Academic Program and Curriculum Committee

Review of the Undergraduate Program in Actuarial Science

Review Team:
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1. Introduction and General Data

The Department of Mathematical Sciences completed the program self-study on the Actuarial Science program in October 2021. The review team used the self-study report as a reference for interviews with the faculty, students, and academic staff. The self-study report covers the 2014-2015 through 2020-2021 academic years. The review team appreciates the time and thoughtful responses of those interviewed.

The Actuarial Science program, including a B.A. in Actuarial Science and a minor in Actuarial Science, is administered by the Department of Mathematical Sciences in the College of Letters and Science. Even though the Program is relatively new (established in 2005), it has already obtained world-class recognition. The Program has been designated as a Center of Actuarial Excellence (CAE) by the Society for Actuaries (SOA) since 2016. Only 33 programs have this highly coveted designation globally, 17 in the United States, and 2 in the UW system.

According to the most current data provided in the self-report, the Actuarial Science program has 62 intended and 34 declared majors. The Program also administers M.S. and Ph.D. degrees in Actuarial Science. In addition to the Actuarial Science program, the Department of Mathematical Science offers three other majors (Mathematical Science, Applied Mathematics & Computer Science, and Data Science).

The Program's goal is to train actuaries who analyze the financial consequences of risk. Actuaries investigate and evaluate the probability of uncertain future events using mathematics, statistics, business knowledge, and computer science skills. Actuaries also design creative methodology to reduce the financial impact of adverse events. The Program emphasizes interdisciplinary learning and includes economics, business, and computer science courses.

The Program has two tenured and one clinical faculty. However, one tenured faculty member is leaving for another institution. Since CAE designation requires three permanent faculty, the Program will no longer meet this requirement starting next academic year.

The Actuarial Science program contributes substantially to undergraduate education at UWM by providing students with a world-class actuarial education while pursuing a liberal arts degree. The curriculum is consistent with SOA guidelines and well-structured. With a solid connection to local industry, such as Northwestern Mutual, graduates obtain satisfactory employment after graduation, and keep close ties with the Program.

Recommendation:

1. The Actuarial Science program should continue.

2. Accreditation and Review

Accreditation

As mentioned in the previous section, the Program has been awarded the prestigious CAE status by the SOA since 2016. The designation is granted for five years and requires annual evaluation. The letter from SOA in the self-report study indicates that the designation expires in 2026 and requires a renewal review.

Responses to the Most Recent APCC Report

The Actuarial Program has made a good-faith effort to respond to the 2011-2012 departmental review recommendations. The recommendations and responses are summarized below.

1. The undergraduate Program in Actuarial Science is a small program at UWM that not only should be continued and that warrants consideration for expansion. It provides a rather uncommon degree that is in demand in the workplace. The quality and dedication of the faculty is noteworthy, and student and alumni opinions of the Program are high.

The Program has continued to grow and achieved more than anyone expected. However, without additional investments from the university it struggles to maintain its world-class status and cannot consistently attract significant numbers of high-caliber students. This also limits its ability to attract major investments from donors.

2. Faculty from related disciplines should be invited to be affiliated with the Actuarial Science program, and a larger steering body for the Program should be created. While the Mathematical Sciences faculty involved with the Program do an exceptional job and should remain the core of the Program, improved communication between program elements would likely be achieved through such an enhanced structure.

Students in this Program take two courses from each the Department of Economics, the Lubar School of Business, and from the Department of Computer Science. Those courses are taught by multiple people, sometimes part-time lecturers or graduate students. The Society of Actuaries views such faculty as lacking commitment to the Program, therefore we did not invite any faculty from those disciplines to participate in managing the Program. The group that teaches a lot (six core courses) for this major and are knowledgeable about the profession are statisticians of the Department. We do maintain excellent communication channels with statisticians. And they did meet with the SOA site visit teams when the Program applied for CAE designation. One way to make this relationship even stronger is to hire a new faculty who has expertise at the intersection of data, statistical and actuarial sciences.

3. Advisors in the College of Letters & Sciences should meet annually with program faculty to be sure that they are able to provide correct assistance when contacted by students.

In 2013-14, we had several meetings with advisors in the College of Letters & Science, which helped improve the quality of advice students get. The only challenge that remains is frequent staff turnover at Letters & Science (we need to "retrain" the college advisors every two years).

4. Space for a student resource center should be found in the vicinity of the Department of Mathematical Sciences, and such a facility should be created.

We have a room in the old Physics building which is used for undergraduate statistics tutoring. (This year the tutoring center is being relocated to Bolton.) Since most of the tutors are actuarial MS students, the undergraduates use tutoring services for actuarial advising as well. However, having a dedicated study room on the fourth floor of EMS would be better. There, students could prepare for professional exams, have access to a small library of actuarial journals, books, and exam preparation materials.

5. The size of the program faculty should be increased so as to allow for additional course offerings to prepare students to take additional actuarial exams. If the number of faculty increases, such courses should be developed.

The additional courses have been developed by the existing program faculty. The curricular changes addressed CAE evaluation committee concerns, but it became extremely difficult to maintain those new commitments due to the shortage of actuarial faculty. We remain hopeful the university will recognize this urgent need and help us preserve the CAE status.

6. *A mechanism in the College of Letters & Sciences should be found to improve publicity for the Actuarial Science program, so that more students are aware of the Program and may be interested in pursuing it. This Program has advantages in comparison to the other actuarial Program in the UW System, and good marketing of the Program could draw more incoming students towards the Program.*

Over the years the Letters & Science' College Relations office has developed brochures and other promotional materials about the Program. This office also helped the Actuarial Club organize a student conference which gave a boost to program visibility. In 2018, UWM hosted the 6th Annual Midwest Actuarial Student Conference. More than 100 actuarial students from other universities and local high schools, representatives from both SOA and CAS, and guest speakers from industry were the participants of this exciting event. This event drew generous sponsorship from insurance companies, consulting firms, and actuarial organizations.

7. In addition to Item 5, the Mathematical Sciences Department itself should also work to increase their efforts to publicize the Program and recruit students to the Program.

Similar to Reply 6, the department website is better structured now than it was 7-8 years ago. Also, having a CAE designation, Industry Advisory Board, ActSci curricular area, and program newsletter helps. Of course, more could be done but that requires more manpower.

Recommendation:

2. The Program should continue to meet all the criteria to maintain the CAE designation.

3. Faculty

Standards addressed in this section:

Faculty and instructional academic staff are qualified and in sufficient numbers to provide quality learning experiences.

At least 25% of total tenure-tenure track faculty time is committed to the undergraduate Program.

At the time of the most recent Self-Study, the Program was served by two tenured faculty members and one academic staff member in the Mathematical Sciences department. This minimal level of staffing is exacerbated by the departure of Professor Wei, reducing the Program to one tenured research position and one clinical professor. The continuing faculty are:

- Brazauskas, V. (Ph.D., Statistics, University of Texas at Dallas, 1999; ASA, Society of Actuaries, 2013; Professor, 2011-present; Associate Chair for Actuarial Science, 2017-present).
- Skordi, P. (Ph.D., Mathematics Education, Curtin University (Australia), 2015; FCAS, Casualty Actuarial Society, 2011; Associate Clinical Professor, 2020-present; Actuarial Science Undergraduate Director, 2020-present).

The Program's designation as a Center of Actuarial Excellence requires three permanent faculty. Based on the CAE requirements, there is a clear need for at least one additional tenure-line hire beyond the VAP to support the Program. A Visiting Assistant Professor (VAP) position has been authorized, but it is crucial to convert or replace the VAP position with a tenure-leading line.

Professor Skordi, the Actuarial Science Undergraduate Director, is responsible for activities related to student advising and mentoring; student recruitment, outreach and fundraising activities; supervision of internships and capstone projects; administration and improvement of the Program. He serves as faculty advisor for the Actuarial Club and builds connections with local and national employers and actuarial organizations.

Professor Brazauskas regularly teaches ActSci 391 (Investment Mathematics I), MthStat 361, 362 (Introduction to Mathematical Statistics I, II), ActSci 596/796, 597/797 (Actuarial Statistics I, II), ActSci 895 (Ph.D. level topics), and multiple other courses in Statistics. Professor Skordi teaches ActSci 290 (Introduction to Actuarial Science), ActSci 490 (Introduction to Actuarial Practice), and ActSci 599 (Capstone Experience). He also leads fundraising activities.

Professor Wei taught ActSci 391, 591/791 (Investment Mathematics I, II), MthStat 361, 362 (Introduction to Mathematical Statistics I, II), ActSci 593/793, 594/794 (Actuarial Models I, II), ActSci 596/796, 597/797 (Actuarial Statistics I, II), ActSci 891 (Actuarial Risk Theory), ActSci 895 (Ph.D. level topics). Due to faculty shortages, Ph.D. students are teaching some upper-division courses. Graduate teaching assistants who teach their own course are qualified, hold at least a Master's degree in Actuarial Science or a related field, and are closely supervised.

On average, during the review period more than 25% of faculty time seems to be allocated to supporting undergraduate education. The Program also contributes significantly to graduate education to fulfill another critical mission of an R1 institution. The Associate Chair for Actuarial Science, Prof. Brazauskas administers the M.S. and Ph.D. programs. Supervision of doctoral theses has been shared between Professor Brazauskas and Professor Wei.

The faculty are distinguished professionals. One member is a Fellow of the Casualty Actuarial Society (FCAS), and one is an Associate of the Society of Actuaries (ASA). These designations are essential for actuaries working in industry, government, or academia. Research interests of the actuarial science faculty include many areas at the intersection of actuarial science, cyber risk management, quantitative risk management, statistics, and applied probability. Their research contributions have appeared as published articles in top-tier actuarial journals (e.g., *Annals of Actuarial Science*, *ASTIN Bulletin*, *Insurance: Mathematics and Economics*, *North American Actuarial Journal*, *Scandinavian Actuarial Journal*) as well as peer-reviewed journals in statistics, applied probability, and related areas.

Members of the group have also been successful in securing external funding from the National Science Foundation, the Society of Actuaries, the Casualty Actuarial Society, the Actuarial Foundation, and the Actuarial Profession. Further, they have been regular speakers at various actuarial research meetings, such as Actuarial Research Conference and Congress on Insurance: Mathematics and Economics. Prof. Brazauskas and Prof. Wei have led the research activities of the group. From 2015 to 2021, they published 24 peer-reviewed papers, secured five research grants, supervised 6 Ph.D. dissertations, and presented their research findings at 22 conferences. At present, four dissertators work on their theses under the supervision of actuarial faculty.

Conclusion:

The standard addressed in this section is met. The Program seems to be functioning well despite its declining faculty size. Still, it needs to hire new faculty to sustain successful undergraduate education without jeopardizing graduate education and to maintain the CAE designation.

Recommendation:

3. The Program should be allowed to hire a permanent tenure-line faculty to replace Professor Wei, in order to avoid losing the prestigious CAE status. It is also ideal to add another tenure-line faculty to allow for more stability and growth of the program.

4. Students

Standard addressed in this section:

There are adequate numbers of qualified students for meaningful cohorts to meet learning objectives.

Students indicating an intended major in Actuarial Science are put on an email reflector and invited to meet with advisers during Open Advising events staffed by actuarial faculty in the Fall and Spring semesters. Students who have completed at least 15 university credits can declare their major. The declaration can be done at the Open Advising events or at any time with the Actuarial Science Undergraduate Director and with the Department's Assistant Chair or Associate Chair. The self-report mentioned the difficulty of screening and recruiting qualified students.

Statistics reported in the Self-Study show declines in both intended and declared majors between 2014 and 2020. However, the numbers generally track overall enrollment trends at UWM and do not reflect a diminished interest in Actuarial Science. Actuarial Science is an appropriately demanding program, given its professional application. The Program appears to be graduating the same number of highly competent and successful students that it was in 2014. During the site visit, the faculty noted that interest in the major has shown a recent improvement and suggested that lower numbers in the last two years are probably due to the effects of the pandemic. Authors of the Self-Study note: “The drop in intended majors in 2020-21 is an outlier. In Fall 2021, the numbers bounced back: Intended = 62, Declared = 34.”

Out of the 73 students who graduated between Fall 2014 and Spring 2021, 8 were of self-reported ethnicities other than Caucasian or International, and 34 were female. Of the intended and declared majors (96) enrolled in Fall 2021, 29 are self-reported females, 3 African American, 2 Asian American, 12 International, 4 Latino/Latina, and 11 self-identified Multi-Ethnic. The faculty strive to improve through more attention to reaching out to and mentoring under-represented students.

During the site visit, the committee interviewed five students. Of those, 3 were women, and 2 were racial/ethnic minorities. Those students indicated strong general satisfaction with the Program and their likely career outcomes. Actuarial Science is a highly demanding area of practice, with up to 12 professional examinations required for full certification. These tests require outlays of several hundred dollars for registration and preparatory materials. UWM reimburses these expenses, but the terms and procedures for reimbursement do not seem clear to the students, who noted that payment had previously been available for any passing attempt and is now given in advance for a single attempt, regardless of the outcome.

All the students interviewed had passed at least one exam, and several had passed more than two. Students and faculty reported markedly improved pass rates over the last three years, attributable to improved curriculum and mentoring.

The faculty reported that a University Enrolled Credit (UEC) arrangement is planned for implementation soon. This will allow students to meet some of their certification requirements from coursework alone, bypassing some exams. However, it should be noted that the UEC program will impose an additional

burden on the faculty in the form of administration, reporting, and curriculum review. Students were firmly in favor of UEC.

Students voiced only minor concerns and suggestions as follows:

- The need for greater clarity about reimbursement policies;
- The need for more communication from the Program upon students' declaration of the major;
- The need for a review of the curriculum to allow students who have passed professional exams to waive courses that duplicate the exam topic;
- The need for common space for students;
- The need for coordination with the Business School about prerequisites for Business Administration courses that are required for the Actuarial Science major (e.g., students said that they were told to take BUS ADM 350 as a prerequisite for BUS ADM 450, but they felt that the 350 material had already been covered in other courses they have taken).
- Improvement to academic advising at the L&S level, possibly by training/designating a specialized advisor for the Actuarial Science program, whose requirements seem notably complex in relation to other majors.

Conclusion:

The standard addressed in this section is met.

Recommendation:

4. Faculty should continue their efforts to recruit and retain students, especially underrepresented students (e.g., first-generation, female, and racial and ethnic minorities).

5. Because of the Program's complexity, faculty should continue to communicate clearly with students regarding requirements, exam-fee reimbursement, course waiver, and prerequisites.

6. The program may want to consider a joint effort with other UWM data and statistics-related programs for student recruitment. Perhaps it could ask UWM to create a web page with a list of such programs with a detailed description of each, including mathematics prerequisites.

7. The program should work with the L&S to improve academic advising at the L&S level, possibly by training/designating a specialized advisor for the Actuarial Science program.

5. Curriculum

Standard addressed in this section:

There is an organized and coherent sequence of coursework that prepares students to meet the educational goals of the Program, secure appropriate employment, and pursue graduate study.

The learning outcome reflects expected workforce competencies.

To address the CAE evaluation committee concerns, the Actuarial Science major and minor requirements were substantially revised starting in Spring 2020. To maintain up-to-date training in the field, the Program has an Industry Advisory Board with members from Humana, Northwestern Mutual, and Milliman. The Board provides guidance and advice on various program improvement issues such as

curriculum revisions, student recruitment and outreach, co-op and internship programs, and scholarships and fundraising.

The curriculum of the Actuarial Science program has two educational goals. The immediate goal is to have graduates secure employment as actuarial trainees. (Note that an employee is not regarded as an actuary unless they have received a professional qualification.). The long-term goal is to provide an educational foundation for students to acquire professional qualifications by self-study.

Courses for the major are organized in preparatory and core coursework. Preparatory coursework consists of four categories: 1) the course that serves as an introduction to the profession (ActSci 290), 2) the courses required to earn Validation by Educational Experience (VEE) credit in Economics (Econ 103-104), 3) the prerequisite course for the Core Coursework in Finance (BusAdm 201), and 4) the courses that are prerequisites for the core coursework in Actuarial Science and Statistics, including three semesters of calculus (Math 231-233), one semester of linear algebra and differential equations (Math 234), and two computing courses (CompSci 250-251).

The core coursework covers probability, financial mathematics, investment and financial markets, short- and long-term actuarial mathematics, statistics for risk modeling, and predictive analytics. All majors are required to take a capstone course (ActSci 599). In addition to coursework in actuarial knowledge and skills, the Program offers courses that facilitate employment opportunities for students. For example, ActSci 490 invites professional actuaries to provide students with a general understanding of financial consequence risks and address current events. It includes an Actuarial Career Day when our students have one-on-one discussions with our professional colleagues about any career-related topics and get coaching in presentation and interview skills. Students are also encouraged to pursue internship opportunities (ActSci 590) with insurance companies, consulting firms, and other organizations requiring actuarial knowledge and skills.

The preparatory Coursework and Core Coursework jointly serve to prepare students for professional Exams P, FM, IFM, and either LTAM or STAM, VEE credits (which can be earned in accounting and finance, economics, and mathematical statistics), and parts of Exam SRM or Project PA (depends on which courses are selected).

For the minor, students are expected to have adequate training in mathematics (Math 231-234), be familiar with the actuarial profession (ActSci 290), and have the necessary background to pass Exams P (MthStat 361) and FM (ActSci 391) and earn VEEs in Mathematical Statistics (MthStat 362) and Accounting and Finance (BusAdm 450).

Conclusion:

The standard addressed in this section is met.

Recommendation:

8. The course content and sequence for Actuarial Science major and minor should continue to support both academic inquiry and employment preparation.

6. Resources

Standard addressed in this section:

There are sufficient resources to meet program needs:

A. ***For Assisting Students.*** The Undergraduate Director is mainly responsible for advising undergraduate students.

B. ***Providing Program Stability***. The budget for the Actuarial Science Program is under the Department of Mathematical Science. The Department's overall budget and S&E has declined past few years, but it did not have a negative impact on the Program. With the departure of Dr. Wei, the Actuarial Science program is now at risk of losing the prestigious CAE designation if they do not hire tenure-track or tenured faculty within a year. Although the Program does not have a separate budget, it received funding from Northwestern Mutual between 2006-2014, which provided $730,000 for scholarships, exam-fee reimbursements, faculty position support, student recruitment, outreach, and similar activities.

C. ***For Facilities and Space within the University***.
The Program is located in the Department of Mathematical Science. Faculty have individual offices, but the larger offices might be necessary, especially for the Actuarial Science Undergraduate Director with the most considerable advising load. There is no official space for students.

Conclusion:

The standard addressed in this section is met.

Recommendations:

9. The gift from Northwestern Mutual between 2006 and 2014 certainly helped the Program obtain the world-class CAE status. To maintain its stability, the Program should receive continuous financial support for scholarships, exam fee reimbursement, and other necessary activities.

10. If necessary, the Program faculty should ask the Department chair for a larger advising space.

11. It is ideal to have an official space equipped with computers and a printer for Actuarial Science students to study for professional exams. Teamwork is an effective tool for preparation.

7. Evaluation

Standard addressed in this section:

A. An evaluation process that involves students, faculty, graduates, and community members, as appropriate, is in place and the data gathered is used to monitor the Program and direct its changes.

The Society of Actuaries' criteria guide the Program's ongoing self-evaluation for designation as a Center of Actuarial Excellence. In addition to standards focusing on the curriculum and faculty, other benchmarks include a four-year rolling average of at least ten graduates (at all levels) per year, production of high-quality graduates in demand by employers, and meaningful industry connections. The Program's periodic applications for this designation require substantial documentation indicating satisfactory outcomes on these criteria. These efforts are in addition to the submission of outcomes assessment data to WEAVE that is required of all programs on campus.

The Program conducts exit interviews with graduating students and collects testimonials from employers who have hired its graduates. The Society of Actuaries' professional exams also provide a unique opportunity to evaluate the Program's outcomes via assessing the number of students who take and pass the exams.

B. 90% of students complete the program within five years.

On average, Actuarial Science majors completed their Bachelor's degree within 24 months after declaring the major (based on an educated guess made by the Program's faculty).

C. 75% of graduates have satisfactory employment within one year of graduation.

The Program uses a stringent standard for determining "satisfactory employment", as it counts only those graduates working in a job that directly uses their actuarial training; an attractive, well-paying job in some other domain does not count. Further, this assessment is made six months after graduation, rather than after one year. These choices are sensible in light of the requirements surrounding the Program's applications for Center of Actuarial Excellence designation, but they do have the effect of depressing the satisfactory employment percentage relative to other programs on campus that define the term more loosely or use a one-year follow-up period.

Among the 73 B.A. graduates produced between 2014-15 and 2020-21, 38 (52%) secured full-time employment in the actuarial field within six months of graduation. Given that there are undoubtedly many other graduates who either continued to further education, took somewhat longer than six months to find a job, or obtained BA-appropriate jobs in non-actuarial settings, it seems likely that the 75% standard is being met. Also, employer testimonials indicate a high level of satisfaction with UWM graduates' preparation and job performance.

D. Relevant credential, if any, achieved within one year of graduation.

Students' results on the Society of Actuaries' professional exams offer some relevant credentialing information. From 2014-15 through 2020-21, 31 B.A. graduates (representing 42% of all B.A. graduates) had passed two or more professional exams while at UWM. This rate seems reasonable, but improvement in it could also be the focus of more targeted efforts by the Program.

The Program has also produced an impressive number of alumni who have achieved credentials as Fellows or Associates of major professional societies. These graduates' average time to receive their credentials is right in line with the field's overall average.

Conclusion:

The standards addressed in this section appear to be met.

Recommendations:

12. The Department should continue to monitor learning outcomes, completion rates, and, to the extent possible in practice, post-graduation employment rates. While it is appropriate to continue collecting employment data that line up with reporting requirements in the application for Center of Actuarial Excellence designation, for internal purposes it also would be helpful to collect data that are more consistent with UWM's guidelines (expanding to include non-actuarial employment and a one-year follow-up period).

13. As part of providing relevant education, training, and post-graduation preparation, the Department should continue to carefully monitor student performance on professional exams and think of feasible steps to increase the proportion who graduate with at least two exams passed.

14. The Department should continue to provide a supportive and welcoming environment for all students, including racial/ethnic minority, gender and sexual minority, first-generation, and female students.

8. Summary and Recommendations

In summary, the undergraduate Program in Actuarial Science is impactful and meaningful. It prepares students for entry into the workforce while still providing the rich context of a liberal arts education. The most notable feature of the Program is the prestigious CAE designation. Finding an immediate permanent replacement for Professor Wei is mandatory to keep the designation, and the UWM should make that a top priority.

The Department and the Program are functioning exceptionally well despite the decline in faculty. The faculty are attentive to changes in students' needs concerning academic inquiry and employment preparation. We expect that the Program will continue to attract many students in the future, and we hope that our recommendations will help maintain the Program's strength and contribute to further improvements.

Recommendations:

1. The Actuarial Science program should continue.

2. The Program should continue to meet all the criteria to maintain the CAE designation.

3. The Program should be allowed to hire a permanent tenure-line faculty to replace Professor Wei, in order to avoid losing the prestigious CAE status. It is also ideal to add another tenure-line faculty to allow for more stability and growth of the program.

4. Faculty should continue their efforts to recruit and retain students, especially underrepresented students (e.g., first-generation, female, and racial and ethnic minorities).

5. Because of the Program's complexity, faculty should continue to communicate clearly with students regarding requirements, exam-fee reimbursement, course waiver, and prerequisites.

6. The program may want to consider a joint effort with other UWM data and statistics-related programs for student recruitment. Perhaps it could ask UWM to create a web page with a list of such programs with a detailed description of each, including mathematics prerequisites.

7. The program should work with the L&S to improve academic advising at the L&S level, possibly by training/designating a specialized advisor for the Actuarial Science program.

8. The course content and sequence for Actuarial Science major and minor should continue to support both academic inquiry and employment preparation.

9. The gift from Northwestern Mutual between 2006 and 2014 certainly helped the Program obtain the world-class CAE status. To maintain its stability, the Program should receive continuous financial support for scholarships, exam fee reimbursement, and other necessary activities.

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