Strategic plan for the Chemistry Department at MS&T (2014-2020)

Mission: The Chemistry Department at Missouri S&T will integrate education, research and application to create and convey knowledge that serves our State and helps solve the world’s great challenges.

Vision: The Chemistry Department at Missouri S&T will be the premier choice for chemistry majors in the state, recognized nationally for our education, high-impact research and expertise. We will cultivate curiosity, creativity and confidence in our graduates, making them highly sought-after for their talents and qualifications. We will pursue innovative research, offer products and services, and produce technology and ideas to help solve the great challenges of our time.

Values
As a department we share the values of the greater campus community and recognize that the values Lifelong Success, Creativity, Integrity, Sustainability, Partnerships and Inclusion have additional importance within the department.

Lifelong Success: We add immeasurable value. The rewards of the Missouri S&T experience extend far beyond a college education, valued degree or gratifying career. The S&T experience prepares for a fulfilling life defined by the confidence to succeed, a desire to excel in all endeavors and a love of learning that never stops.

Creativity: We are innovators. Building a better world demands a creative spark, innovative and entrepreneurial approaches, and curiosity to discover and explore new solutions to the world’s great challenges.

Integrity: We hold ourselves accountable for our actions. We strive to uphold the highest ethical standards, to conduct ourselves with trustworthiness and respect for all of humanity, and to instill in our campus community these same principles.

Sustainability: We live by example. As stewards of the public goodwill, the financial resources entrusted to us, and the environment, we emphasize resilient and sustainable practices in all our endeavors.

Partnerships: We are great partners. We focus on adding value and creating mutually beneficial partnerships. The solutions to today’s great challenges require agile collaboration, teamwork and engagement with our stakeholders, both on campus and in the greater business, civic, national and international communities.

Inclusion: We are an inclusive, welcoming community. We seek to build a creative learning environment marked by openness, understanding and valuing all people and perspectives.
Department Organization, Governance, and Personnel

Department Chair
Philip Whitefield
position currently held by Interim Department Chair Klaus Woelk

Assistant Department Chair
Klaus Woelk

Administrative Assistant
position currently unoccupied

Office Support Staff
Shannon Roark
Melinda Warner
Barbara Harris*

Technical Support Staff
Rex Gerald
Kun Liu*
Michael Myers*
Jonathan Sidwell
David Satterfield

Center of Excellence for Aerospace Particulate Emissions Reduction Research
Philip Whitefield (Director)
Max Trueblood†
Steven Achterberg†
Elizabeth Black*

The Coatings Institute
Michael Van-De-Mark (Director)

Institute for Applied Chemistry and NMR Spectroscopy
Klaus Woelk (Director)
Rex Gerald

TT Faculty

Analytical Chemistry Division
Yinfa Ma (Division Head)
Paul Nam
Shubhender Kapila
Philip Whitefield

Biochemistry Division
Nuran Ercal (Division Head)
one position unoccupied

Inorganic Chemistry Division
Jay Switzer (Division Head)
Amitava Choudhury
Gary Long
Manashi Nath
Pericles Stavropoulos

Organic Chemistry Division
Chariklia Sotiriou-Leventis (Division Head)
Nicholas Leventis
Prakash Reddy
Thomas Schuman
Michael Van-De-Mark

Physical Chemistry Division
Klaus Woelk (Division Head)
Richard Dawes
Garry Grubbs
Jeffrey Winiarz

NTT Faculty

Teaching
Cynthia Bolon
Terry Bone
Emmalou Satterfield†

Research
Joseph Counsil
Honglan Shi*

* Not paid by general operating (GO) funds
† Partially paid by general operating (GO) funds
Specific plan including themes, levers and relation to the campus plan

We begin with a highly focused Strategic Statement, list of Comparator Groups and Strategy. Next we expand on the reasons and motivations behind them. Then we will discuss a broader list of objectives and finally their relation to themes and levers in the campus strategic plan.

**Strategic Statement:** By 2020, the chemistry department will increase its national ranking by 30 ranks through improved visibility and enhanced scholarly output, recognizing that this will help provide the best return on investment to students, employers, and research partners.

**Comparator Groups:** We set metric-based goals within three comparator groups:

- University of Missouri system campuses (UMC, UMKC, UMSL, S&T)
- CO School of Mines, Kansas State, Oklahoma State, U New Mexico, Wyoming U, S&T (peer institutions with similar numbers of graduate students selected from the 15 institutions of the Mid-America State University Association, MASUA)
- The entire group of 180 Ph.D. granting institutions nationally

**Strategy:** We will focus on performance metrics shown to correlate strongly to department national rankings. In particular, we will promote more balanced scholarly output among faculty members. We pledge to take personal responsibility for our individual contributions, motivated through merit-based salaries and raises.

**Reasoning and Motivations**

We have chosen the three Comparator Groups for the following reasons:

**Comparator group 1:** UM system campuses (UMC, UMKC, UMSL, S&T)
- We draw many of our undergraduate students from in-state and want to become the premier choice for chemistry majors. This is part of our Vision Statement (see above).

**Comparator group 2:** Colorado School of Mines, Kansas State, Oklahoma State, U New Mexico, Wyoming U, Missouri S&T
- These are peer institutions with similar numbers of graduate students, selected from institutions of the Mid-America State University Association (MASUA).
- MASUA department chairs hold annual meetings exchanging detailed statistics and discussing issues relevant to institutions like ours. The similarity of institutions and the availability of detailed statistics make this group particularly relevant.

**Comparator group 3:** Entire group of 180 Ph.D. granting institutions nationally
- This group is important as many prospective graduate students will research institutions across the nation to take advantage of their best opportunities.
- The majority of our research funding comes from federal agencies meaning that we automatically compete in this group.

Our strategic plan is focused on improving our national ranking (Theme 2 from the campus plan is enhance reputation and raise visibility). The goal of achieving a higher ranking is not set for its own sake, but rather because it will address many issues that our faculty members are passionate about. The
quality of graduate students that we can attract depends on our national rank and visibility. It also affects the outcomes that we can provide our students (return on investment). Each time we receive approval to hire new faculty, the caliber of applicants is directly a function of our visibility and reputation. Increasing our recognition improves our success with securing research funding.

Our goal by 2020 is to increase our national ranking by 30 ranks through improved visibility and enhanced scholarly output, recognizing that this will help provide the best return on investment to students, employers, and research partners. Nationally, we are currently ranked outside the top 100 of the 180 Ph.D. granting departments by the National Research Council (NRC). NRC rankings are only published at long and irregular intervals, so our plan is to focus on the more immediate metric-based feedback available through Academic Analytics. A more detailed discussion of our rationale with respect to ranking and metrics is provided in Appendix A.

Broader specific objectives and their relation to the Campus Plan

A. Research

Our three year average for the total annual number of publications by the 18 tenured or tenure track faculty for the years 2009-2011 is about 62. However the output is extremely uneven. The top 6 individuals (33% of faculty) account for 80% of all publications. The top 9 individuals (50% of faculty) account for 90% of all publications. This means that the bottom half of the department account for only 10% of the total number of publications. The top 6 individuals can state without exaggeration that their individual output is greater than the combined effort of half the department. External funding is also very uneven. To address this:

- All faculty members pledged to publish at least twice per calendar year and present their work at least once per year at a national or international meeting. This refers to peer-reviewed high-impact journals appropriate to a given research area. Fulfillment of the pledge is a minimum requirement to be eligible for inclusion in any merit-based salary raise pool.
- Faculty having consistent difficulty meeting this goal will benefit from peer mentoring in project design and execution.
- Faculty lacking sufficient research funding should apply at every opportunity to the most appropriate agencies. Applications supported by recent publications have greater likelihood of success. The overall increase in our national profile (through our combined efforts) will help everyone. We strive to increase our annual research expenditures linearly from currently $2.3M to about $3.5M in 2020.
• We should proofread and provide suggestions for each other's proposals before they are submitted. Even senior personnel at National Labs (such as Argonne) are not too proud to have their proposals polished through internal review.

• Volunteer to serve on review panels (e.g. NSF or DOE). Contact your program managers to let them know that you are active in your area and available.

• Each faculty member will create a Google Scholar Profile to raise our visibility and help assess the impact of our work through citations.

B. Graduate Student experience and outcomes (meaningful interactions)

In order for our students to achieve the best possible outcomes we need to keep them on track to graduate in a reasonable number of years with excellent training and research experience. Our students contribute a great deal to our profile and reputation. Our students need to shine and somehow standout despite the fact that we are not yet a top 100 department.

• Strongly urge the campus to follow through on lever 4.5 (pg 89 of campus plan) which covers graduate student fee waivers. The importance of this cannot be overemphasized as we lose top students to other institutions (even within the UM system, e.g. Mizzou) every year as our offers are consistently $6,000-$8,000k less than other offers they receive.

• A glaring difference between us and our peers within the MASUA group of Midwestern Universities is the (low) percentage of graduate students that are supported as research assistants (RAs). Our goal should be to increase that percentage such that each student is afforded at least two years of research-focused activity, supported as an RA. Currently, graduate students are supported on average one year of RA.

• We propose that graduate student committees play a central role in assessing and guiding their progress. An annual meeting of the student with committee members should assess their plans including coursework and in terms of the progress and direction of projects, with an emphasis on publication of completed projects.

• Involve the students in manuscript preparation and encourage their interaction with outside collaborators.

• Discuss the (perhaps evolving) career goals of the student and develop a plan to facilitate success. Students planning to work in a particular industry should initiate and maintain industry contacts throughout their program in order to be aware of sought after qualifications as well as special opportunities.
• As a department we should be aware and proud of the work in other research groups. We should advertise, attend and celebrate each thesis defense.

• Some written rules already exist and should be adhered to and in some cases strengthened. We propose that a bare minimum of two published articles be required of each Ph.D. student before graduation. This is a stronger than our current (unenforced) requirement of two submitted or one accepted article.

C. Undergraduate Student experience and learning outcomes (meaningful interactions)

• Maintain American Chemical Society (ACS) Certification for all Chemistry BS degree programs. The continued certification of our BS degree programs (Chemistry, Chemistry with Biochemistry Emphasis, Chemistry with Polymer & Coatings Science Emphasis, Chemistry with Pre-medicine Emphasis) will assure national competitiveness and quality standards for our undergraduate education in chemistry. The ACS Committee on Professional Training (CPT) continuously updates certification requirements and evaluates all certified programs on a 5-year cycle. Our BS degree programs are currently under review by the CPT, so that the next evaluation and certification will be conducted in 2019.

• We will reenergize Chem 11 (Intro to Chemistry) to become a superior community-forming “101” course among our chemistry majors. We will offer meaningful face-to-face interaction of faculty and staff with students new to our programs (freshman and transfer students) and strive to motivate students to interact with each other in their study efforts. Chem 11 will include career counselling, research project discussions, and research laboratory visits. The success will be measured by surveys about student satisfaction with these points.

• Become a nationally recognized leader for buffet-model course redesign in general chemistry education. The buffet model offer students a variety of paths for achieving a sound level of chemical knowledge and conceptual scientific understanding. It has been developed and implemented for the first in a series of two general-chemistry courses targeting diverse learning needs in large-enrollment courses, enhancing learning outcomes, and saving instructional costs. We will develop additional online course material to assist in student learning and expand our enhanced Learning Enhancement Across Disciplines (LEAD) program to create an intense yet inviting and beneficial learning environment. Data from the redesign will be disseminated nationally and internationally through workshops, conference contributions, and journal publications.
D. Miscellaneous

- Begin planning for CBE (Chemical and Biochemical Engineering) to vacate Schrenk Hall. Have the space committee note the features and condition of each area. Begin discussions with Physical Facilities about renovation needs and the Chancellor about a renovation budget.
- Identify and pursue infrastructure improvement projects aimed at enhancing faculty research productivity and students’ experiential laboratory experiences.
- Revive the Missouri S&T Academy of Chemists and Biochemists. The Academy is mentioned in the news as recently as 2010 when seven new members including Professor Nuran Ercal were inducted. [http://news.mst.edu/2010/01/seven_inducted_into_missouri_a/](http://news.mst.edu/2010/01/seven_inducted_into_missouri_a/)
- Aggressively pursue support from alumni (through the Academy) for endowments, graduate student fellowships and equipment funds.
- Improve our seminar program. We need to recognize the importance of a high-quality seminar program and direct some necessary funds into it. Each division will be responsible for arranging one high-profile speaker per semester. Having top researchers from a variety of areas pass through our department could significantly enhance our reputation and visibility. This will only be successful if we all make the effort to meet with each candidate and attend the seminars. Some of our current filler seminars (e.g. how to use the library) should be moved to chem 411 for new graduate students.
- Coordinate the seminars with a more active local American Chemical Society (ACS) speaker program.
- Enhance interactions between academia and industries to stimulate collaborations. We should go beyond just asking industry partners for research funds. We should pursue student fellowships and ask for input into our degree programs. An industry supported student working on collaborative projects would be very employable after graduation.
- Showcase our work and talents. Everyone should have an attractive and informative faculty webpage and recent conference posters on displays in the Schrenk Hall hallways.
- Volunteer to meet prospective students at open-house events. We need to improve and update the materials that are distributed at these events. We need to compile information about our research groups and centers so that we are aware of all the opportunities that we can offer.
Relation to themes and levers in the campus strategic plan

At the campus level, four themes were identified: 1. inspire creative thinkers, 2. enhance reputation and raise visibility, 3. ensure return on investment and 4. increase meaningful interaction. Clearly the objectives and specific actions detailed above touch on all of the themes. Our main focus on improving our national ranking directly reflects theme 2, but the details of our plan impact all themes.

Here we emphasize some campus levers of particular significance:

- **Lever 2.3** (pg 39 of campus plan) notes that the annual average number of citations for our current 400 faculty is 14. The campus goal is to increase this to 20 by 2020 as a key measure of the relevance and impact of our research. The distribution of citation numbers among chemistry faculty is very uneven, yet just a few chemists contribute a large fraction of the campus total.

For example, just three chemistry professors (Drs. Long, Ercal and Switzer) account for nearly 1600 citations in 2013 (a significant fraction of the campus total). The campus average of 14 comes from some people contributing hundreds of citations while many have essentially zero. We believe that the most effective way to improve the campus average is to encourage more balanced participation. For an individual, there are tools that help us identify areas where we can have the most impact. We will use Google Scholar to help us recognize which of our projects are getting the most attention and in which journals.

- **Lever 2.3 (Action 2.3.2, pg 37)**: Choose 5 departments and track their national ranking. We propose being chosen as one of these 5. We are the second highest ranked department on campus and have a detailed plan focused mainly on this very objective.

- **Lever 2.5** (pg 49): Modify our conventional methods of teaching to accommodate current, new and advanced technology that will enhance student learning and increase faculty productivity. The expansion of our general-chemistry course redesign model and dissemination of the related learning outcome results closely address this lever.

- **Lever 3.1 (Action 3.1.2, pg 54)**: Identify and take action to improve national ranking. This is central to our plan.

- **Lever 3.5** (pg 69): Create and implement a student and alumni lifetime engagement strategy. Our engagement to revive and intensify activities of the Academy of Chemists and Biochemists and the Foundation of Chemical Research will pertain to this lever.

- **Lever 4.3**: We strive to enhance the innovative use of teaching technologies through the increase in number of courses that follow our successful redesign model in General Chemistry.
• **Lever 4.5**: (pg 89 of campus plan) covers graduate-student fee waivers. The importance of this cannot be overemphasized as we lose top students to other institutions (even within the UM system, e.g. UMC) every year as our offers are $6,000-$8,000k less than other offers they receive.

**Appendix A: National Rankings and Performance Metrics**

The National Research Council has published detailed statistics and rankings of 180 Ph.D. granting institutions in the US. One can freely download the report and the 35MB Microsoft Excel file of raw data. The report is also discussed in the weekly newsletter of the American Chemical Society (ACS): Chemical and Engineering News (C&EN). They have compiled statistics such as faculty publications, citations, and grants. Regarding our students they consider incoming GRE scores, student support, and outcomes including mean time to graduation, and employment. The data was collected in 2006 and published in 2010. The ranking uses two statistical measures (R- and S-rating) and provides a 5% and a 95% ranking for each measure. This comes from the uncertainty in the correlations used to determine the rankings and represents the most optimistic (5%) and pessimistic (95%) interpretations of the data. The R-rating reflects reputation, while the S-rating reflects the actual performance measures. Our most recent department rankings (placing out of the 180 departments) for the R-rating are 130 and 172 for the 5% and 95% measures respectively (average of 151). The corresponding S-rating measures are 91 and 157 (average of 124). The discrepancy between R and S ratings implies that our actual performance is slightly better than our reputation (we need to get the word out).

Another ranking used by some is that by the US News and World Report. We consider this a much less useful measure since it simply reflects a survey of department chairs collecting a single score ranging from 1 to 5 to rate each institution. “*Rankings of doctoral programs in the sciences are based solely on the results of surveys sent to academics in biological sciences, chemistry, computer science, earth sciences, mathematics, physics, and statistics during fall 2009. The individuals rated the quality of the program at each institution on a scale of 1 (marginal) to 5 (outstanding). Individuals who were unfamiliar with a particular school’s programs were asked to select don’t know.*” Moreover the response rate to the 2009 survey was only 25% meaning that the ranking reflects the opinion of fewer than 50 people. Therefore we favor metric based rankings. We urge our campus and other departments to focus on more quantitative and reliable measures such as *Academic Analytics* and *NRC*.

Table 1 compares our national ranking to other departments at Missouri S&T and the corresponding department at University of Missouri-Columbia (Mizzou) if there is one. Because the number of
departments varies for each discipline (e.g. 180 chemistry, 162 physics, 127 mathematics), a normalized \textit{percentile} ranking was used. The percentile R and S-rankings express the average of the 5\% and 95\% ranking for each measure normalized to the number of departments.

\textbf{Table 1: National rankings of S&T departments (bold) and corresponding departments at Mizzou. Departments are ordered by S-ranking percentile (performance based), with R-ranking percentile in parentheses (reputation based).}

<table>
<thead>
<tr>
<th>Department</th>
<th>S-percentile (R-percentile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math (Mizzou)</td>
<td>36.6 (49.2)</td>
</tr>
<tr>
<td>Geo (Mizzou)</td>
<td>49.6 (75.0)</td>
</tr>
<tr>
<td>Soil (Mizzou)</td>
<td>52.1 (62.0)</td>
</tr>
<tr>
<td>Chem. (Mizzou)</td>
<td>60.3 (60.3)</td>
</tr>
<tr>
<td>Mech. (Mizzou)</td>
<td>61.3 (68.4)</td>
</tr>
<tr>
<td>Material Sci. Ceramics</td>
<td>62.5 (80.4)</td>
</tr>
<tr>
<td>Eng. Manag. (Mizzou)</td>
<td>66.2 (48.6)</td>
</tr>
<tr>
<td>Physics (Mizzou)</td>
<td>66.7 (69.1)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>68.9 (83.9)</td>
</tr>
<tr>
<td>Civil (Mizzou)</td>
<td>69.5 (74.0)</td>
</tr>
<tr>
<td>Mechanical</td>
<td>69.9 (86.7)</td>
</tr>
<tr>
<td>Elec. And Comp.E</td>
<td>77.2 (64.7)</td>
</tr>
<tr>
<td>Elec. (Mizzou)</td>
<td>77.9 (77.2)</td>
</tr>
<tr>
<td>Math</td>
<td>81.1 (75.6)</td>
</tr>
<tr>
<td>Civil</td>
<td>83.6 (36.6)</td>
</tr>
<tr>
<td>Material Sci. Metallur.</td>
<td>88.1 (91.7)</td>
</tr>
<tr>
<td>Physics</td>
<td>88.9 (91.7)</td>
</tr>
<tr>
<td>Eng. Management (systems)</td>
<td>89.9 (85.1)</td>
</tr>
<tr>
<td>ChemE</td>
<td>90.1 (83.5)</td>
</tr>
<tr>
<td>Earth Sci. Geo. And geophys.</td>
<td>90.1 (88.4)</td>
</tr>
<tr>
<td>Earth Sci. Geo. E</td>
<td>96.5 (97.9)</td>
</tr>
<tr>
<td>Material Sci. Mining</td>
<td>98.2 (98.2)</td>
</tr>
<tr>
<td>ChemE (Mizzou)</td>
<td>98.6 (92.9)</td>
</tr>
</tbody>
</table>

The data in Table 1 show that our S-ranking of 124/180 chemistry departments places us in the 69\textsuperscript{th} percentile which is the second highest ranked department on the S&T campus. Most of the departments at Missouri S&T are ranked below their Mizzou counterparts. Most of the S and R rankings are similar, but the fact that Chemistry has a better S than R-ranking, suggests that we can hope to see an improvement in our R-ranking the next time the rankings are determined.

Within our first comparator group (the Missouri system) we are slightly ahead of UMSL and UMKC who are ranked in the 70\textsuperscript{th} and 73\textsuperscript{rd} percentiles respectively. We are significantly behind Mizzou (60\textsuperscript{th} percentile).
• We determined and plotted correlations between all metrics used by the NRC as a function of national ranking. Average number of peer-reviewed publications per faculty has the strongest correlation, no serious outliers, and is directly within our control. No department averaging 4+ publications per faculty is ranked outside the top third (60/180).

• Our current average output is about 3, meaning that a relatively small increase is expected to make a big difference. (slope of the correlation is -29.5 ranks/publication)

• Our plan is to focus on this measure in order to be ranked at least 95/180 (53rd percentile nationally) by 2020, surpassing Mizzou in the process.

• A linear increase in number of publications per TT faculty member is expected so that we will increase our base value of 3.0 to 3.3 in 2016, 3.7 in 2018, and 4.0 in 2020.

Due to the irregular availability of new NRC rankings and the significant lag time between collection and publishing of data, we will focus on results from Academic Analytics. Also, we participate in annual meetings with peer institutions in the Midwest (Mid-America State University Association, MASUA) and can track our progress relative to our second comparator group. Since the NRC S-rating simply reflects our performance in each category, we can monitor those metrics continuously. Using tools such as Academic Analytics and Google Scholar Profiles we will take stock of our status at the end of each year.

1 http://www.nap.edu/rdp/