

Uncertainty Quantification (SIAG/UQ) Charter Renewal

June 2, 2014

Prepared by Max Gunzburger, Chair of the SIAM Activity Group on Uncertainty Quantification

This charter renewal applies to the SIAM Activity Group on Uncertainty Quantification. SIAG/UQ was established in December 2010 by the SIAM Council and by the SIAM Board of Trustees with its initial operating period beginning December 11, 2010 and ending December 31, 2012. The charter for SIAG/UQ was renewed in 2012 to extend its operating period to December 31, 2014. Thus, this application is for a second renewal and to extend the SIAG/UQ operating period to December 31, 2016. The SIAM Activity Group on Uncertainty Quantification requests that the SIAM Council and Board of Trustees renew its charter for a two-year operating period beginning January 1, 2015.

According to its Rules of Procedure, the purpose of the SIAM Activity Group on Uncertainty Quantification is to foster activity and collaboration on all aspects of the effects of uncertainty and error on mathematical descriptions of real phenomena. It seeks to promote the development of theory and methods to describe quantitatively the origin, propagation, and interplay of different sources of error and uncertainty in analysis and predictions of the behavior of complex systems including biological, chemical, engineering, financial, geophysical, physical, and social/political systems. SIAG/UQ serves to support interactions between mathematicians, statisticians, engineers, and scientists working in the interfaces of modeling, computation, analysis, statistics, and probability.

The functions of SIAG/UQ are to organize and manage activities in Uncertainty Quantification. The SIAG is expected to:

- Organize a biennial SIAM Conference on Uncertainty Quantification.
- Organize minisymposia at the SIAM Annual Meeting, especially in years where there is no SIAM UQ conference.
- At least once every five years either organize a track of at least six minisymposia at the SIAM Annual Meeting or have a SIAM UQ conference held jointly with the Annual Meeting.
- Consider organizing specialized workshops jointly with other SIAGS.
- With proper approval, organize minisymposia at other SIAM conferences and at conferences organized by other organizations.

The SIAG has complemented SIAM's activities and supported its proposed functions. The answers to the questions below indicate how this was accomplished and what the officers propose as the future directions for the SIAG.

1. List all current officers of the activity group.

Chair: Max Gunzburger

Vice-Chair: Mark Berliner

Program Director: Raul Tempone

Secretary: Youssef Marzouk

The current Chair has begun the process of seeking nominations for the next set of officers. The approved nominating committee consists of Jim Berger (Duke), Don Estep (Colorado State), Max Gunzburger (chair), David Higdon (Los Alamos), Catherine Powell (Manchester), and Ralph Smith (North Carolina State).

2. How is the field covered by the activity group doing? Is it growing, is the focus shifting? What have been the significant advances over the last two years?

UQ has been around for a long time due to the recognition that it is a crucial, indeed necessary, aspect of simulation, design, and, ultimately, science-informed policy and risk assessment. However, within the last 10 years there has been an explosion in interest in UQ among applied and computational mathematicians, an interest partially spurred by the great advances in computer simulations which enable the treatment of UQ problems that were theretofore not possible. Because UQ has not until recently been a large blip on the radar of mathematicians, it has proved to be of special interest to junior researchers. SIAM members responded admirably to interest in UQ by establishing the troika of a UQ interest group, a UQ conference, and, jointly with the ASA, a UQ journal.

Despite the explosive growth in interest in UQ, the field continues to grow in the number of people involved, in the scope of the problems treated, in the number of journals, conferences, workshops, short courses, and summer schools devoted to the area, in the number of Ph.D.s awarded to students in the US and abroad who worked on UQ dissertations, and in the number of calls for UQ funding from Federal agencies.

In the last two years the most prominent advances have been in the areas of better algorithms and in the wider scope of applications in which mathematicians have become interested and contributed to. Algorithmic advances include very substantial improvements to methods that existed two years ago (polynomial chaos, stochastic collocation, Bayesian inference, Monte Carlo methods, etc.) and in the development of new algorithms, at least new to UQ. Synergistic and parasitic interactions with approximation theory, probability, and control and optimization methods have enabled some of these advances. The algorithmic advances have resulted in, for example in the setting of parametric uncertainty, the ability to treat problems with a substantially higher number of parameters than was possible two years ago.

Two years ago, the mathematical and computational treatment of UQ was already prominent in fluid and solid mechanics, geophysics, electromagnetics, and other areas in which mathematics has played a crucial role for decades if not centuries. In the last two years, mathematics has made new and substantial inroads into UQ for the life and medical sciences and other areas in which mathematical interest is of a more recent vintage.

3. How is the activity group doing? Is it remaining vibrant? Is the size of the SIAG stable or increasing? How is the SIAG keeping up with the changes in the field? How are the broader interests of SIAM reflected in the activities of the SIAG?

SIAG/UQ is doing very well and certainly remains vibrant. Unquestionably, it is looked at on the global stage as the leading organization for fostering UQ research and training. After it was first established, many joined SIAG/UQ; this was confirmation of the need for such SIAG, as was written about in the proposal for its establishment. By the end of 2012, SIAG/UQ had 417 members. Since that time, growth has continued so that as of today, SIAG/UQ has 493 members.

In the next two years, we expect membership growth to continue, albeit at a lower rate; one reason for this optimism is that more and more students are being trained in UQ research who first become student members and then transfer to full memberships once finishing their graduate studies.

UQ is a rapidly developing area of applied and computational mathematics. However, SIAG/UQ has many members from outside of mathematics, especially in engineering. Thus, its activities, especially the SIAM UQ conference (see Question 4) and the SIAM-ASA Journal in Uncertainty Quantification (see Question 5) involve diverse, interdisciplinary personnel. These activities provide mechanisms for the mathematical community to learn about the UQ needs of scientists and engineers, information they can use to guide their research directions. Thus, SIAG/UQ is a crucial enabler of changes in UQ research.

Some consider UQ to be one of the several specialty areas, e.g., finance and imaging, that SIAM has, in relatively recent times, served with a SIAG, journal, and conferences. This, however, is not an accurate characterization of UQ. In fact, UQ is part of, overlaps with, and even pervades all of SIAM's interests. For example, every SIAM journal could publish a UQ-related paper and UQ-related talks could be delivered at every SIAM conference. Indeed, we venture to conjecture that many SIAG/UQ members are members of other SIAGs and most who publish in the SIAM UQ journal and talk at SIAM UQ conferences do likewise in other SIAG-related journals and conferences. Thus, the activities of SIAG/UQ, e.g., its journal and conferences, provide a focus for broad SIAM interests.

4. Please list conferences/workshops the activity group has sponsored or co-sponsored over the past three years, and give a brief (one sentence or phrase) indication of the success or problems with each.

In the past 3 years, SIAG/UQ has sponsored two conferences. The first SIAM UQ conference (in 2012) was very successful, substantially exceeding SIAM's expectations for attendance (which totaled 359), so much so that an extra day had to be added to accommodate all minisymposia. It was decided that SIAM UQ conferences would have an applications theme; for 2012, the theme was mechanics and USACM was a co-sponsor, as was the ASA. The second SIAM UQ conference (held in Savannah in 2014) had geophysics being its application theme; it was co-sponsored by the ASA again and by the AGU and also by GAMM. The co-chairs of the conference organizing committee were Michael Griebel (Bonn), Max Gunzburger (Florida State), Marcia McNutt (Science Magazine), and Philip Stark (UC Berkeley). The SIAM UQ14 conference had 542 attendees.

5. Please indicate the number of minisymposia directly organized by the activity group at the last two SIAM annual meetings. When did the SIAG last organize a track of minisymposia at an annual meeting or meet jointly with the SIAM Annual Meeting?

SIAG/UQ has not yet organized a track of minisymposia at an annual meeting or met jointly with the SIAM Annual Meeting.

In response to requests from the officers of SIAG/UQ, several sponsored minisymposia have been organized at the last two SIAM annual meetings. Unfortunately, in some, perhaps most cases, the organizers failed to designate their minisymposium as being SIAG/UQ sponsored so that the number of "official" SIAG/UQ minisymposia is smaller than it should have been. Our estimates for the total number of "official and unofficial" such minisymposia at the last 2 annual meetings is 4 and 6, with all of these involving at least 2 sessions, and some involving as many as 4 sessions.

6. Please indicate other activities sponsored by the activity group, to include newsletters, prizes, and web sites. Have each of these been active and successful?

A major activity organized SIAG/UQ was the establishment of the SIAM-ASA Journal on Uncertainty Quantification; this is an electronic-only journal; its first papers appeared online in May 2012. Jim Berger, Don Estep, and Max Gunzburger were the Founding Editors and currently manage the journal, with Berger and Estep serving as co-editors in Chief and Gunzburger as Senior Editor. The journal has been a resounding success. In fact, we have been told that, compared to other recently established SIAM journals, the UQ journal received substantially more submissions in its first year of operation.

SIAG/UQ operates the SIAG on Uncertainty Quantification mailing list (siam-uq@siam.org). This service has been very active with several email per week and has become the most important avenue for providing information (job opportunities, conferences and workshops, summer schools, new books, etc.) to the UQ community.

SIAG/UQ maintains a web site. Unfortunately, that site has not been use to anywhere near its full potential.

7. What activities are planned and proposed for the next period of the charter? Please describe scheduled and suggested future activities in detail.

The first list is about current activities whose ultimate fruition may occur under the aegis of the next set of SIAG/UQ officers, although in some cases they are far enough along that they may come to pass before the end of 2014.

i. Planning for the SIAM UQ16 conference is already underway with the site selection to be made by the end of June; it is likely to be somewhere in Europe. It is also likely that SIAM UQ16 will have multiple applications themes, each of which may not currently have sufficient UQ gravitas to warrant being a single applications area, but which promise to be very active UQ areas in the near future. It is hoped that by having each of these areas be a theme of the UQ16 conference, those areas will develop more quickly and attract more researchers. One very likely theme is the life sciences.

ii. Articles for SIAM News about UQ are useful for disseminating information about hot trends in UQ research to the larger SIAM community and thus attracting more people, especially junior researchers, to the UQ fold. The co-chairs of the SIAM UQ14 conference are currently preparing an article about that recent conference. In addition, we are soliciting selected members of SIAG/UQ to prepare articles about important trends in UQ research. We hope that UQ related articles will become a regular feature of SIAM News.

iii. Increasing the functionality of the SIAG/UQ web site would increase its usefulness. Possibilities in this regard are posting or linking to preprints and papers; advertising conferences, workshops, and summer schools; advertising employment opportunities; advertising graduate research programs and research assistantships; posting model/challenge problems and UQ case studies; and a moderated forum for communications, discussions, and questioning among SIAG/UQ members. An important issue related to this activity is who and where the effort needed to develop such a functional web site is going to come from, and, beyond that, the same issues for sustaining and updating the web site. Some of the functions listed for the web site could also be taken care of or duplicated by an electronic newsletter.

iv. Increasing ties between the SIAM and ASA UQ communities and with statistics as a whole is a continuing effort of SIAG/UQ and of its officers. Such ties have been a central focus of SIAG/UQ since the earliest planning activities for its establishments. The organizers of both SIAM UQ

conferences and the founders and current managers of the SIAM-ASA Journal on Uncertainty Quantification have all been adamant about including statistics and statisticians in all aspects of those activities, e.g., as co-chairs and members of the organizing committees and as co-Editors in Chief and members of the editorial board. In this regard, we have been very successful, as highlighted by the fact that the ASA was a sponsor of both UQ conferences and is a joint offerer of the UQ journal. However, there is still a ways to go to fully integrate the mathematics and statistics UQ communities, partly because of inertia within and “cultural” differences between the two communities. Given that the ASA has a special interest group in UQ whose members hope to elevate to ‘section’ status within ASA, and given that many members of the ASA are also active in SIAG/UQ (including co-chairs of the SIAM UQ14 conference, officers of the SIAG/UQ, and co-Editor in Chief and members of the editorial board of the SIAM UQ journal), we believe there are ample, very good opportunities for increasing the synergy between the statistics and mathematics UQ communities.

Similarly, we should enhance our ties with the UQ special interest group within GAMM, especially because UQ research is very good and very prolific in Germany. That special interest group was a co-sponsor of the SIAM UQ14 conference so there is an opening for improving ties between the two special interest groups.

The second list is about activities that we hope the next SIAG/UQ officers consider to undertake. Some of these ideas have already been subjects of discussion among SIAG/UQ officers and members, but others are more in the nature of brainstorming.

v. SIAG/UQ participation in other professional society workshops/conferences including and especially ASA and other statistics conferences. When discussing the improvement of mathematics–statistics interactions, we mathematicians often expect statisticians to come to us, including our conferences, but it is much more rare for math folks to go to statistics conferences. We have to do so if we have genuine interest in interacting with statisticians. An excellent way to do so is for the SIAG/UQ to organize events, where possible, at statistics conferences. Similar arguments can be made for fomenting better interactions between mathematicians and, say engineers, although there is more of a history for such interactions than perhaps there is with statistics.

vi. UQ SIAG sponsored regional workshops, tutorials, short courses, and training sessions can be of help in attracting and retaining junior researchers into the UQ fold and to help them learn about open problems and new developments. Regional workshops also gives such researchers the opportunity to publicize their research.

vii. Improving connections with UQ needs and developments in industry would provide an excellent source of problems for the mathematical UQ community and help in making that community’s contributions more relevant. As of the end of last year, industry accounted for 13% of the membership in SIAG/UQ so that there is definite interest within that sector for UQ and for what SIAM can offer. Organizing a SIAG/UQ sponsored workshop on UQ in Industry may be a good way to get more going in the nature of mathematics–industry interaction in UQ. One activity that would be beneficial in educating students and informing UQ researchers in general is the creation of a well curated and peer reviewed “case study” and “benchmark problem” repository of UQ in applications; certainly, industrial members of SIAG/UQ could be a big help in contribution to the repository; also, perhaps the ASA-SIAM Journal on Uncertainty quantification could be brought into the selection process.

8. How can SIAM help the activity group achieve its goals?

The SIAM staff have been extremely helpful in all aspects connected to SIAG/UQ. Exploring the issues involved with creating a better UQ web site and ideas about increasing membership would be a natural means for SIAM to provide additional support and encouragement. Also, increasing ties to ASA and other professional organizations could certainly benefit from help from SIAM.

9. How can the activity group help SIAM in its general role of promoting Uncertainty Quantification?

Most of the activities discussed above for SIAG/UQ would be of substantial help to SIAM in promoting UQ.

Signed:

Max Gunzburger, SIAG Uncertainty Quantification Chair
June 2, 2014