Division of Chemistry (CHE) Response to Findings and Recommendations of the Committee of Visitors

February 7-9-2007, updated Jan 2010

The Division of Chemistry is grateful to the COV for their thoughtful work and participation, and especially to Geri Richmond, the Chair, for her leadership. The engagement of all participants was evident, the environment was open and the process proceeded with the highest integrity. CHE thanks Morris Aizenmann for serving as the COV monitor on behalf of MPS, and MPS leadership Tony Chan and Judy Sunley for their advice, participation and receptivity.

1. The COV urged CHE to develop a Strategic Plan to guide the Division over the next few years as well as further into the future. The vision for the Strategic Plan is broad and includes intellectual pursuits as well as workforce development, tool development and organizational excellence. The COV urged CHE to include topics such as: scientific goals and benchmarks to allow measurement of progress, how to better articulate the high value of the current research that is being done, goals for the chemical workforce including students, postdoctoral fellows and the professoriate, goals for grant size, grant duration, number of grants and special funding modes such as SGERs and Creativity Extensions, guidelines to determine the optimal mix of single investigator grants and other modalities such as small groups and centers, goals for Division staffing and succession planning, and a plan for broadening participation of under-represented groups in all Division activities. The COV also urged CHE to consider a strategy for continued improvement and transparency of merit review: recruitment of diverse and competent reviewers, educating reviewers about programs and NSF review criteria, educating PI's about merit review, and the training and mentoring of program officers. The COV also urged CHE to include a strategy for robust support for instrumentation and instrument development, assessment of effects of the loss of cost-sharing, and education of the community about instrumentation issues and opportunities.

The COV urges CHE to develop and implement assessment tools as part of the Strategic Plan. These would be applied to assess new programs such as the CCIs, CRCs, CRIFCyber, and URCs. The COV recommends that CHE assess the use of the "Broader Impacts" review criterion by reviewers and program officers, and assess the success of the broader impacts aspects of funded work. With the new submissions windows for unsolicited proposals, the COV would like to see an assessment of how the new structure works out for the community and the Division.

Finally, the COV urges CHE to consider its strategic partnerships, such as with other disciplines and with other countries.

RESPONSE: The Division of Chemistry agrees that developing a Strategic Plan is an excellent idea. The Division Strategic Plan will align with those of the NSF and the MPS Directorate. The Division will produce a timeline within one month for the steps to be taken in formulating the plan. The vision is that there will be a great deal of community input (e.g. Town Halls and a website open for comments from the public). The Division leadership has already contacted the NIGMS to coordinate with their current strategic plan exercise. Since the time of the COV, the Division's "Plan for Broadening Participation" has been approved by the NSF administration for public distribution, and this will become part of the Strategic Plan. CHE

aims to complete its Strategic Plan by the end of 2007, and will attempt to make significant progress in achieving the goals by the time of the next COV in 2010.

FY2008 Response: The Division of Chemistry has moved promptly to draft *Strategic Directions: 2008-2012* that is currently available for review by the community. Eight critical issues were identified using a SWOT analysis and extensive community input via Town Halls, Dear Colleague Letters, the web and comments via email. These critical issues include advancing American competitiveness, communicating the value of chemistry and chemical research to the public, increasing global engagement, increasing grand challenge research through centers, broadening participation, addressing funding needs of investigators across career stages, assessing the impact of the broader impacts review criterion, and updating the Division of Chemistry structure.

The Division's Plan for Broadening Participation is an important and integral component of *Strategic Directions: 2008-2012*. We expect that *Strategic Directions: 2008-2012* will be finalized no later than September 30, 2008.

FY 2009 Response: *Strategic Directions: 2008-2012* continues to be a valuable guiding document for the Division of Chemistry. In FY 2009, CHE tackled the challenge of the divisional structure and produced a "realigned" structure that better reflects current chemistry research. Input from the research community and CHE staff were essential to the process and the outcomes. The newly realigned programs will be implemented in FY 2010. Other outcomes to date include the expanding *International Collaborations in Chemistry* Program; a pilot assessment of the broader impacts criterion; several workshops on innovation, intellectual property issues, and academic-industry partnerships; and leadership activities in broadening participation. An update on the *Strategic Directions: 2008-2012* is attached at the end of this response.

2. The COV recognized that the ability to tackle transformational fundamental chemistry is being severely compromised by the shrinking dollar in CHE grants. There is a sense in the report that the grant size (and therefore the supported research group size) is subcritical.

RESPONSE: This is a serious matter and the Division recognizes the problem and the challenge. This will be addressed in the Strategic Plan.

FY2008 Response: Strategic Directions: 2008-2012 recognizes the challenges of optimizing our investments considering grant size, duration and success rate. Programs may consider the use of Small Grants for Exploratory Research (SGERs) and Creativity Extensions to encourage potentially transformative research. The new funding modality of the Centers for Chemical Innovation was developed specifically to address grand challenge, potentially transformative research.

FY2009 Response: CHE continues to try to meet the challenge of balancing award size, award duration and success rate. This is a challenge agency-wide and depends ultimately on the budget the division receives, as well as NSF and division priorities. CHE tries to maintain award size with a small increase on renewal, and CHE continues to be among the larger average award sizes agency-wide. The CHE award duration and success rate is close to the agency average. Despite great effort, CHE has not succeeded in arguments for substantially more funds for the subdisciplinary research programs. However, CHE has

been successful in obtaining new funds for large projects such as centers and facilities, providing new resources for the chemistry research

One NSF goal for ARRA funding was to increase the success rates for all types of proposals, and this was achieved in CHE for FY 2009: research proposals had a success rate of 32% in 2009 vs. 26% in 2008.

3. The COV strongly endorsed the continued emphasis on single investigator grants. The COV warns that new funding modalities such as Collaborative Research in Chemistry (CRC) should be watched carefully so as to not erode the single investigator grants. On the other hand, some members of the COV believe that the establishment of centers may be one way to expand Chemistry's reach, a goal that all supported provided that single investigator grants are not eroded.

RESPONSE: The Division is sensitive to the community's concern about preserving the single investigator "core" but is also sensitive to an increasing number of younger PIs who favor research work in small and large groups. The current plan is to continue to offer the community the possibility of submitting the best scientific ideas in all areas through one of three modalities: as single investigators, as small groups and as larger groups (in centers). The ultimate balance of these three funding modalities will be monitored closely but it will be determined by proposal pressure and quality and thus by the chemistry community. The Division believes that increasing the number and nature of interdisciplinary centers is important, both to provide strong scientific synergism and to increase the Division's ability to increase its funding level. Increasing the number of chemistry centers will only be considered if budgets grow so as not to erode existing single investigator grant support. The issue will be carefully addressed in the Strategic Plan.

FY2008 Response: The Division remains firmly committed to supporting small collaboratives as part of our core research activities. As part of our "Structure" discussion in *Strategic Directions: 2008-2011,* the Division has decided to transition collaborative research into the disciplinary research programs and discontinue special solicitations for collaboratives. Future COV's will be asked to evaluate the Division's internal processes to ensure that both individual and collaborative proposals receive a thorough and fair review and that the disciplinary programs are maintaining a healthy the balance of individual and collaborative awards in the portfolio.

FY2009 Response: Proposals supporting small teams of researchers continue to be reviewed and supported (where meritorious) within the disciplinary research programs. The budget for the Centers for Chemical Innovation Program is increasing as more Phase II CCI's are brought online. This increase in Centers funding has not eroded support for the disciplinary research programs, and provides increased support for the chemistry research community.

4. The COV very strongly recommends that the Division examine its written feedback to the PIs and improve the communications so that the PIs, especially ones that are declined, have enough information to improve their proposals. The COV repeated the advice from the 2004 COV, namely that some version of the Review Analysis be sent to the PI. The COV repeated the criticism of the 2004 COV that some panel summaries were inadequate and the value-added of panels was questioned in some cases.

RESPONSE: The Division will look into the matter of sending "Program Officer Comments" or a version of the Review Analysis to the PIs (edited to remove confidential or sensitive information). There are workload issues that are associated with writing "Program Officer Comments" (these would have to be quite carefully written due to sensitivity, confidentiality and legal reasons), and the idea will be re-examined now that the present staffing structure is somewhat improved over that in 2004. The Division will address the criticism related to panel summaries and will implement new measures (in addition to those undertaken after the 2004 COV) to improve the quality and depth of these documents. The Division will carefully scrutinize the use of panels to be sure there is value-added.

FY2008 Response: A few CHE programs will pilot the use of "Program Officer Comments" in Spring 2008 to provide timely and useful feedback to the PI. Community response and PI workload impacts will determine if this is an effective communication tool. All Program Officers remain committed to clear and open communication with their PIs and encourage direct PI-PO conversations via email, telephone and in-person visits.

FY2009 Response: Following the successful pilot in FY2008, all Programs are using "Program Officer Comments" to provide timely and useful feedback to the Principal Investigators. This is a major change in our practices, and we appreciate the suggestion from the 2007 COV. We continue to encourage direct PI-PO conversations via email, telephone and in-person visits.

The use of panels continues to be discussed in CHE, particularly now in the context of the newly realigned programs and increased proposal pressure. We encourage panelists to write substantive and useful panel summaries and believe that the quality and depth of these documents has improved.

5. The COV repeated the 2004 COV opinion that the Broader Impacts review criterion is sometimes not addressed and there is confusion about it on the part of the PI's and the reviewers. They said that further education by CHE and MPS is essential to clarify what is meant by Broader Impacts, and how broadening participation plays in. RESPONSE: CHE has tried very hard to inform the chemistry community about Broader Impacts, including a symposium held at the National ACS Meeting in Washington DC in August of 2005 and a page on the CHE web site. The Division will continue to develop outreach and disseminate the materials that have been prepared to educate the community about Broader Impacts, including broadening participation. CHE has led and will stay involved in the conversations throughout the Foundation about the Broader Impacts criterion and broadening participation, and will examine this important issue in its Strategic Plan.

FY2008 Response: CHE has launched a pilot assessment of broader impact activities. We expect that this assessment will inform both the division and the community. CHE has also provided an updated Dear Colleague letter (NSF 08-044), sample Highlights focusing on Broader Impacts, and other materials.

FY2009 Response: CHE's interest in this topic predated the America COMPETES Act language that NSF should assess the broader impacts criterion. CHE engaged a research contractor, AIR, Inc., to conduct a pilot study on 45 randomly selected CHE awards. The proposals, review materials, annual reports and final reports were studied and analyzed for evidence of broader impacts. The study was useful in developing some protocols but the conclusions fell short of the level CHE would like to see. The pilot was brought to the attention of the National Science Board in December 2009 as an example of one approach

towards this challenging problem. CHE continues to be interested in this area and will decide on next steps.

6. The COV strongly supports the Research Experience for Undergraduates Program and the Instrumentation Programs, and believes that the Instrument Development Program should be augmented.

RESPONSE: The Division agrees with the COV about the importance and impact of the REU program and increased the level of support for FY 2007 substantially. Future budgetary increases will be considered. CHE will also respond to proposal pressure in the Instrument Development Program and continue to fund meritorious proposals with budgets deemed appropriate by the reviewers and Program Officers. CHE will develop outreach with regard to advertising the Instrument Development opportunities.

FY2008 Response: Instrument Development continues to be an exciting and productive area for CHE. A workshop focused on identifying opportunities for instrument development at the chemistry-biosciences interface is planned for summer 2008. This workshop is cosponsored with NIH and the NSF Division of Biological Infrastructure.

The Division maintains its strong support of the REU Program. A growing part of our REU portfolio is international REU Programs (iREU). In FY08, we are supporting six international REU Programs, sending 60 US students to great research opportunities in eight different countries.

FY 2009 Response: CHE was able to generate considerable ARRA funds in FY2009 for Instrument Development (CRIF, MRI, and MRI-R2). We plan to transition instrument development from the CRIF Program to the Chemical Measurement and Imaging Program over the next three years. The workshop on instrument development at the chemistry-biosciences interface identified opportunities for the community and was key in identifying the needs for research in magnet-based instrumentation.

The REU Program remains a vibrant part of the CHE portfolio. Fifty-eight REU sites supported approximately 600 students in summer 2009. The program has a healthy mix of traditional departmental REU sites as well as interdisciplinary REU sites and international REU sites.

7. The COV is in favor of increasing the number of on-site permanent Program Officers. RESPONSE: We are in the process of selecting 3 (maybe 4) permanent program officers and that will increase the number to 8 (maybe 9), essentially half the total number of program officers. The Division will consider increasing the number of permanent program officers by an additional 1-2 in the future, but considers a 50:50 ratio of permanent:rotator to be a good initial goal. The present focus is having Program Officers on-site (versus off-site at their home institution) so that the Division can provide leadership in the many interdisciplinary and cross-cutting activities in the MPS.

FY2008 Response: CHE was able to increase the number of permanent program officers to eight over the past year and is currently advertising for additional permanent staff. We continue to seek excellent chemists as rotational and permanent CHE staff.

FY2009 Response: CHE currently has nine permanent program officers and continues to seek excellent chemists to add to the permanent and rotational staff. CHE is very pleased with the outcomes of the CHE-MCB shared program director position and has recruited a CHE-DMR shared program director in FY2010.

8. The COV challenged CHE to achieve 80% of proposals finished in 6 months.

RESPONSE: Bring it on!

FY2008 Response: CHE is delighted that it was able to meet this challenge in FY2007, finishing 82% of its 1579 actions in less than six months.

FY2009 Response: CHE continued to meet this challenge in FY2008, with 81% of its 1700 proposals completed in less than six months. The unique situation created by the 2009 budget cycle and ARRA led to slightly processing times – the average time-to-decision was 7.21 months. Due to the historically high workloads caused by ARRA, NSF decided to disband the 6 month goal for processing proposals for 2009.

Update on the NSF Division of Chemistry Strategic Directions: 2008-2012

In the year following the last COV, CHE staff developed *Strategic Directions 2008-2012* with significant input from the research community, stakeholders, partners, and NSF staff. The strategic planning process identified eight key issues. The full strategic plan can be found at http://www.nsf.gov/mps/che/CHE_StrategicDirections.pdf. An update on our progress on these eight critical issues is provided below.

Advancing Competitiveness

CHE is providing leadership to the community in identifying and promulgating industry/university collaboration mechanisms that work. CHE sponsored a series of workshops starting in December 2006 with academic and industrial leaders, a 2008 workshop on industry-university partnerships and intellectual property issues, and a 2009 workshop on the impact of science research and development and how to "right-size" the national investment in chemistry. The report on the first workshop is available on the CHE website at http://www.nsf.gov/mps/che/c_publications_and_reports.jsp; Reports on the latter two workshops will be available by April 2010. The series has identified useful and important directions for future scholarship and implementation in these areas.

To help prepare students to become innovators, entrepreneurs and industrial chemists, CHE initiated a post-doctoral program called American Competitiveness in Chemistry Fellows. The ACC Program resulted in 18 awards in FY 2008-2009. CHE also piloted an Innovation Workshop for 35 students and postdoctoral researchers in connection with the CCI Program.

Communicating the Value of Chemistry and Chemical Research to the Public

In an effort to engage our awardees by showcasing and publicizing the results of their NSF-funded work, CHE dedicated 50% of an FTE for a science assistant to write press releases and news items in conjunction with the NSF Office of Legislative and Public Affairs (OLPA). These were picked up by the Washington Post, Scientific American, NOVA, ABC, CNN, NBC, Federal News Radio and FirstScience.com.

An episode of the popular television show CSI Miami featured the transformative developments in mass spectrometry by one of our PIs, Graham Cooks of Purdue.

To generate content for OLPA activities (including Hill briefings and budget documents), CHE posted a "Best Practices for Writing and Formatting Highlights" document to guide PIs in preparing highlights publicizing their research and educational activities http://www.nsf.gov/mps/che/nuggets/highlight-writing.pdf. The CCI program produced a "Highlights Road Show" – a half day workshop for PIs and students about writing highlights offered initially at several CCI sites.

CHE supported two pilot activities related to public science communication. A CHE awardee sponsored a competition in public communication of chemistry; The eight winners are posted at http://research.chem.psu.edu/resgroup/. Another awardee developed an intensive workshop in communicating chemistry to broader audiences http://faculty.washington.edu/illman/. This pilot was developed for postdoctoral researchers, but may be extended to other groups of chemistry researchers.

Increasing Global Engagement

Partnering with the NSF Office of International Science and Engineering (OISE), CHE initiated and expanded the International Collaboration in Chemistry program in collaboration with Germany, China, the United Kingdom, France and Austria between 2007-2009. Japan, Russia, France, Luxembourg and Spain were added in FY2010. Over the period 2007-2009, 51 collaborative projects were funded by CHE, resulting in a US investment of $22.5M (the corresponding investments by the partner countries are not included). CHE also co-sponsored OISE-led Partnerships in International Research and Education in chemistry.

The Division Director led the development of a group of chemistry funders in five countries in conjunction with IUPAC. CHE is participating in a joint IUPAC call for polymer proposals involving researchers from at least three participating countries. A number of joint workshops were held with other countries to help develop collaborations, some with a focus on new investigators – US-China workshops on energy, materials and supramolecular chemistry, participation in a "sandpit" on synthetic biology with the UK, and a joint workshop on energy with the UK, Germany, China, and Japan.

CHE encourages U.S. students to gain global experience by going abroad for part of their study by sending REU students to Asia, Europe and South America (~170 students conducted undergraduate research in 10 countries during 2007-2009). CHE is also engaged with the community in preparing for the International Year of Chemistry in 2011.

Increasing Grand Challenge Research through Centers

CHE has been successful in making the case for increased funding to support transformative basic chemical research on the "grand challenges" through the Centers for Chemical Innovation Program (CCI). Three Phase II centers have been established and are generating high profile accomplishments. Nine Phase I awards are in the pipeline, allowing groups to develop research, education, outreach, diversity, innovation and management plans to effectively compete for a Phase II Center. The CCI Program has grown from $3M to $15.5M from 2007-2009, entirely on new funds (not taking from the other modes of funding in the division). The Program has engaged the Science and Technology Policy Institute to plan an assessment of the program.

Broadening Participation

CHE sponsored (with DOE and NIH) a series of broadening participation workshops for top-50 department chairs (Gender in 2006, Minorities in 2007 and Persons with Disabilities in 2009). Each of these workshops has or will produce a report for the community. The reports will also inform CHE's future efforts.

CHE has encouraged the academic community to develop departmental plans for broadening participation and now requires (as of 2008) the department plan as part of all its CRIF-MU proposals. ACC-Fellows proposals also contain plans for broadening participation.

CHE sponsors COACh, an organization working to advance women in academic chemistry departments. More recently, COACh expanded to other disciplines such as physics and materials, and to other countries.

REU sites are actively working to broaden the participation of talented undergraduates from underrepresented groups. The sites have varying strategies including strategic recruiting, partnering with minority-serving institutions, and partnering with Louis Stokes Alliances for Minority Participation. These partnerships have resulted in a cohort of 650 REU-supported undergraduates per summer, with 51% female participants and 30% from underrepresented groups.

CHE has its own plan for broadening participation on the CHE website http://www.nsf.gov/pubs2007/nsf07021/nsf0721.pdf , and reports yearly to the MPS leadership and to the Division on outcomes. CHE developed a panel presentation on implicit bias in evaluation that is presented to every CHE panel and has been adopted by many other NSF divisions.

Addressing Funding Needs of Investigators across Career Stages

The community voiced concerns about possible underrepresentation of Mid-Career Faculty (MCF, 10-25 years post-PhD) awardees proportionate to their relative numbers in the academic community. This aspect of the strategic plan has not been studied yet. One possible approach is to encourage high risk/high reward (transformative) research especially for MCF.

Assessing the Impact of the Broader Impacts Review Criterion

CHE engaged a research contractor, AIR, Inc., to conduct a pilot study. Forty-five CHE awards were chosen randomly and the contents of the proposals, review materials, annual and final reports were studied. Significant methodology issues were identified, making it difficult to draw clear conclusions from this pilot. The study was brought to the attention of the National Science Board in December 2009 as an example of one approach towards this challenging problem.

Updating the Division of Chemistry Structure

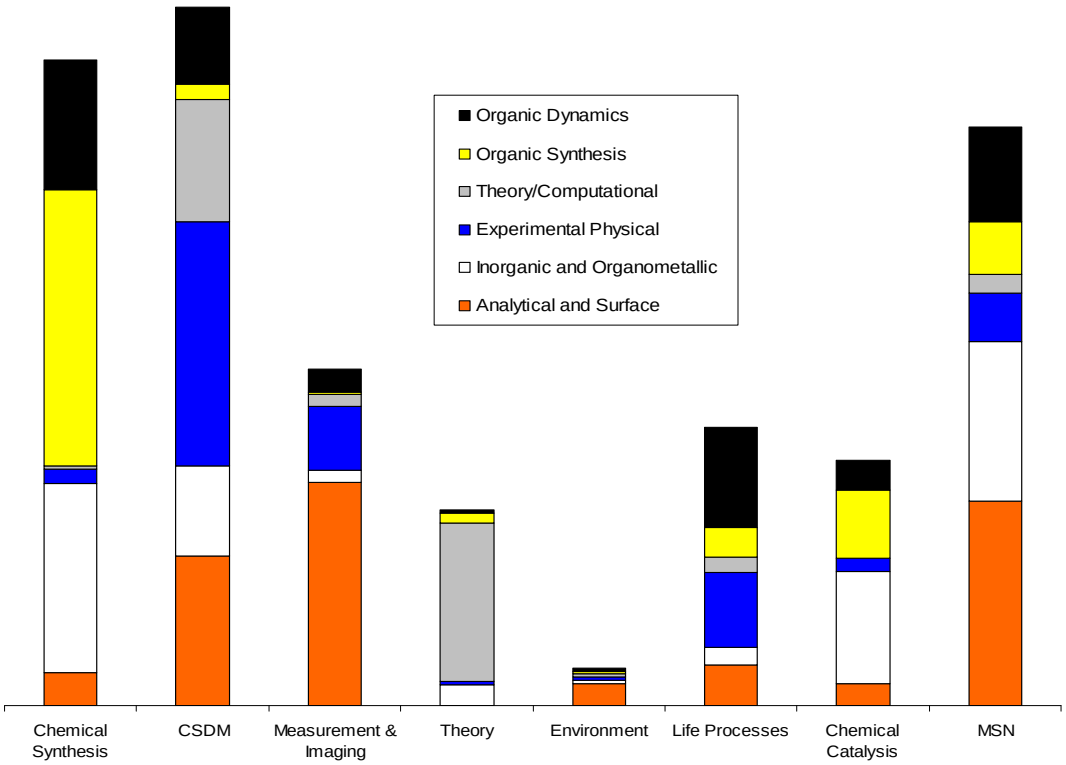
The 2004 and 2007 CHE COV's suggested that CHE consider updating its structure. The goal was to structure CHE to best anticipate and respond to scientific needs and to achieve transformative research in chemistry. CHE obtained community input at ACS Town Hall Meetings (2007, 2008, and 2009), surveyed of chemistry department chairs and solicited input through the web. The landscape of research in chemistry was described through a scientometrics (citations index) study providing maps of chemical research. Multiple groups were consulted both internally (advisory committees, other divisions, policy office, etc.) and externally (including other federal agencies that fund chemistry). CHE staff designed the

realigned structure and handled the implementation and communication at all levels. The realignment resulted in eight new programs implemented in July 2009. The response that CHE received from the community was largely positive and the initial implementation has been successful. Four programs in particular provide point sources for interdisciplinary work, enabling more effective interactions with other divisions.

The eight new programs are:

- Chemical Catalysis (CAT)
- Chemical Measurement and Imaging (CMI)
- Chemical Structure, Dynamics and Mechanisms (CSDM)
- Chemical Synthesis (SYN)
- Chemistry of Life Processes (CLP)
- Environmental Chemical Sciences (ECS)
- Macromolecular, Supramolecular and Nanochemistry (MSN)
- Theory, Models and Computational Methods (TMC)

Additional information on the realignment, including program descriptions for the new programs, is available on the CHE website: http://www.nsf.gov/chem. An analysis of the anticipated redistribution of proposals is shown below. This analysis has allowed us to plan our scientific staffing and ensure that these new programs have an appropriate mix of staff expertise.



Most of interdisciplinary proposals considered by CHE occurred at the borders of the division with the Divisions of Molecular and Cellular Biology (MCB) and Materials Research (DMR). Joint program officers were hired with 50% appointments in each division (CHE-MCB in 2008-2009 and CHE-DMR in 2010). The experiment with the CHE-MCB joint officer was very productive and led the way to the formation of the Chemistry of Life Processes program in CHE.