petitions
- Acts as an appeal board on grievances.
- Administers foreign language and cumulative exams.
- Conducts an evaluation of first year graduate students after the Fall semester and all graduate students after the Spring semester and makes recommendations to the faculty.
- Reviews the progress of students on probation or with other academic or program deficiencies on a semester by semester basis.

GRADUATE ADMISSIONS COMMITTEE
Composition: Four faculty, and one graduate student.
- Reviews the qualifications of applicants for the graduate program and makes recommendations to the Department Chair.

GRADUATE RECRUITING COMMITTEE
Composition: Four faculty members.
- Administration of programs to recruit graduate students.
- Coordination of the annual graduate recruiting weekend.
- Evaluation of prospective graduate students for supplemental fellowships.
- Communication with prospective graduate students after they have formal offers.
- Review and update of recruitment materials (hard copy and web site).

**GRADUATE RECRUITING WEEKEND COMMITTEE**
Composition: Four faculty members.
- Coordination of the annual graduate recruiting weekend.

**Chemistry Department Committee Organizational Chart**

**Questions for External Reviewers**
1. Is our current staffing level commensurate with the activities of the department?
2. Is the existing distribution of staff responsibilities appropriate given the activities of the department?
Alumni Relations

The Department of Chemistry needs to seek methods to better connect to our alumni and better market our innovative research and educational programs to potential donors. Within the last two years, Chemistry alumni have provided gifts and bequests for the Department and its programs totaling in excess of $3M. Clearly, a number Chemistry graduates who have had highly successful careers are willing and even eager to express their support for our research and education missions. Though the current economic dislocation seems likely to slow the pace of giving, we should be laying a foundation of communication that will allow us to capitalize on the generosity of our friends once the economy improves. The Department’s Chair Advisory Committee has reviewed and approved the following priorities for departmental giving:

1) The department has established faculty development funding as its top priority for alumni giving. Funds to enhance the careers of talented faculty and provide them with resources that help them build their careers at KU must be far and away the department’s top priority.

2) Fellowships to bring more highly talented foreign students to KU are our second priority. With our current provisional offers, it is currently difficult for us to compete for the best non-native students from China, India, Sri Lanka and other nations. These students could dramatically enhance the competitiveness of our programs.

3) Non-needs-based graduate and undergraduate fellowship funding (resources that we can use to try to attract the best graduate and undergraduate students) are a third priority for the department. We want to place a particular emphasis on attracting the best and largest possible classes of incoming students.

4) Finally, the Department needs to continue to build its unrestricted general fund resources. This money helps us overcome unanticipated expenses associated with faculty recruitment, student financial need and opportunities to enhance research.

• Recommendations. We need to reach out to all our former students with more information about the accomplishments of our program and success of our graduates. We are developing a web based clearing house that will enhance connections with our friends and alums. This resource will provide detailed information about how alumni and friends can contribute to the improvement of our education and research missions. The following strategies will be used to improve these contacts:
  o Create a departmental alumni advisory board that will advise the department on reaching out to alumni, will inform the department about alumni priorities and will work for the development of the department in targeted areas,
  o Use regional and national professional meetings to create events for Chemistry alumni,
  o Increase Departmental cooperation with the KU Endowment Association,
  o Use surveys of recent graduates to plan future enhancements to Departmental education and research initiatives,
  o Upgrade the Departmental web page to incorporate Chemistry alumni content and provide alumni list serves, and
  o Evaluate and pursue prospects for international alumni support of research and graduate study.
We can also learn from our alumni, and in the process of learning from them draw them into a
closer relationship and into greater personal commitment in the growth and development of the
department. The potential value of developing close contact with practitioners of chemistry in the
private sector and government laboratories is obvious to individuals who have cultivated
industrial internships for students or seen the power of industry to enhance R&D efforts through
the workings of the Center for Environmentally Beneficial Catalysis (CEBC) Industrial Advisory
Board (IAB). We have a wealth of individuals, primarily alumni, who would be willing to serve
on a Departmental Advisory Board. These individuals could help us focus our message and the
presentation of the Department to the scientific profession, identify opportunities for industrial
collaborations through research funding and internships for KU students, advocate with the
administration for resources and support, and enhance alumni giving. It seems to be a logical
step to establish a Departmental Advisory Board and engage members of the faculty and alumni
to draw up a plan for the development and future activities of this group.

**Anticipated outcomes:** Our long term goal in this effort is to sustain alumni loyalty to the
Department, and to build a network of external collaborators who will help us work for the
betterment of our programs. We anticipate that specific outcomes of this effort will be to:

- Quadruple annual giving to Departmental discretionary funds and double the total size of
  the Department endowment,
- Generate support of specific alumni for faculty enhancement initiatives, including
  funding for four additional chaired and named professorships,
- Initiate major efforts to endow chairs in the names of some prominent recently retired or
  soon-to-retire faculty,
- Enhance giving directed toward building our population of high-quality foreign born
  graduate students,
- Establish a core group of alumni who will provide guidance to departmental efforts to
  build programs and develop new research thrusts, and
- Support the Department’s ambition to achieve a ranking among the top 25 chemistry
  programs in the nation.

**Questions for External Reviewers**

1. What are additional ways that we should be seeking to involve alumni in order to develop
closer relationships and benefit the department?

2. Have we established appropriate development priorities for the department?

3. What models have you observed for developing alumni advisory boards, and which of
   these models seem to best fit the culture and function of our department?
Appendix I.

Student and Faculty Measures for the Department of Chemistry,
University of Kansas

Data reported from the Academic Information Management System (AIMS),
Office of Institutional Research & Planning, KU
Department of Chemistry  
Executive Summary

Mission  
“The Chemistry Department makes significant contributions to learning and knowledge that benefit our students, the scholarly community and the population of our state and nation, because understanding the atomic and molecular nature of matter informs us about ourselves and our universe, and creating and finding applications for new and modified forms of matter helps to conserve and enhance our world.” Chemistry Department Statement of Purpose adopted January 2007.

Faculty  
As of the fall semester of 2011, the Chemistry Department consisted of 28 tenure track faculty members (24.83 FTE). All courses at all levels in the department are taught by tenure track faculty, except on the occasion when a faculty member with a high administrative load is unable to meet their department teaching responsibility. The large extra-departmental administrative load members of the Chemistry Department shoulder should be noted. We “lose” over four faculty FTE to external duties each year. Teaching in the undergraduate programs is augmented by GTAs who oversee laboratory sections, conduct help sessions, and run discussion groups. As chemistry is the central science, a significant amount of the department’s teaching effort is devoted to service to other department’s degree programs both within CLAS and in the professional schools. In particular, all engineering, pharmacy, and nursing students take one or more chemistry classes.

Productivity  
Teaching  
Student credit hour production in chemistry has steadily increased over the past several years. For the 2010/2011 academic year, the department produced 19,419 SCH, or 767 SCH/FTE. This is above the average productivity for chemistry departments at comparable universities. Chemistry faculty members have won eight Kemper Teaching Awards and one HOPE award for outstanding teaching.

Research  
The department generated over $7.5M in research expenditures for the 2010 fiscal year. This translates into expenditures of $316,910 per faculty FTE. These numbers do not fully reflect the interdisciplinary contributions made by chemistry faculty to research initiatives nominally housed in the School of Pharmacy and the School of Engineering, particularly key participation in the Center for Excellence in Chemical Methodologies and Library Development, the KU Cancer Center, and the Center for Environmentally Benign Catalysis.

Degree Programs  
The Chemistry Department at the University of Kansas offers three degree programs: (1) a BS/BA Program; (2) an MS Program; and (3) a PhD Program. The BS degree in Chemistry continues to be certified by the American Chemical Society (ACS). The department conducted a self-study and external review in 2009 that has led to several changes to be the undergraduate and graduate programs.
Bachelor’s Degrees (BA, BS)
The department’s two bachelor degree programs serve different student cadres. The BS is the primary degree for students wanting to enter the chemical profession, particularly those intending to continue their education with graduate school in chemistry. The BA is targeted to students seeking a multidisciplinary program and those intending to go to medical school. Students obtaining Chemistry degrees have been very successful at placement in top tier graduate programs and medical schools. The current large number of general education requirements has left no room for interdisciplinary programs of study in the BS program. The department is preparing to develop new programs of study once the anticipated changes to the general education requirements are implemented. A significant issue faced by these programs is the large service teaching load provided by the department. This results in potential chemistry majors being in very large lecture sections (several hundred students) for their first two years. We lose several majors each year as they are “lost” in these large lecture courses. We have created a freshman/sophomore seminar course and honors sections of the General Chemistry courses to help alleviate this problem. We are also trying to get approval from CLAS to implement an Introduction to Chemistry for Science Majors course that would include potential chemistry, biochemistry, physics, and chemical engineering students.

Master’s Degree (MS)
In chemistry the MS is not an important degree compared to the BS and the PhD. Students obtaining an MS have essentially the same options as those with a BS. In general, students obtain an MS because they are not sufficiently prepared for the PhD program but want to pursue a PhD. Earning the MS can prepare those students to continue on toward the PhD. Because the PhD is a research degree, the chemistry department requires a research thesis for the MS as part of the preparation to continue on in the student’s education. The MS degree can also be used for preparation to teach at the high school and community college level.

Doctoral Degree (PhD)
The PhD degree is the primary professional degree in chemistry. The PhD is necessary for either an academic career or a professional research career in industry. As a result of the External Review, the department has adopted a new model for its graduate curriculum. We no longer use the traditional chemistry divisions developed in the 19th century but rather base the curriculum on modern multidisciplinary research areas and individualized curricula. Graduate students, in conjunction with their research advisor, now devise an individual plan of study based on their research interests rather than follow a one-size-fits-all set curriculum based on the old division structure. This new system has proven to be popular with potential graduate students and in recruiting new faculty to KU.

Changes as a Result of the Review Process
The major change has been the revision of the graduate curriculum discussed above. The second major change will be the implementation of a freshman level chemistry course targeted specifically to science majors, once it is approved. The department needs to develop interdisciplinary curricula, particularly in conjunction with the BS degree, once the general education requirements are revised.