

**University of Washington**  
**Department of Mathematics**  
**Ten Year Review, February 2016**

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## Executive Summary

The Department of Mathematics has again made major strides since the previous review. The dominant theme of the current review is the explosion in size of both the undergraduate service and majors instructional programs. The Department deserves enormous credit and praise for accommodating this rising demand with high-quality coursework. The graduate program is in good health, having grown in quality; Ph.D. degree production has approximately doubled. The Department has made outstanding hires, continuing a tradition of excellence in research. K-12 programs remain extraordinarily strong and unusually high in number for a science unit at the UW. The governance structure is robust, with functional committees, and clear signs of a next generation of faculty leaders ready to take the reins when called upon. Everyone we spoke to—faculty, staff, students—expressed happiness with their experiences in this community.

The committee is pleased to offer a number of recommendations to both the Department and the administration of the University. Most of the recommendations to the Department are items they have already recognized as opportunities for productive change.

The committee unanimously offers two overarching recommendations from this report, one each for the Department and the University. These overarching recommendations arise from the following circumstances: The Department accommodated dramatically rising demand for undergraduate instruction at the same time that the tenure stream faculty count declined by 5.5 FTE. The age distribution of the tenure stream faculty is heavily skewed toward members for whom retirement is likely in sight. For the most part, the Department has stood by the decision taken in earlier years to maintain relatively small undergraduate class section sizes. As a result, a large proportion of coursework, particularly at the 300 and 400 levels, is now instructed by faculty other than tenure stream or lecturers, and instead by graduate teaching assistants, post-doctoral associates, or part-time lecturers. If allowed to continue, the situation would be unhealthy.

For the Department, the overarching recommendation is to reconsider the deployment of human instructional resources in the large undergraduate program as well as to reconsider class sizes at all levels, specifically considering increasing sizes so as to lower the number of sections that must be offered. We urge consideration of the deployment of the tenure-stream faculty to include participation throughout the instructional program. We urge consideration of shifting graduate teaching assistants incrementally away from being primary instructors in courses. This should come as no surprise to the Department: they are already asking themselves these same questions. Members of the Department are in the best position to provide thoughtful answers.

For the University, the overarching recommendation is to communicate to the Department and follow through on a commitment to support a program, consistent across time, of hiring tenure-stream faculty, some above the level of Assistant Professor, to ensure at a minimum no further decline in the tenure stream faculty count. The understanding that hiring will occur on a regular basis will reduce the tendency to attempt to hire in one's own area rather than to support hiring the very highest quality candidates in other areas. Failure to communicate and follow through on this assurance could result in hiring "in desperation" rather than adherence to very highest standards of excellence that the Department has consistently demonstrated in hiring.

The committee congratulates the Department on a successful decade. We recommend the continuation of all degree programs, and a next review a decade from now.

## Principal recommendations to the Department

### *Overarching Recommendation*

Reconsider undergraduate course section sizes and how the human instructional resources of the Department are deployed in the undergraduate program.

### *Other Recommendations*

1. Reconsider the decision to focus tenure stream faculty at the 100-level that has resulted in graduate teaching assistants dominating instruction at the 300-level. This may require a rebalancing, redesign, or even abandonment of the "point system" which drives tenure stream faculty teaching preferences.

2. Consider expanding the maximum class size in all service courses, and adopting a more traditional TA-led quiz section model.
3. Consider limiting the number of times a graduate student is assigned as a course instructor, to retain the benefits to the graduate student of the instructional experience, but also to protect the graduate student's time for research.
4. Take steps to ensure that department-determined quality standards are both set and met by all service course instructors, particularly courses not taught by the continuing lecturers and tenure stream faculty.
5. Ensure that graduate teaching assistants assigned to teach service courses have access to course materials (lecture notes, sample exams, syllabi, etc.) to reduce duplication of effort, maintain quality of instruction, and protect graduate student time for their independent research.
6. Complete the careful comparison of student outcomes in traditional and on-line service courses that is already underway.
7. Work with other participating departments to increase the number of student-slots in the ACMS degree program if this can be done without significantly compromising quality.
8. Reconsider the deployment of tenure stream faculty so that more are available to participate and provide leadership in instruction of the 300- and 400-level curriculum for undergraduate majors. Here again, the "point system" may need to be reconsidered.
9. Endeavor to improve the alignment of student interest in and the offerings of upper division courses (size of courses or number of offerings, as well as specific curriculum). At a minimum, the Department should attempt to meet demand by increasing the size of current popular course offerings. The addition of computational-based courses should receive consideration.
10. Attempt to improve the environment for the undergraduate majors, including the addition of mechanisms for student interaction, both academic (group work) and social. If the long-standing goal of providing a student space remains beyond reach, at a minimum some social events ("pizza parties") should be sponsored.
11. Revisit the language exam requirement in the graduate program. Despite the recent reduction from two languages to one, this remains an artificial hurdle in the program that as currently administered appears not to be offering benefit to the students.
12. The average time to the Ph.D. degree is 6 years. This is in line with comparable institutions but an effort could be made to reduce it to 5-6 years.
13. Reduce the teaching load of graduate students. Graduate students leading the teaching of 300- and above level courses should be the exception and not the rule.
14. Connect the graduate student cohorts in the Department of Mathematics and the Department of Applied Mathematics.
15. Skype interviews could be considered when recruiting graduate students.
16. Consider launching a professional masters degree program anchored in the Department of Mathematics and possibly bridging with other professional masters programs offered across campus with an optimization flavor.
17. Work with the administration to create a plan for the renewal of the tenure stream faculty, continuing the collegial process of strategic planning in parallel with opportunistic hiring which has served the Department well.
18. Consider offering to the postdoctoral associates a title other than "Acting Assistant Professor", such as a title including the name of a great mathematician associated with the University.

### **Principal recommendations to the University**

#### *Overarching Recommendation:*

The University should communicate to the Department a commitment to support a program, consistent across time, of hiring tenure-stream faculty, some above the level of Assistant Professor, to ensure at a minimum no further decline in the tenure stream faculty count. Failure to do so could result in hiring "in desperation" rather than adherence to very highest standards of excellence.

#### *Other Recommendations:*

1. Use this review as an opportunity to assess the adequacy of the resource portfolio of the Department of Mathematics in light of what the committee believes are unparalleled levels (compared to all other units in the College of Arts and Sciences) of enrollment increases in their undergraduate instructional program.

2. Work with the Department of Mathematics to identify a work/social space for undergraduate students.

## Undergraduate Instructional Service Program

Nearly every undergraduate STEM degree program at the University of Washington requires up to several service courses that are taught by the Department of Mathematics. The quality of these courses has significant impact on the quality of a wide range of undergraduate degree programs. The availability of spaces in these courses is important for timely progress toward degree for undergraduate students in many majors. These courses are thus of critical importance to the University.

The primary courses that serve undergraduate degree programs outside the Department of Mathematics are:

- MATH 120 (pre-calculus)
- MATH 124-125-126 and its Honors equivalent MATH 134-135-136 (calculus for science and engineering majors)
- MATH 111-112 (business pre-calculus and calculus)
- MATH 307-308-309 (differential equations and linear algebra)
- MATH 324 (multivariable and vector calculus)

Of these, MATH 124-125-126 and MATH 307-308-309 have the largest enrollments and were the focus of most of the discussion at the site visit.

At the time of the last review, the Department of Mathematics had undertaken a major effort to improve the quality of the 100-level calculus series, efforts that seem to have paid off in greater satisfaction on the part of students and client departments. The steps taken included assigning tenure-stream faculty to teach calculus and reducing class sizes in MATH 124 and 125 from 160 to 80. Funding cuts that followed the 2008 recession led the Department to increase slightly the size of 124 and 125. However enrollment is still limited to 120 in each of those (it has remained at 160 for MATH 126). It is noteworthy that these class sizes are much smaller than is typical of introductory series in other science departments.

Recently an online section of calculus has been added that enrolls up to 240. This section is being carefully monitored by Department of Mathematics staff in collaboration with the University of Washington Office of Educational Assessment (OEA). Currently all indications are that the effectiveness of the online section is comparable to the in-person versions. The Department expects to have analyzed the OEA report soon. In any case, the Review Committee was satisfied that the Department's insistence on assessment and their cautious approach to expanding in this direction will ensure that the online courses are of high quality.

An effort to revamp the 300-level series along the lines of the reform of the 124-125-126 series is apparently planned. The Review Committee was impressed with the commitment and competence of the faculty and staff who will be leading this effort. It is clear they have the support of Department leadership and the faculty as a whole.

All of the evidence suggests that the Department is taking seriously its responsibilities to provide high-quality, up-to-date courses taught by faculty and instructional staff who feel valued, respected and supported. Therefore, the major focus of the review committee was the question of how best the Department should address the challenge of increasing enrollments, a level of growth that can only be called extraordinary. Demand for the service courses has increased dramatically over the past few years, driven by growth in many STEM degree programs. As shown in the Department's Self Study, enrollment in the 124-125-126 series was about 5000 at the time of the last self-study but is currently around 7500. In the same time period, enrollment in the 307-308-309 series essentially doubled, from 3000 to 6000. The Department should be commended for accommodating growth levels of 50% and 100% respectively in what were at the outset already very high enrollment courses.

The Department of Mathematics has responded to the demands of growing enrollment by ensuring that students have access to the courses they need while minimizing any diminution in quality. Thus the Department is now offering nearly 60 separate sections in the 124-5-6 series and over 150 sections in the 307-8-9 series. However, while enrollments have been growing dramatically, the size of the tenure-stream faculty has been shrinking. *Thus in order to maintain their commitment to try to place tenure-stream faculty in the 100-level courses, most of the 300-level courses are being taught by graduate teaching assistants and postdoctoral associates.*

The committee has serious concerns about the current situation, especially given that enrollments are projected to continue to rise. Specifically, we worry about threats to the quality of the service courses and to the scholarly activity of the Ph.D. students teaching these courses. The Department leadership indicated that they share these concerns.

Though small classes in principle offer more opportunities for interaction (as is apparently the case in a 300-level “proofs class”), it does not appear that instructors are taking advantage of these opportunities. If instruction is conventional (i.e., students listening and perhaps taking notes but not engaged in discussion or problem-solving) then larger classes can be as effective as smaller ones.

Offering many sections of the same course is a potential threat to quality and consistency. While we do not advocate a “cookie cutter” approach, and we appreciate that individual instructors can make unique contributions, there is an enormous duplication of effort in the current system, effort that could be invested elsewhere (in research, for example). Moreover, discussions of the nature of course exams at the 300-level raised serious concerns about the uniformity of quality across sections. While an effort to increase the sharing of class materials is under way, the Committee found that some TAs were unaware of it.

Graduate teaching assistants who are entirely responsible for a course may end up investing more time than their nominal assignments require in an effort to be conscientious. In addition, they are likely engaged in more intense, higher pressure activities than those associated with grading or running recitation sections. While graduate students pursuing academic careers may gain valuable experience, it is not obvious that repeated assignments confer additional benefits.

Online sections may offer an “easy” way to increase accessibility but providing opportunities for interaction among students and between students and staff is a continuing challenge for online education broadly. Also, it should be noted that online courses, if conducted carefully, do not necessarily require fewer resources than in-person courses.

In summary, while the Department works to improve quality and maintain accessibility, we hope they will consider that larger class sizes coupled with systematic sharing of course materials could promote uniform standards, reduce the burden on graduate teaching assistants and postdoctoral associates and increase the time and effort available for research with little or no reduction in instructional quality. In particular, a system of larger lecture classes with smaller TA led recitation sections could be explored.

The recommendations that follow urge the department to reconsider assumptions concerning the focus of tenure stream faculty effort, class sizes, and deployment of graduate teaching assistants. The recommendations should in no way be construed as critical of decisions made years ago. Rather, these recommendations reflect the reality that dramatically surging enrollments which are being accommodated with a smaller tenure track faculty demand the reconsideration of models that were thoughtfully chosen years ago, but might no longer be optimal in these changed circumstances.

#### **Recommendations to the Department:**

1. Reconsider the decision to focus tenure stream faculty at the 100-level that has resulted in graduate teaching assistants dominating instruction at the 300-level. This may require a rebalancing or even abandonment of the “point system” which drives tenure stream faculty teaching preferences.
2. Consider expanding the maximum class size in all service courses, and adopting a more traditional TA-led quiz section model.
3. Consider limiting the number of times a graduate student is assigned as a course instructor, to retain the benefits to the graduate student of the instructional experience, but also to protect the graduate student’s time for research.
4. Take steps to ensure that department-determined quality standards are both set and met by all service course instructors, particularly courses not taught by the continuing lecturers and tenure stream faculty.
5. Ensure that graduate teaching assistant assigned to teach service courses have access to course materials (lecture notes, sample exams, syllabi, etc.) to reduce duplication of effort, maintain quality of instruction, and protect graduate student time for their independent research.
6. Complete the careful comparison of student outcomes in traditional and on-line service courses that is already underway.

## **Recommendations to the University**

1. Use this review as an opportunity to assess the adequacy of the resource portfolio of the Department of Mathematics in light of what the committee believes are unparalleled levels (compared to all other units in the College of Arts and Sciences) of enrollment increases in their undergraduate instructional program.

## **Undergraduate Degree Program**

In the most recent year, the Department of Mathematics reported 1018 declared majors, which is a striking increase from the 199 majors in 1994 and 300 in 2004. The mathematics major was recently reclassified as “competitive,” meaning in practice that the Department’s undergraduate advisors, consisting of staff and student advisors, accepted (or rejected) student applications for the major. The group reported that in the most recent cycle, 140 students were accepted out of 240 applications. Rejections were mostly the result of mediocre grades in calculus or subsequent courses, and the advising group reported that students were only rejected when it was judged that they were unlikely to be successful in the major. The committee agrees this is an appropriate criterion.

The ACMS (Applied Mathematical Computation Sciences) major is an additional multidisciplinary major in which the Department participates. This major is “highly competitive”, in contrast to the Mathematics major, and is capped at 200 students, with a very high grade point average among accepted students. The ACMS major is undergoing a substantial revision, including a new pathway in Statistics and Data Science. If indeed highly qualified students are being turned away from this program, the cap should be reconsidered.

With the exception of the honors courses (134-5-6) and (334-5-6), which received very positive reviews from students who spoke with the committee, the courses for majors suffer from some of the same problems facing the service courses. Due to the preference for placing tenured faculty into calculus classes, the major classes at the 300 and 400-level are too often taught by graduate students (limited to 307-8-9 and 324) and postdoctoral instructors. This was viewed by the committee as problematic.

Moreover, undergraduate students and advisors reported a mismatch between student interests and course offerings. Perhaps because of the fact that many majors would have preferred to be in the ACMS program, there was some dissatisfaction with the “traditional” proof, algebra and analysis courses offered by the Department, while the courses in probability, optimization, number theory and modeling were oversubscribed. It was mentioned several times that when a new section of one of these courses opens at registration, it fills immediately.

There is a definite sense that the Department is near the point of being overwhelmed by the numbers of majors. The advising group does not have the staffing to meet with students individually, and while students were able to enroll in enough courses to graduate, they reported that they were often not able to enroll in the courses that they wanted. Department leadership is aware of these issues and the committee strongly supports their efforts to rethink their teaching assignments and course offerings for their majors to accommodate the large number of students as well as student interests in more computational-based courses.

The group of students who met with the committee seemed generally pleased with the program, with one exception. Students reported that while their instructors stressed the importance of working in groups, the Department did not furnish them with any practical opportunity to do so. Department leadership is aware of this issue, and the committee, while cognizant of the severe space constraints at the University of Washington, nevertheless recommends that the Department find a way to carve out some real estate for afternoon or evening student study groups. Similarly, the Department could consider sponsoring events that would provide opportunities for undergraduate students meet and socialize with one another.

The committee feels that the Department deserves accolades for accommodating the dramatic expansion of both the service and majors programs. The Honors Program within the Department particularly stands out with numerous prize-winning graduates to attest to its success in inspiring students. The Department’s record of supporting successful nominations for the Dean’s Medal is unparalleled.

## **Recommendations to the Department:**

1. Work with other participating departments to increase the number of student-slots in the ACMS degree program if this can be done without significantly compromising quality.
2. Reconsider the deployment of tenure stream faculty so that more are available to participate and provide leadership in instruction of the 300- and 400-level curriculum for undergraduate majors. Here again, the “point system” may need to be reconsidered.
3. Endeavor to improve the alignment of student interest in and the offerings of upper division courses (size of courses or number of offerings, as well as specific curriculum). At a minimum, the Department should attempt to meet demand by increasing the size of current popular course offerings. The addition of computational-based courses should receive consideration.
4. Attempt to improve the environment for the undergraduate majors, including the addition of mechanisms for student interaction, both academic (group work) and social. If the long-standing goal of providing a student space remains beyond reach, at a minimum some social events (“pizza parties”) should be sponsored.

#### **Recommendation to the University:**

1. Work with the Department of Mathematics to identify a work/social space for undergraduate students.

### **Graduate Degree Program**

The quality of the graduate program is excellent. The efforts invested by the Department leadership in enhancing the social fabric of the graduate student cohort have paid well. The newly renovated graduate student lounge, the “beer bashes” and other social activities have no doubt contributed to the present level of satisfaction, collegiality, and sense of community among the graduate students. Graduate students choose the University of Washington Department of Mathematics for their graduate education mostly because of its reputation and excellence in mathematics. The students we interviewed expressed satisfaction with the scientific advising that they are receiving.

John Palmieri is the Graduate Program Coordinator and Director of Graduate Admissions, assisted by Brooke Miller, the Graduate Program Assistant. The Graduate Student Representative and the Lead TA represent the graduate student cohort at different administrative bodies of the department.

Since the review of 2004, the graduate applicant pool grew from 150, with about 1/2 of entering class from the top 1/3, to now 400 applicants with almost the entire entering class of 15-17 students (a yield of about 25%), drawn from the top 1/3. The size of the program has been kept almost constant at about 85 graduate students, which seems to be about the right size as compared to the number of potential advisors in the faculty. However, the quality of the students has significantly improved (e.g., three of the current graduate students have been awarded highly competitive NSF Graduate Research Fellowships). Again, while the size of the graduate class has remained the same for the last decade, the degree production has almost doubled, from 7 in 2004 to 12 currently. This is a remarkable achievement, and it is possible that the VIGRE and RTG grants that the department received in recent years (that, by itself, is worth mentioning) have contributed to this success. The average time to degree is 6 years. This is in line with comparable institutions but an effort could be made to reduce it to 5-6 years.

The department pays great attention to the demographics of its graduate student cohort. In particular, 18% are women. Although a bit below average as compared with 21%, at other programs at Public Large Universities, it is still a very solid percentage given the national scarcity of women in STEM fields and, in particular, in mathematics. Retention of women may need some attention, as there is a marked difference between the numbers of those who complete the program versus their male counterparts. Perhaps a tighter connection to WiSE could help female graduate students in Mathematics to discuss personal situations and resolve them more frequently in a way that allows the student to complete her degree. Increasing the number of other underrepresented minorities is a very difficult task that afflicts the University of Washington and many, many other institutions of higher education in the United States. 47.3% of the endowment goes to graduate fellowships that are used, in part, as recruitment incentives to enhance diversity and to attract the strongest applicants. Likely more of these are needed. It is worth noting that last year a student chapter of the AWM (Association for Women in Mathematics) was inaugurated at the University of Washington.

Most graduate students are supported with Teaching Assistantships, with a small percentage (10%) with Research Assistantships paid from individual faculty grants. Graduate students are assigned TA mentors (advanced



TA/graduate students), they are videotaped to guide them with their teaching skills, and are observed at times by the instructor in the course. This seems to be a remarkably thorough TA orientation and training process. Graduate students are doing a very good job in the classroom, and we heard that at times they may be even better in the classroom than regular faculty!

The teaching load of graduate students, measured by number of assignments, is similar to peer institutions. But unlike peer institutions, UW Mathematics TAs appear to have a higher frequency of the very high responsibility associated with leading 300-level undergraduate courses. This should be decreased to allow the graduate students more time to develop their research program and broaden their mathematical background. Although sporadically such courses could be assigned to graduate students, this should not be the “status quo”. This same point is made in the section on the undergraduate program.

In the 2004 self-study, the Department questioned the system of the (then) three prelims that were the focus of attention of the majority of students during their first two years, to the detriment of moving earlier into research. Recently this was revised, and currently only two prelims (among the four core areas of algebra, real analysis, complex analysis, topology and manifolds) are required to be passed within two years of entering the program, and one of these may be passed based on the grades received in the corresponding core course. The students expressed marked relief with this new system, and confessed to a release of a great deal of anxiety concerning their prospects in the program. The committee applauds the change.

About 1/4-1/3 of the Ph.D. recipients do not follow an academic career. For this reason, career development activities that guide students on how to apply to non-academic jobs and how to better place them in the workforce are central. The department is aware of this need and career training is in their agenda, with activities ranging from workshops and panels where alumni now in the industrial sector share their experiences with the students to panels addressing how to apply to academic jobs.

The large percentage of Ph.D. Graduates pursuing non-academic jobs has motivated the faculty to participate in an upcoming Ph.D. Degree with an Advanced Data Science option. With its strong group in optimization and other data science relevant areas, with its neighbors in Amazon, Google, Boeing, Microsoft and other high-end technology ventures, the University of Washington is in a privileged position to put together a first of its kind mathematics program in data science that may have a major impact nationwide. Several initiatives across campus related to data science are being coordinated by the eScience Institute.

On a related note, the expertise of the faculty in optimization is ripe to launch a professional masters in optimization anchored in the mathematics department, and possibly bridging with other professional masters offered across campus with an optimization flavor. The intellectual value of this venture, just as the Ph.D. Degree with an option in Advanced Data Science, spans the interdisciplinary flavor of the program, while the tangible returns include a considerable source of external funding that may help with diversity recruitment/retention, postdoc hires, conference and workshop organization, graduate student teaching release, etc.

#### **Recommendations to the Department:**

1. Revisit the language exam requirement in the graduate program. Despite the recent reduction from two languages to one, this remains an artificial hurdle in the program that as currently administered appears not to be offering benefit to the students.
2. The average time to the Ph.D. degree is 6 years. This is in line with comparable institutions but an effort could be made to reduce it to 5-6 years.
3. Reduce the teaching load of graduate students. Graduate students leading the teaching of 300- and above level courses should be the exception and not the rule.
4. Connect the graduate student cohorts in the Department of Mathematics and the Department of Applied Mathematics.
5. Skype interviews could be considered when recruiting graduate students.
6. Consider launching a professional masters degree program anchored in the Department of Mathematics and possibly bridging with other professional masters programs offered across campus with an optimization flavor.

## Research

The Department of Mathematics has a long and distinguished tradition in research. A substantial number of faculty members, both from the past and the present, are very well known for their fundamental contributions to the discipline. There are many examples of prizes and awards that clearly demonstrate this quality. A few examples follow: The prestigious Simons Fellowship, started only in 2012, has already been awarded to several members of the faculty, namely Tatianna Toro, Gunther Uhlmann, Hart Smith, Sandor Kovacs, and very recently Chris Hoffman. Another very prestigious set of prizes given by the American Mathematical Society have recognized Department members: The Bocher Prize in Analysis was won by Gunther Uhlmann and the Bergmann Prize in Several Complex Variables was awarded to Jack Lee.

In addition, it should be pointed out that there are very encouraging signs that the Department's less senior faculty are similarly distinguished researchers: For example, The National Science Foundation CAREER Award has been awarded to Max Lieblich, Jayadev Athreya, Julia Pevtsova, Ioana Dumitriu and Bianca Viray. Finally, it should be mentioned that the majority of the faculty have research funding from outside sources (mainly NSF) at a time when such funding is extremely competitive. Of course we could continue at length, but we hope this has conveyed our view that there can be little doubt of the distinction in research by the Department of Mathematics.

The Department is also quite broad and forward looking in terms of the parts of mathematics that it considers priority areas. These areas span both pure and applied mathematics and the committee is impressed by recent high quality appointments in such areas as probability theory, numerical analysis, optimization and the more mathematically oriented part of computer science which allows it to branch out beyond the more traditional core areas of pure mathematics. We support this breadth, and, for example, the recent appointments of Drusvyatskiy and Rothvoss are healthy avenues toward valuable interaction with intellectual neighbor departments. Such interactions should be increased in the future if opportunities present themselves.

The committee found that the junior faculty and postdoctoral researchers were quite happy, and felt that the Department gave them the ability to participate in various aspects of the Department's activity and they felt well mentored by the senior faculty. Currently there are 12 postdoctoral associates, with Ph.D. degrees from excellent institutions. This is a happy cohort with a great sense of camaraderie. Still, there is but one female postdoc, as the Department is well aware. Effort to increase diversity among postdocs should be continued. There may be opportunities for support from the UW Women in Science and Engineering (WiSE) program. For example, financial assistance could be provided for daycare when graduate students are close to finishing. Although WiSE may be more focused on engineering, it is open to anyone at UW, and for example, the recent WiSE conference had many discussions (<https://www.engr.washington.edu/current/studentprogs/wiseconfsched>) relevant to STEM fields.

The postdoctoral associates appear to do a fine job in their instructional roles, have reasonable teaching loads, and have achieved subsequent good job placement. The substantial size of the contingent of postdoctoral researchers and their importance to the intellectual life of the Department makes it all the more important that the current success in attracting strong candidates be continued and for this we recommend the consideration of a change in their title from the current "Acting Assistant Professor" to a named instructorship or assistant professorship, carrying the name of a great mathematician associated with the University. While it would be ideal for the position to carry additional financial reward, there is no reason that it must (i.e. no endowment is required). This has been done successfully by a number of top departments of state universities such as Berkeley, UCLA, and Michigan and we recommend its consideration here.

While the quality of the faculty is a great strength, the age distribution of the Department is a great concern and represents a huge challenge. To be specific, there are currently sixteen faculty members over the age of sixty. Many of these faculty members will no doubt retire in the next decade, and a concerted effort of replacement should be made. Should this effort not be successfully made, with some entry level faculty members and some in the prime of their career, it is likely that in the coming years there will be a major decline from which it will be difficult to recover.

The Department has already contracted since the downturn of the economy (by 5.5 FTEs) and further contraction certainly seems harmful in the current environment when the number of majors has undergone a huge increase as has the demand on the faculty to provide quality service instruction to undergraduates in a wide variety of majors. It

seems most likely that, if anything, the number of students requiring various mathematics courses in the future will continue to grow substantially.

We recognize and appreciate resources the administration has invested in the Department over the last decade when 12 appointments were made. It is also important and commendable that the Department has been allowed to make offers at various levels of seniority, because the presence of outstanding senior faculty in the prime of their career will help to recruit excellent faculty at all levels.

We strongly urge the administration to communicate to the Department that there is a longer term plan for recruitment and stability in the administration's attitude toward recruitment so that the Department will be confident in its recruitment work in the years to come. This is not only fundamentally important in creating good morale for the faculty, but it will have a profound impact on the quality of the decisions that the Department makes in the hiring process. When faculty members are not confident of the availability of positions in the near future there is always a tendency to attempt to hire in one's own area, even if the available candidates in this area are not of as high a quality as candidates in other areas.

We have observed a remarkable collegiality, good citizenship, and general happiness of the faculty. However, several Department members pointed to the lack of predictability in the determination, year to year, of available positions as a serious concern, and one that could erode this collegiality and happiness were it not to be addressed.

The Department identified a possible source of flexibility which the Committee would like to suggest for consideration: There is evidently a permanent unallocated fund which might be used as a bridge fund in the following way: When the Department wishes to make a tenure-track or tenure appointment prior to the retirement of a current member, this permanent fund might be used to make an appointment and to pay the hire's salary until such a time as the next retirement occurs, at which time the fund would be returned to the Department. This would help the Department to gain the flexibility it needs to take advantage of outstanding opportunities.

When opportunities present themselves for the appointment of an absolutely off-scale appointment we urge the administration to allow the Department to make the corresponding offer. It has been our experience that in peer institutions, the Provost or President of the University can provide the needed funding should such funding not be available at the level of the College Dean's office.

We wish to reiterate our admiration of the Department and Administration on its record of recent appointments. The recent appointees were known to the outside members of the committee and were viewed as very strong. In addition, the committee views the Department's method of selecting candidates for its hiring to be very effective. This features both the designation of priority areas as well as opportunistic hiring, where the exact area (as long as it is regarded as an important, central one within mathematics) is not considered as much as the extreme quality of the potential hire. The Committee agrees with the Department that it is extremely important to be able to make these appointments, and, again, this requires flexibility in terms of the timing of appointment resource allocation.

The Committee is happy to recognize the contribution of the Department to teaching at all levels and to making the University of Washington a destination of choice for so many outstanding students. We feel that the quality of the research faculty has played, and continues to play, an important role in this process. Whether one considers students at the graduate level, undergraduate majors, or undergraduates who need service courses from the Department the presence of distinguished researchers is crucial, and this is another reason that we feel it is so important to maintain the scope and high quality of the Department's research.

In summary: This department has a long and distinguished tradition of excellence in research that is threatened by the combination of a dramatically rising instructional workload, a declining tenure-stream faculty count, and a tenure-stream age distribution skewed toward faculty members in sight of retirement. Now is the time for the administration and department to collaborate to create and execute a hiring plan that assures the continued outstanding health of the research program.

#### **Recommendations to the Department:**

1. Work with the administration to create a plan for the renewal of the tenure stream faculty, continuing the collegial process of strategic planning in parallel with opportunistic hiring which has served the Department well.

2. Consider offering to the postdoctoral associates a title other than “Acting Assistant Professor”, such as a title including a name of a great mathematician associated with the University.

### **Recommendations to the University:**

1. In light of rising undergraduate instructional responsibilities, falling tenure-stream faculty count, and age distribution of the tenure-stream faculty, it is extremely important that the administration communicate to the Department an intention to support a program, consistent across time, of hiring tenure-stream faculty, some above the level of Assistant Professor. Failure to do so could result in hiring “in desperation” rather than adherence to very highest standards of excellence. This is the overarching recommendation to the administration of this review.

### **K-12 Outreach**

The K-12 and outreach activities performed by member of the Department of Mathematics are exemplary! The outreach activities target many different audiences including middle-school students, high-school students, and current undergraduate students. Mathday, led by Jim Morrow, is primarily attended by students in the greater Seattle region, although students from eastern Washington, Idaho, and Oregon have participated. The Department of Mathematics runs SIMUW, a 6-week summer residential program for high school students, led by Ron Irving, with undergraduate and graduate mathematics students recruited from across the country as residential counselors and Mathematics faculty and post-docs participating. Math Circles is led by Julia Pevtsova, and Rekha Thomas, Ioana Dumitriu, and Chris Hoffman are leading MathAcrossCampus. Tatiana Toro has joined the UW CAMP board; CAMP which targets mathematics students from migrant families working in agriculture, primarily in Yakima and eastern Washington. Its goal is aimed at retention, particularly of completing the student's first year of college with a heavy emphasis on calculus. William Stein runs SAGE, an open source software with a developer workshop, that has international impact, and Neal Koblitz encourages women internationally (including Mexico, Vietnam, Cuba and southern Africa) to pursue mathematics at various stages of their careers. Other outreach activities are described in the self-study.

The outreach activities are highly valued by the department. They are primarily funded through grants and donors, and the department assists financially with small amounts of money to bridge gaps. Volunteers from the department are easy to come by, and nearly everyone participates when asked to volunteer.

### **Culture and Governance**

The Department of Mathematics appears to be a wonderful place to work. Everyone that spoke to the committee (undergraduate students, graduate students, postdoctoral associates, administrative staff, advising staff, computing staff, lecturers and faculty) expressed happiness with their employment in the Department. The culture is one of openness, and it seems that everyone is comfortable approaching an appropriate person (chair, advisor, professor, peers) if any problem arises.

In the last ten years, considerable effort has been made to build community amongst the graduate students and post-docs with a remodel of a lounge, happy hour activities, seminars, and pizza parties. This has contributed to the good feeling of the students. As mentioned above, more attention now needs to be placed on building the undergraduate community. Although a request for an undergraduate lounge from the last ten-year review has not materialized, other activities to develop the community of undergrads are recommended. These may include pizza parties every quarter and dedicating a classroom during off-hours for collaborative work on mathematics coursework.

The Department of Mathematics is well-structured with a set of committees (including an Executive Committee, Planning Committee, Undergraduate and Graduate Committees, and several others described in the self-study) that work well with the chair of the department. Everyone said that Ron Irving, Chair of the Department, is doing an excellent job. His effort to groom future leadership is commendable and appears to be highly effective.

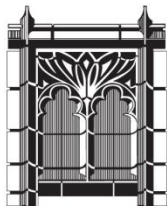
One area of frustration for the Chair, the Planning Committee, and the Department at large, is the lack of an agreed upon long-term hiring strategy from the College. This issue is described in the Research section. The morale of several faculty in leadership positions is declining and would be buoyed by increased communications and strategic

planning between the department and the administration. That this occurs is the overarching recommendation of this report.

Another area of frustration is the current teaching credit system, which will be referred to as the "points" system. The points system is a visible means for allocating teaching and workload assignments. The value of points for teaching undergraduate calculus is very high, thus encouraging tenured and tenure-track faculty to teach calculus, as mentioned in the sections on Undergraduate Service Teaching and Undergraduate Degree Programs. Several opinions were voiced that the teaching credit system needs revision, as it is now creating some unwanted, and maybe perverse, consequences. One example is that the 300 level courses (in particular, 307, 308, and 309) are vastly undervalued in the points system. The department should rethink the system in light of their experience with it over the last ten years, and also be clear as to the goals.

## **Review Organization**

The committee charge letter is included as Appendix A. The review is based upon the contents of the Self-Study document submitted by Department Chair Ron Irving and information shared with the committee during the site visit on February 25 and 26. The agenda for that site visit is included as Appendix B.



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October 14, 2015

Department of Mathematics Review Committee

Paul Hopkins, Professor, UW Department of Chemistry (Committee Chair)

Paula Heron, Professor, UW Department of Physics

Zelda Zabinsky, Professor, UW Department of Industrial and Systems Engineering

Aaron Bertram, Professor, Department of Mathematics, University of Utah,  
Salt Lake City, UT

Robert Fefferman, Max Mason Distinguished Service Professor of Mathematics,  
Department of Mathematics, University of Chicago, Chicago, IL

Irene Fonseca, Professor, Department of Mathematical Sciences, and Director,  
Center for Nonlinear Analysis, Carnegie Mellon University, Pittsburgh, PA

RE: Charge to Committee for the Department of Mathematics Review

Dear Review Committee:

Thank you once again for agreeing to serve on the committee to review the Bachelor of Arts (BA), Bachelor of Science (BS), Master of Arts (MA), Master of Science (MS) and Doctor of Philosophy (PhD) degrees offer by the Department of Mathematics at the University of Washington. Academic program reviews are conducted in accord with the State of Washington legislative mandate, and in conjunction with the College of Arts and Sciences, Undergraduate Academic Affairs, and the Office of the Provost. The Office of Academic Affairs and Planning in the Graduate School will coordinate the review.

As background information, the last review of the Department's degree programs was completed in July 2005. The Graduate School Council unanimously recommended that the Department continue on a 10-year review cycle, with the next review in the 2013-2014 academic year. The Department Chair requested that the review be scheduled to the 2015-2016 academic year.

Review Committee Charge

In general, the committee's charge in this review is to assess the quality of the undergraduate and graduate degree programs and to provide faculty with constructive suggestions for strengthening the programs. These reviews provide the University with a clearer understanding of each program's quality, educational value, role within the academic discipline, role within the University and community, and resource requirements.

For this review, the possible recommendations range from suspension of student entry into the degree programs to a recommendation for continuing status with a subsequent review in ten

years. A shorter term can be recommended if you deem it appropriate. Equally important to this status recommendation, your review can offer the Department and the administration an independent assessment of the “health” of the programs and constructive advice on how they can be strengthened.

The most important objective of your review is an assessment of the academic and educational quality of the unit. Guiding questions for the review include:

1. Are they doing what they should be doing?
2. Are they doing it well?
3. How can they do things better?
4. How should the University assist them?

### Self-Study and Site Visit Agenda

The Department will submit its self-study and draft of the site visit agenda by **February 1, 2016**. The documents will be available for you shortly thereafter on the following Catalyst site: <https://catalyst.uw.edu/workspace/gacad/51099/>, where all the review documents will be located. In addition to the standard (Part A) questions from the academic program review guidelines, the Department is expected to address the issues it has outlined in the Part B: Unit-Defined Questions of the self-study. The questions are attached as an appendix on pages four and five of this letter. Professor Ron Irving may contact the review committee Chair if he has questions about what written documentation would be most useful to the committee as it does its work.

After reviewing the self-study, you may wish to initiate your work before the site visit to ensure a thorough and rigorous review. Based on our experience, we suggest that the external reviewers be relied upon as content experts who can evaluate the quality of the degree programs from a national perspective. They are also likely to be able to comment on recent developments in the field and their incorporation into the Department’s programs. We encourage you to communicate with Professor Irving so that he knows your interests and expectations, particularly for the site visit, and to communicate with other key faculty, if time permits. UW committee members may conduct interviews prior to the site visit as they deem appropriate.

### Site Visit

The two-day site visit on **February 25-26, 2016**, will culminate with an exit discussion. In this discussion we will request the committee’s formal recommendations regarding continuance of the degree programs. The exit discussion will be divided into two portions. The first portion will include Professor Irving and other faculty he may invite, the Associate Dean in the Graduate School, the Divisional Dean for Natural Sciences in the College of Arts and Sciences, the Associate Dean of Undergraduate Academic Affairs, Graduate School Council representatives, and the Associate Vice Provost for Academic and Student Affairs. The second portion, the executive session, will include only the review committee, administrators, and Graduate School Council representatives.

The Graduate and Professional Student Senate (GPSS) participates actively in the program review process. The GPSS will send a survey to current graduate students in the Department. Prior to the site visit the results of the survey will be sent to the review committee and the Department. The report will become a part of the formal record of the review. A GPSS

representative may join the graduate student meeting with the review committee during the site visit. The Department is encouraged to convey the importance of the students' participation in the survey and to assure broad representation in the graduate student session with the committee during the site visit.

#### Review Committee Report and Department Response

We request that the committee submit its written report within 4 weeks of the site visit. Specifically, the written report is due **March 25, 2016**. We will request that the Department submit a written response to the report which will be due on **April 25, 2016**. When the response is available, the report and response will be considered by the Graduate School Council. I will then convey in a letter to the Dean of the College of Arts and Sciences the final recommendations on the Department's review for his consideration and action.

#### Review Documents

Please note that upon completion of program reviews, the primary review documents become public documents and are placed on the UW accreditation web site. The web site and program review documentation are password protected. These documents include the self-study, the review committee report, the GPSS report, the unit's response to the report, and my letter on final recommendations of the review to the Dean of the College of Arts and Sciences.

Thank you for your time and effort. Please contact Augustine McCaffery, Senior Academic Program Specialist, at amccaf@uw.edu with any questions you may have about the review.

Sincerely,



David L. Eaton  
Vice Provost and Dean

- c: Patricia Moy, Associate Vice Provost for Academic and Student Affairs,  
Office of the Provost  
Ron Irving, Professor and Chair, Department of Mathematics  
Werner Stuetzle, Associate Dean for Natural Sciences, College of Arts and Sciences  
Jason Johnson, Associate Dean, Undergraduate Academic Affairs  
Tatina Toro, Professor and Graduate Program Coordinator, Department of Mathematics  
Rekha Thomas, Professor Department of Mathematics  
Brooke Miller, Director of Student Services, Department of Mathematics  
Michael Brown, Professor, Department of Earth and Space Sciences, and  
Graduate School Council Representative  
Dan Turner, Principal Lecturer, Foster School of Business, and Graduate School  
Council Representative  
Rebecca Aanerud, Associate Dean for Academic Affairs and Planning,  
The Graduate School  
Augustine McCaffery, Senior Academic Program Specialist, Academic Affairs  
and Planning, the Graduate School



## Department of Mathematics Unit-Defined Questions

May 21, 2015

### 1. Faculty composition, research profile, and demographics

- (a) What is the optimal balance of tenure-line faculty, lecturers, postdocs (AAPs), and part-time lecturers in order to staff our courses and fulfill our research program?
- (b) What areas of mathematics that are existing departmental strengths should we maintain or add to? What areas where we are not represented should we consider developing? What opportunities might there be to build partnerships with other departments, including making joint faculty appointments? How should our department evolve in the next decade?
- (c) How can we enhance our opportunities to build a more diverse faculty?
- (d) Should we continue to focus our hiring at the tenure-track assistant professor and early associate professor levels? Under what conditions might we consider opportunities to hire at a more senior level?

### 2. Scale and nature of graduate program.

- (a) How many graduate students should we aim for, to the extent that we have discretion over this number?
- (b) Does the current core curriculum serve our students? Do we have suitable mechanisms in place to allow effective reflection, discussion, and revision of our core curriculum and preliminary exam system when warranted?
- (c) What more can or should we do to prepare our PhD students for academic careers of research and teaching, and for potential non-academic careers?
- (d) Should we develop a new, fee-based MS program that prepares students for careers in industry? If so, with what mathematical emphasis?

### 3. Scale and nature of undergraduate program.

- (a) Are we meeting the needs of client departments in our 100-level and 300-level offerings? Do we have the right mix of faculty and graduate students to teach these courses?
- (b) What is the number of BA and BS majors our program can accommodate successfully?
- (c) Is there a preferred mix of BA and BS students?
- (d) Does the BS program meet the needs of our students?
- (e) Can the BA program be re-designed to meet the needs of the students we attract, while still providing a rigorous degree?

#### 4. Technology.

- (a) Are there opportunities to enhance our research infrastructure through new technology?
- (b) Are we taking sufficient advantage of technology in our courses and classrooms?  
Should we aim to transform certain courses via technology?
- (c) Is our online calculus experiment successful? Should we continue to offer calculus online, and should we consider online versions of other courses?
- (d) How is WebAssign working for us? Should we expand its use or look at alternatives?  
Also, should we consider online grading systems for exams?
- (e) Should we develop a social media presence?
- (f) What is the best framework for evaluating new technological opportunities and providing ongoing support? What mix of faculty, departmental staff, university staff, and university facilities should be employed?

**UNIVERSITY OF WASHINGTON**  
**Department of Mathematics**  
**Review Site Visit Agenda**  
**Conference Room C 401 Padelford Hall**  
**February 24-26, 2016**

<b>DAY 1</b>	<b>GROUP</b>
6:00 p.m.	Dinner: Review Committee – Nell’s Restaurant (206.524.4044) 6804 E. Green Lake Way North
<b>DAY 2</b>	
8:30 – 9:15 AM	Department Leadership: Ron Irving Chair; Tatiana Toro, Associate Chair; John Palmieri, Graduate Program Director; Rekha Thomas, Undergrad. Program Director; Steffen Rohde, Planning Committee Chair
9:15 – 10:00	Planning Committee (Steffen Rohde, Chair)
10:00 – 10:15	<i>Break</i>
10:15 – 11:00	Graduate Program Committee and Graduate Admissions Committee (John Palmieri, Chair)
11:00 – 11:45	Undergraduate Program Committee (Rekha Thomas, Chair) and Advising Staff (Brooke Miller, Director, Student Services)
11:45 – Noon	<i>Break</i>
Noon – 1:00 PM	Lunch – Review Committee with Graduate Students: Caleb Geiger, Sean Griffin, Courtney Kempton, Dali Nimer, Bharathwaj Palvannan, Manar Riman, Tuomas Tajakka, Jair Taylor, Elizabeth Wicks, Amy Wiebe
1:00 – 1:15	<i>Break</i>
1:15 – 2:00	Principal Lecturers, Senior Lecturers, Lecturers
2:00 – 2:45	Assistant Professors
2:45 – 3:00	<i>Break</i>
3:00 – 3:45	Associate Professors and newest Professor
3:45 – 5:00	Open session for individual faculty (ten-minute mini-slots for faculty who wish to meet with committee)
6:00	Dinner: Review Committee – Tilth Restaurant (206.633.0801) 1411 N. 45 <sup>th</sup> St.

**UNIVERSITY OF WASHINGTON**  
**Department of Mathematics**  
**Review Site Visit Agenda**  
**Conference Room C 401 Padelford Hall**  
**February 24-26, 2016**

**Day 3**

- |                 |   |
|-----------------|---|
| 8:30 – 9:15 AM  | Department Staff  |
| 9:15 – 10:00    | Undergraduate Mathematics Majors: John Yearsley, Austin Tran, Mark Bennett, Will Dana, Ada Beale, and ACMS Major: Calvin Cotton   |
| 10:00 – 10:15   | <i>Break</i>  |
| 10:15 - 11:00   | Applied and Computational Mathematical Sciences director Marina Meila (Statistics), ACMS Steering Committee members Tom Duchamp (Math), Anne Greenbaum (AMath), Randy LeVeque (AMath)   |
| 11:00 - 11:30   | Outreach: Jim Morrow (Mathday), Julia Pevtsova (Math Circles), Ron Irving (SIMUW), Neal Koblitz (Kovalevskaja Fund), Tatiana Toro (CAMP), William Stein (Sage), Chris Hoffman (MathAcrossCampus)  |
| 11:30 – Noon    | Acting Assistant Professors and Postdoctoral Fellows  |
| 12:00 – 1:00 PM | Lunch -- Review Committee: UW Club, Colleen Rohrbaugh Room  |
| 1:00 – 2:30     | Review Committee Executive Session  |
| 2:30 – 3:30     | Exit Discussion: Part One<br>Review Committee with Department Leadership<br>Werner Stuetzle, Divisional Dean of Natural Sciences,<br>College of Arts and Sciences<br>Patricia Moy, Associate Vice Provost for Academic and Student Affairs,<br>Office of the Provost<br>Rebecca Aanerud, Associate Dean, Academic Affairs and Planning<br>The Graduate School<br>Jason Johnson, Associate Dean, Undergraduate Academic Affairs<br>Augustine McCaffery, Senior Academic Program Specialist,<br>The Graduate School<br>Graduate School Council Representatives: Michael Brown, Professor,<br>Department of Earth and Space Sciences; Dan Turner, Principal Lecturer,<br>Foster School of Business |
| 3:30 – 4:30     | Exit Discussion: Part Two<br>Review Committee with Administrators, Graduate School Council<br>Representatives without Department Leadership   |
| 4:30 – 5:00     | Review Committee Debriefing   |