# Committee of Visitors Report

Department of Energy
Advanced Scientific Computing Research
Applied Mathematics Program FY10-12

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## Committee of Visitors

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# Executive Summary

The DOE Advanced Scientific Computing Research Advisory Committee was requested by Dr. Brinkman to assemble a Committee of Visitors to review the management processes for the Applied Mathematics elements of the ASCR program. In the charge, the COV was asked to consider and provide an evaluation of the following two major program elements of the Applied Mathematics Program:

- For both the DOE laboratory projects and the university projects, assess the efficacy and quality of the processes used to:
  a) Solicit, review, recommend, and document proposal actions, and
  b) Monitor active projects and programs

- Within the boundaries defined by DOE missions and available funding, comment on how the award process has affected:
  a) The breadth and depth of portfolio elements,
  b) The degree to which the program is anticipating and addressing emerging challenges from high performance computing and DOE missions, and
  c) The national and international standing of the program with regard to other applied mathematics research programs that are also focused on the demands of high performance scientific computing and analysis of massive datasets.

In response to this charge, the COV met on July 22-23, 2013 at the DOE facility in Germantown, MD. During this meeting, the ASCR staff gave several presentations describing the overall program and the processes used in the selection of new proposals. The COV would like to acknowledge the ASCR staff both for their outstanding support and their willingness to provide all needed materials for this COV to accomplish its task.

With regard to the specific questions the COV has several summary findings and recommendations.

Overall, the Committee finds that the Applied Mathematics Program is highly effective in its processes to solicit, review, recommend, and document proposal actions. Some specific recommendations include:

1. **A significant number of new investigators have been funded by the program in recent years. The COV recommends that the program managers continue to look for ways to enhance the program's ability to attract new investigators, while seeking to maintain the overall excellence of the program.**

2. **The COV recommends that program managers be allowed to travel as needed to scientific meetings. Communicating with the research community is essential to maintaining the program's vitality and is especially important to attracting new investigators to the program.**

3. **Regarding the CSGF program, the COV concurs with the 2011 report in recommending that the focus of the program be expanded and funding doubled over the next five years. The COV observes that it is critical that the graduate fellows are placed in projects that are related to the priorities of DOE. Consequently, the COV also recommends that the CGSF remain within ASCR to**

**enable appropriate placement of graduate fellows and not be moved to the National Science Foundation.**

4. **The COV recommends that funding rates for Applied Mathematics Program solicitations be made publicly available. This information would be useful to prospective proposal submitters.**

The COV finds that the Applied Mathematics Program managers do an excellent job of monitoring all aspects of their portfolios including awards, projects, and overall programs. Both the University and Laboratory programs have a requirement of annual progress reports that help to document the accomplishments made by the PIs. In addition, the Applied Math Program has an annual PI meeting that is attended by over 200 researchers, postdocs, and graduate students. Some specific recommendations include:

1. **The COV recommends adding an annual center directors meeting In order to enhance linkages among the three Mathematical Multifaceted Integrated Capability Centers (MMICCs). The meetings could serve to highlight technical achievements and open problems could be shared to enable opportunistic collaborations. Additionally, it could serve as a forum to share lessons learned about effective center management.**
2. **The COV recommends instituting the use of a standard reporting format for the annual progress reports, including length and description of information to be provided.**

The overall breadth and depth of the Applied Mathematics portfolio is excellent. The MMICCs constitute a bold program initiated in 2012 to enable highly innovative research that can impact DOE mission efforts in five to ten years. Two other recent targeted solicitations, Mathematics for Analysis of Petascale Data and Advancing Uncertainty Quantification (UQ) in Modeling, Simulation, and Analysis of Complex Systems, illustrate the evolution of the Applied Mathematics portfolio to include important and mission-relevant new science thrusts. Some specific recommendations include:

1. **The COV recommends that ASCR develop a short-term visitors program with the MMICCs, with concomitant funding, to enable promising researchers to develop collaborations with center members. Even with a relatively modest investment, such a program holds the potential for greatly increasing the scale and scope of new capabilities developed at an MMICC by leveraging research supported in large part through universities and other agencies. It may also help to bring new researchers into the Applied Mathematics Program.**
2. **The COV recommends investigating the addition of a new interdisciplinary program of applied mathematics-statistics-computer science-facilities that could drive the next generation of fundamental research broadly applicable to the analysis of experimental/observational facilities data.**
3. **The COV recommends that ASCR continue its outreach efforts to professional societies and research communities through sponsored workshops and conference attendance, as these are critical to program development.**

The DOE ASCR office has a long and rich tradition of supporting some of the best applied mathematics research in the nation, especially with regard to applications arising from the DOE mission. The Applied Mathematics Program also maintains an international leadership position in certain key mathematical areas. Some specific recommendations in this area include:

1. **The COV recommends that the review and annual reporting process for the MMICCs include a listing of awards and accolades received by the project participants with brief summaries indicating the associated technical achievements. This report can be used to highlight the leadership role of the MMICCs.**
2. **The COV recommends that the Applied Mathematics Program develop a set of key mathematical areas that will have the greatest impact on the DOE mission and in which they can either currently claim or plan to develop international leadership.**

# Table of Contents

# Efficacy and Quality of the Program's Processes

## Processes to solicit, review, recommend, and document application, proposal, and award actions

**Targeted Solicitations (MMICCS, UQ, RX-Solvers)**

The ASCR Office received proposals for the first competition to fund Mathematical Multifaceted Integrated Capability Centers (MMICCs) in 2012. Three such centers were funded after completion of a two-phase review process. The goal of the solicitation was to encourage "*applications for basic research that addresses grand challenges of increasing complexity within DOE's mission areas of energy, environment and security, from a mathematical perspective that require new integrated, iterative processes across multiple mathematical disciplines. This Funding Opportunity Announcement (FOA) will holistically address mathematics for increasingly complex DOE-relevant systems for scientific discovery, design, optimization and risk assessment*." The solicitation received a total of 48 pre-applications that were reviewed to assess relevance to the DOE mission and responsiveness to the areas of priority indicated in the solicitation. Of these 48 pre-applications, 14 teams were encouraged to submit a full proposal. Following a thorough peer-review, three projects were selected for funding.

Six projects were awarded in 2010 through the solicitation entitled Advancing Uncertainty Quantification (UQ) in Modeling, Simulation, and Analysis of Complex Systems. This solicitation was done in the traditional way, with announcements on the program web pages and the use of federal program web sites. Laboratories were also able to use an internal laboratory point of contact with the program managers that provided more direct communication. The UQ solicitation resulted in 119 full proposals resulting in 90 distinct projects. The program managers deemed 26 projects out of scope, resulting in 64 projects that were reviewed using a rigorous process of panel and mail-in reviews. The committee noted that the Applied Mathematics office gave considerable attention to constructing a review panel that had broad multi-disciplinary coverage to allow fair and complete review of the proposals. All documentation of the review process and decisions was collected in a protected document repository. Overall, the committee was impressed with the rigor applied to the proposal review and decision process.

The final targeted solicitation released in June 2012 was a funding opportunity announcement (FOA) for "RX-Solvers" that received applications near the end of FY2012. This call focused on, "... basic research in Resilient Extreme-Scale Solvers ("RX-Solvers") that demonstrably advances the state of science and practice for scalable, resilient, extreme-scale numerical algorithms, to enable scientific discovery on the supercomputers expected to come online in the next 5-10 years and lay the foundation for research in numerical algorithms for extreme-scale scientific computing". As with the other targeted solicitations, a workshop was held prior to the release of the FOA to garner input from the laboratory and university research communities. Peer review of the proposals was held in FY2013, but at the time of this committee's meeting no decisions had been made on awards. However, approximately five awards are expected to be made during the FY2013 fiscal year.

**Unsolicited Proposals (PDEs, Optimization)**

Unsolicited proposals from universities are accepted through the ASCR Annual Notice publicly posted on the Office of Science web site for funding opportunities. Unsolicited proposals typically represent the culmination of a process in which a prospective principal investigator (PI) first informally discusses a research idea with a program manager. If encouraged, the PI would submit a short "white paper" fleshing out the idea in more detail. Finally, if further encouraged, the PI would submit a full proposal.

Consistent with Office of Science policy, each unsolicited proposal is reviewed by at least three "mail reviewers." These are chosen with an eye toward their expertise in the area of the proposal. From input available to the COV, it appears that the pool of potential reviewers is sufficiently broad to provide balanced reviews drawing on appropriate expertise while avoiding conflicts of interests.

Proposals are reviewed in a timely fashion, typically within six months of submission. Program officers make the case for funding recommendations through a written selection statement that summarizes the strengths and weaknesses of the proposal. The selection statement along with the reviews themselves are then considered by upper management. For both funded and declined proposals, appropriately sanitized reviews (with inappropriate information redacted, e.g., comments that identify the reviewer or other submissions) are provided to investigators.

Unsolicited proposals from laboratories are accepted through a laboratory counterpart of the Annual Notice. These proposals, which include renewal proposals for laboratory projects, are reviewed by panels of experts in the subject areas drawn from universities to avoid conflicts of interest. The panel reviews take place on a specified timetable known well in advance to the laboratory investigators and the laboratory point of contacts. Following the panel reviews, funding decisions are made in a timely fashion, with appropriate feedback provided to the investigators. Proposals are recommended for funding through selection statements similar to those for university proposals.

The COV reviewed unsolicited proposals funded in the areas of partial differential equations (including multiscale mathematics) and optimization during the FY2010-2012 period. For the PDE projects, the data available to the COV showed a slight decline as a fraction of the Applied Mathematics budget from about 27.5% in FY2011 to about 26% in FY2013. For the optimization projects, the fraction of the budget similarly declined slightly from about 6.3% to about 5.2% over this period. Since the Applied Mathematics research budget itself declined from about $40M to about $38.5M (3.75%) over the same period, these declines seem to indicate a reduction of effort in PDE and optimization research. This reduction may have been mitigated to some extent by the new MMICCs, which support considerable PDE and optimization research.

The COV expressed a concern, based on anecdotal evidence, that investigators who had previously not received funding from the Applied Mathematics Program had a more difficult time in obtaining funding than investigators currently funded by the program. However, the program managers provided evidence indicating that a significant amount of recent funding has gone to new investigators through both unsolicited proposals and targeted solicitations. For example, 13 of 17 researchers who received awards through the Mathematics for Analysis of Petascale Data are new to the Applied Mathematics Program (see section on Breadth and Depth of Portfolio Elements).

In summary, the procedures for processing unsolicited proposals are well established and highly effective. The submission process for unsolicited proposals is streamlined to increase the likelihood that

proposals received by the program will be relevant to programmatic needs. Once received, unsolicited proposals are reviewed in a timely fashion by well-qualified reviewers. Documentation of the review and decision process is well maintained, with appropriate feedback forwarded to proposal submitters. A significant number of new investigators have received Applied Mathematics funding in recent years, and the COV encourages ASCR to continue its outreach efforts to new investigators, while seeking to maintain the overall excellence of the existing programs.

**Early Career and CSGF**

The Early Career Research Program continues to receive a large number of proposals (76,48, and 54 in each of the fiscal years during this review), particularly when viewed in terms of its low funding rate. The Applied Mathematics Program makes only two to three awards per year, as ASCR has a total allotment of five. It is clear that there are well deserving and excellent proposals that must be declined due to the limited amount of funding available. Additionally, the administrative load on the program officers appears to be higher for this program than for others, primarily because all proposals must be reviewed unless they are significantly out of scope, even if the proposal does not make a clear connection with DOE priorities. Despite these concerns, it is clear that those PIs who receive awards through the Early Career Research Program are extremely well deserving and the review and decision-making processes result in sound decisions.

A full review of the DOE Computational Science Graduate Fellowship (CSGF) program was done on November 23, 2011. While this program spans more offices within DOE than ASCR, it does address the training of computational scientists and is relevant to the Applied Mathematics Program. During that review, the subcommittee concluded, "… *the CSGF is a unique educational program with features the DOE can best provide and recommends that the DOE and ASCR continue stewardship of the CSGF program*."

Recommendations from the CSGF subcommittee included an expansion of the focus of the CSGF program, as well as a doubling of funding over the next five years. The COV concurs with the results of this report and endorses the recommendations made by the CSGF subcommittee.

In addition, the COV recognizes that recommendations have been made to move the CSGF program from DOE to the National Science Foundation. The COV has significant concerns about this proposal, as the CSGF program would likely be subsumed into existing graduate fellowship programs at the NSF and, therefore, it would likely no longer specifically address the need for training and growth of the computational science workforce. The CSGF should remain under the auspices of ASCR because the placement of graduate fellows in appropriate projects that are related to the priorities of DOE is crucial and, as one of the relevant programs, ASCR has the expertise to facilitate the training of the next generation of computational scientists. Additionally, ASCR should take stewardship to track the successes of the CSGF and ensure the community retains the best human resources in the field.

## Recommendations

The Committee finds that the Applied Mathematics Program is highly effective in its processes to solicit, review, recommend, and document proposal actions.

1. A significant number of new investigators have been funded by the program in recent years. The COV recommends that the program managers continue to look for ways to enhance the program's ability to attract new investigators, while seeking to maintain the overall excellence of the program.

2. The COV recommends that program managers be allowed to travel as needed to scientific meetings. Communicating with the research community is essential to maintaining the program's vitality and is especially important to attracting new investigators to the program.

3. Regarding the CSGF program, the COV concurs with the 2011 report in recommending that the focus of the program be expanded and funding doubled over the next five years. The COV also recommends that the program remain within ASCR and not be moved to the National Science Foundation.

4. The COV recommends that award rates for Applied Mathematics Program solicitations be made publicly available. This information would be useful to prospective proposal submitters.

## Processes to monitor active awards, projects and programs

**Targeted Solicitations (MMICCS, UQ, Rx-Solvers)**

The first annual reviews of the MMICCs have recently begun. The committee views the annual review process used to evaluate the MMICCs as being both appropriate and effective. External reviewers involved in the evaluation receive the original solicitation (FOA) and a copy of the full proposal. In addition, the center is required to provide a five-year roadmap and a progress report outlining the center activities, as well as data about the organizational structure, presentations and publications, and a one page summary by each investigator on their research highlights. Reviewers are asked to evaluate the potential long-term impact, the five-year research plan, progress that has been made towards identifying and addressing integrated mathematical approaches, major technical accomplishments, and program management. During the review, presentations are given by a subset of the center participants on a focused number of technical achievements, allowing peer review at an appropriate level of depth. Additionally, with the inclusion of program managers from other ASCR divisions in the review panel, the annual review provides a suitable forum to assess DOE relevance, to seek course corrections if necessary and to enable rapid translation into applications when appropriate.

For the UQ program, the Applied Mathematics Program managers use generally effective mechanisms, including site visits, PI meetings, and progress reports, to monitor ongoing projects and collect information about progress and accomplishments. Overall these mechanisms are effective and maintain the high quality of the research.

While grants have not yet been made under the RX-Solvers targeted solicitation, the COV anticipates that similar effective processes will be used for monitoring these projects as for the other two targeted solicitations.

**Unsolicited Proposals (PDEs, Optimization)**

Annual written progress reports are now required for all funded projects at both universities and labs. However, the format of these is not specified, and the committee believes that there is benefit in requiring a specific format. This should specify length and a description of the information to be

provided, such as publications, presentations, awards, and patents based on project research, together with any other available information (such as citation data) that relate to the impact of the project on the scientific community and DOE. In addition to the progress reports, there are periodic meetings of PIs supported by the Applied Math Program. These meetings are well attended and highly effective in promoting communication and a sense of community among all of the investigators and program managers.

In general, the COV finds that the Applied Mathematics Program managers do an excellent job of monitoring all aspects of their portfolios including awards, projects, and overall programs. Both the university and laboratory programs have a requirement of annual progress reports that help to document the accomplishments made by the PIs. In addition, the Applied Math Program has an annual PI meeting that is attended by over 200 researchers, postdocs, and graduate students.

## Recommendations

1. The COV recommends adding an annual center directors meeting In order to enhance linkages among the three MMICCs. The meetings could serve to highlight technical achievements and open problems could be shared to enable opportunistic collaborations. Additionally, it could serve as a forum to share lessons learned about effective center management.
2. The COV recommends instituting the use of a standard reporting format for the annual progress reports, including length and description of information to be provided.

# Effect of the Award Process on Portfolios

## The breadth and depth of portfolio elements

**Targeted Solicitations (MMICCS, UQ, RX-Solvers)**

The Mathematical Multifaceted Integrated Capability Centers (MMICCs) is a bold program initiated in 2012 to enable highly innovative research that can impact DOE mission efforts in five to ten years. One aspect of this innovation is that the topics were not predetermined. Instead, proposals concern a set of interrelated mathematics research problems that represent abstractions of grand challenges related to the mission of DOE.

The MMICCs program brings depth and breadth to ASCR's research portfolio. More significantly, MMICCs provide a new mechanism to evolve research along new science thrusts in order to effectively serve mission-critical applications in this five to ten year timeframe. It is commendable that the MMICCs program's review processes have built-in elements to develop linkages to other divisions in the Office of Science and DOE.

Three MMICCs were funded; each with twenty or more researchers, to develop a multifaceted yet integrated approach to develop new capabilities to address DOE grand challenges in the long term. The center for "Multifaceted Mathematics for Complex Energy Systems" seeks to address challenges related to complex energy systems. The centers for Modeling Mesoscale Processes of Scalable Synthesis, and An Integrated Multifaceted Approach to Mathematics at the Interfaces of Data, Models, and Decisions seek to respectively develop new capabilities for the mesoscale modeling of materials and biofuels and the predictive multiscale modeling of subsurface flows and materials for energy storage.

Two other recent targeted solicitations, Mathematics for Analysis of Petascale Data and Advancing Uncertainty Quantification (UQ) in Modeling, Simulation, and Analysis of Complex Systems, illustrate the evolution of the Applied Mathematics portfolio to include important and mission-relevant new science thrusts.

The Petascale Data solicitation focused on research "addressing the mathematical challenges involved in extracting insights from extremely large datasets and investigating fundamental issues in finding key features and understanding the relationships between those features." While the portfolio has a consistent focus on large-scale simulation and experimental/observational facilities data, this call is a start toward defining a niche in "big data analytics." The initial investments focus on data and dimension reduction, automated analysis, and integration of observational data, experimental data, simulation and models. Importantly, 13 of 17 researchers who received awards through this solicitation are new to the Applied Mathematics Program.

The UQ solicitation focused on research addressing "the broad range of activities aimed at assessing and improving confidence in simulation." The DOE National Nuclear Security Administration (NNSA) has funded work in this area for many years, but the Office of Science Applied Mathematics Program solicitation offers an opportunity to develop the fundamental research that will allow the UQ area to stay mission-relevant. Like the data solicitation, many of the researchers who received awards from the UQ solicitation were new to the Applied Mathematics Program (7 out of 15).

Since these are new areas for the Applied Mathematics Program, both sets of awards (10 for Data, 6 for UQ) appear to have focused more on developing breadth rather than depth. As part of this breadth, sets of awards have incorporated statistics researchers, which the COV believes is an important addition to the portfolio. In particular, the COV appreciated the clear care with which the reviewers for the UQ proposals were selected, as they represented a wide range of research interests across statistics, applied mathematics, and computation.

Moving forward, all of these new areas will require particular attention to grow and develop both excellence and mission relevance. Since these areas reach out to many new researchers, it will be important to explicitly help build connections to the peta- and exascale simulation communities (particularly to enhance the UQ portfolio) and to the experimental/observational facilities (particularly for the Data portfolio). Outreach to the professional societies (e.g., Society for Industrial and Applied Mathematics and the American Statistical Association) and research communities (through sponsored workshops and conference attendance) are critical as these programs are starting to develop and evolve.

The COV understands that there is increasing "pull" from the experimental/observational facilities to develop and/or translate research from the Applied Mathematics Program. The COV encourages the Applied Mathematics Program to build on these initial awards to jump start applied mathematics-statistics-computer science-facilities collaborations that could drive the next generation of fundamental research broadly applicable to the analysis of experimental/observational facilities data.

A tentative slate of proposals that are likely to be recommended for the RX-Solvers program reflect involvement of investigators from national laboratories, universities, and industry. As the projects are not beginning until after FY2012, the COV did not further evaluate this program.

**Unsolicited Proposals (PDEs, Optimization)**

The unsolicited proposal projects in PDEs and optimization are of excellent quality overall. The investigators include many distinguished leaders in their areas and also a number of highly qualified mid-career and early investigators at both labs and universities. Within the broad areas of PDEs and optimization, a wide range of subtopics and applications are represented. The COV found the projects to be well aligned with the priorities of the Applied Mathematics Program, ASCR, and the Office of Science. This alignment has doubtless resulted from diligence and good judgment exercised by the program managers in deciding which proposal ideas and white papers to encourage and which proposals to fund.

As previously noted, there were concerns based on anecdotal evidence that new investigators may find it extremely difficult to obtain funding from the program. While this concern was largely allayed by evidence that a significant amount of recent funding has gone to new investigators, some concern remains. As in the previous section, the COV encourages ASCR to continue its outreach efforts so that prospective new investigators gain a better understanding of DOE ASCR priorities."

**Early Career and CSGF**

As already noted, the Applied Math Program makes only two to three Early Career awards each year. However, the range of topics among recent awards is significant, including projects in data mining,

optimization, complex fluids, materials, and uncertainty quantification. Overall, this program has notable breadth and depth notwithstanding the small number of awards.

## Recommendations

1. The COV recommends that ASCR develop a short-term visitors program with the MMICCs, with concomitant funding, to enable promising researchers to develop collaborations with center members. Even with a relatively modest investment, such a program holds the potential for greatly increasing the scale and scope of new capabilities developed at an MMICC by leveraging research supported in large part through universities and other agencies. It may also help to bring new researchers into the Applied Mathematics Program.
2. The COV recommends investigating the addition of a new interdisciplinary program of applied mathematics-statistics-computer science-facilities that could drive the next generation of fundamental research broadly applicable to the analysis of experimental/observational facilities data.
3. The COV recommends that ASCR continue its outreach efforts to professional societies and research communities through sponsored workshops and conference attendance, as these are critical to program development.

## The national and international standing of the portfolio elements

The DOE ASCR office has a long and rich tradition of supporting some of the best applied mathematics research in the nation, especially with regard to applications arising from the DOE mission. In particular, the Applied Mathematics Program has recently made strong investments in computational mathematics at extreme scale including analysis for large data sets arising from the leadership class supercomputing facilities as well as experimental facilities. Evidence of leadership in the applied mathematics area can also be seen in the number of highly regarded PIs that DOE funds including 10 National Academy of Sciences members, 44 SIAM Fellows, 2 AAAS Fellows, and several winners of prestigious prizes such as the ICIAM Lagrange Prize, the ICIAM Pioneer Prize, and the George B. Dantzig Prize.

The Applied Mathematics Program also maintains an international leadership position in certain key mathematical areas. A recent report by a WTEC Panel on International Assessment of Research and Development in Simulation-based Engineering and Science states, "The United States leads both in computer architectures (multicores, special-purpose processors, interconnects) and applied algorithms (e.g., ScaLAPACK, PETSC), but aggressive new initiatives around the world may undermine this position". The DOE Applied Mathematics Program has invested extensively in both of these areas and the US leadership described in the report no doubt is a reflection of those long-term investments.

The same report found that while the US has many research efforts in UQ, several other countries are also addressing this issue (mainly for high-dimensional problems), in particular Germany, Switzerland, and Austria. Hence the UQ efforts being supported by ASCR are commendable, but an active role by the program managers in developing strategic areas applicable to the broad DOE mission would likely enhance this portfolio.

Maintaining international leadership in any area requires both a long-term and sustained level of effort. The Applied Mathematics Program office has done a commendable job in the past of maintaining a good balance of a long-term vision for mathematics research and a focus on the DOE mission. With an ever increasing number of mathematical areas that are relevant to DOE, it will be important for the program

managers to develop a set of priorities based on input from the research community and the other offices within the Office of Science. Part of developing this set of priorities should include developing a set of metrics for comparing the research funded by DOE versus other international groups.

**Targeted Solicitations (MMICCS, UQ, RX-Solvers)**

The MMICCs hold the potential for high-risk yet high-impact research and thus represent a unique element of the ASCR portfolio. Additionally, the centers also involve promising junior researchers who have been recognized through the highly competitive DOE and NSF early career awards. The MMICCs bring such talented researchers together in a concerted effort to consider complex problems through appropriate abstractions in a discipline spanning manner. Such an approach holds the potential for fundamental breakthroughs that may otherwise not be possible.

**Unsolicited Proposals (PDEs, Optimization)**

As stated earlier, the unsolicited proposal projects in PDEs and optimization are of excellent quality. The investigators include many distinguished leaders in their areas as well as a number of highly qualified mid-career and early investigators at both labs and universities.

## Recommendations

3. The COV recommends that the review and annual reporting process for the MMICCs include a listing of awards and accolades received by the project participants with brief summaries indicating the associated technical achievements. This report can be used to highlight the leadership role of the MMICCs.
4. The COV recommends that the Applied Mathematics Program develop a set of key mathematical areas that will have the greatest impact on the DOE mission and in which they can either currently claim or plan to develop international leadership.

## DOE Response to 2010 COV Report

The 2010 COV report made a number of recommendations to which ASCR responded. With regard to the efficacy and quality of the processes, ASCR made several changes that have improved the overall processes including advertising their solicitations on their web pages, discussing ASCR funding opportunities and providing proposal preparation guidelines to participants at technical conferences, being proactive about announcing new solicitations to the professional societies, limiting targeted solicitation proposals to 15 pages, and providing explicit guidelines for progress reports. The 2013 COV commends the Applied Mathematics Program for following up with those recommendations and instituting these changes.

The 2010 report recommended that well-detailed guidelines be instituted for progress reports. This recommendation has not been implemented, and it is repeated in this report.

The previous COV did not give any specific recommendations for the second component related to the breadth and depth of portfolio elements or the national and international standing of the applied mathematics research program.