Actuarial Science at One Four-Year Comprehensive University

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Abstract: Building an Actuarial Science program designated as advanced requires dedicated faculty, support from the administration, and a core group of strong students. Washburn University may serve as a model for those wishing to start or enhance such a program at their institution. We face three main ongoing challenges: first, the hiring and retention of high-caliber statisticians; second, attraction and retention of top-quality students; and third, concerns over small upper-division classes. We examine the relevant history of the program at Washburn, the actuarial science curriculum, necessary computing experience, the Society of Actuaries/Casualty Actuarial Society exam series, work experience including internships, and some useful actuarial science sites on the World Wide Web.

Keywords: Actuarial science, internships, mathematical statistics, Society of Actuaries, theory of interest.

1. ABOUT WASHBURN UNIVERSITY

Founded in 1865 as Lincoln College, Washburn University is a public, liberal-arts teaching-focused 4-year comprehensive university located in Topeka, Kansas, and is accredited by the Higher Learning Commission. As of Fall 2013, overall enrollment stood at 6973 (headcount). The department of Mathematics & Statistics is one of 19 departments housed in the College of Arts & Sciences. Mathematics & Statistics supports three major tracks in mathematics: (i) Pure Mathematics; (ii) Mathematics for Secondary Education; and (iii) Actuarial Science. Actuarial students at Washburn University pursue a BA or BS in Mathematics, with a concentration in Actuarial Science. The requisite business, accounting and economics courses for the actuarial science track are taught in the School of Business.

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2. INITIAL ACTUARIAL SCIENCE PROGRAM AT WASHBURN (PRE-2000)

Washburn University’s actuarial science program was spearheaded by the author’s former Chair, with the program’s first graduates graduating in 1992–1993. The need for our program arose from demand from employers with actuarial departments such as Blue Cross/Blue Shield of Kansas and Security Benefit Group in Topeka. At that time, the Society of Actuaries (SOA) and Casualty Actuarial Society (CAS) exam series contained exams on operations research, numerical analysis (among other topics, no longer part of the exam series). Thus, appropriate existing courses were used to support the new program; however, some new courses had to be created, most notably Mathematical Statistics II and Actuarial Mathematics. These two new courses were offered as MA 390 Special Topics courses from 1989–1990 to 1994–1995 at which point they were formally put on the Washburn University catalog with their own course names, descriptions, and catalog numbers.

To better understand the requirements for actuarial students, our program’s director passed five SOA/CAS exams; the process began during an academic sabbatical in Spring 1989. (Faculty may be reimbursed for passing exams beyond P1 and FM2.) The director also visited the University of Nebraska-Lincoln, to learn how their actuarial science program was structured. The initial mathematics requirements for the actuarial track were the three-semester Calculus sequence, Linear Algebra, Applied Statistics, Theory of Interest, Mathematical Statistics I and II, Operations Research, Numerical Analysis, and Actuarial Mathematics. The goal of the program at its inception was to prepare students to pass Exams 100 and 110 prior to graduation, and offer sufficient preparation in the theory of interest, operations research, numerical analysis, and actuarial mathematics to facilitate further independent study on those topics after graduation.

In the late 1990s, SOA/CAS announced major changes to the exam series to take effect in November, 2000. The new philosophy made the exam series less purely mathematical, and moved to exams focused heavily on applied probability and statistics encountered in everyday actuarial problems. For instance, the old Exams 100 and 110 essentially became the current Exam P1 (“probability”). To pass the new Exam P1, candidates needed a strong understanding of the elements of calculus and linear algebra to solve a probability application; questions testing strictly calculus or linear algebra concepts were deemed unnecessary. The new Exam FM2 (“financial mathematics”) examined theory of interest concepts and topics in economics/business finance; this exam bears some similarity to the old SOA Exam 140.
3. WASHBURN’S POST-2000 ACTUARIAL SCIENCE PROGRAM

In response to the significant changes to the SOA/CAS exam series, the author and a statistician colleague made curriculum revisions in 1998–1999. In particular, the courses in Operations Research, Numerical Analysis, and one Business course were removed as requirements. In their place, we required courses in Regression Analysis, Time Series Analysis, and Stochastic Processes. The Business requirements were Principles of Risk and Insurance, Property and Liability Insurance, Life Insurance, and Theory of Insurance; the new requirements are Principles of Risk and Insurance, Business Finance, and Investments. We updated the syllabi for the Mathematical Statistics I and Theory of Interest to reflect the topics for Exams P/1 and FM/2, respectively. The goal was to meet the SOA requirements for an Advanced Undergraduate Program: a program of this caliber must have courses offering complete preparation for Exams P/1 and FM/2, and, a minimum of nine credit hours towards Exams M (now Exams MLC and MFE) and C. These program changes took effect in Fall 2000.

In August 2007, the author formed an actuarial advisory board comprised of local practicing actuaries. Of the initial group of 10 actuaries who agreed to serve on the board, six were Washburn graduates; one non-Washburn graduate had spoken to our math club on several occasions about the actuarial profession, and another non-Washburn graduate with the FSA designation (Fellow in the SOA) taught evening courses in the Theory of Interest and Actuarial Mathematics. The board first met in November 2007 and again in May 2008; we meet every May on Washburn’s campus for a luncheon to discuss issues currently affecting the actuarial profession. Our current board includes practicing actuaries from Aviva USA, Blue Cross/Blue Shield of Kansas, Miller & Newberg, Inc. (Kansas City, MO), the National Association of Insurance Commissioners (Kansas City, MO), Preferred Health Systems (Wichita, KS), and Security Benefit Group.

Guidance from our advisory board has been invaluable to our program. In particular, discussion topics have included:

- whether or not to maintain the program’s Calculus III requirement;
- whether or not to require a proof-based course (i.e., Washburn’s Discrete Mathematics course) as a prerequisite to upper-division statistics courses;
- internship and full-time employment opportunities;
- desired/expected computing skills.

As a result of these discussions, we decided to keep Calculus III (multivariable calculus) as an actuarial science requirement. Furthermore, we opted not to require Discrete Mathematics; however, instructors of upper-division courses in our program understand that actuarial science students may not possess
strong preparation in reading/writing proofs. Each year, at least one of our advisory board members has, or is aware of, internship or employment opportunities for students. Finally, we created a new 3xx-level Excel/VBA course taught by our Computer Information Sciences department every second year to address deficiencies in computing skills, especially for student interns (please see Section 6).

4. FACULTY AND STUDENTS

Hiring qualified statisticians to create and maintain our actuarial science track has proven challenging. In particular, when the author was hired in 1997 to assist with the continuation of the program, two statisticians had declined the position on the basis of salary. The author is not a statistician by trade but had passed Exams 100 and 110 in 1989 prior to returning to graduate school to earn a Ph.D. in Pure Mathematics. A Washburn University alumnus joined our faculty in 1984 and assisted the director in the creation of the Actuarial Science program. In 1998, we hired a statistician to shore up our actuarial track, but they left in 2001 to pursue an opportunity in industry. In 2001, an experienced biostatistician joined our faculty and currently directs our program. In 2004, we hired another biostatistician; that faculty member had passed three SOA/CAS exams prior to 2004. In 2011, we hired our third statistician. He has an MS in Actuarial Science and PhD in mathematics, and he recently passed SOA/CAS exams P/1, FM/2, MLC, MFE and C.

As of 2013–2014, about 70 students declared majors across our three tracks, roughly 40% of whom declared the Actuarial Science concentration. (Our number of declared majors is fluid as students may easily change majors on Washburn’s online major declaration system.) Students typically decide to major in one of our three tracks during their time in Calculus I. About 40% of those who declare Actuarial Science for their major do not progress in mathematics beyond Calculus III. Student recruitment for Actuarial Science occurs through current and former students, our November Math Day for local high school students, and our Admissions Office. As time permits, our director visits local high schools to present on the actuarial field, to stir interest among prospective students. We are very fortunate for an institution of our size to have two major scholarship funds, endowed with $250,000 or more each, earmarked for freshman and transfer students interested in pursuing degrees in mathematics. These scholarships require a minimum math ACT score of 28 and attract some very talented students. Our upper-division statistics courses at the core of our program often have enrollments in the 6–12 range. As a result, students form close-knit study groups that benefit the class as a whole – anecdotally, we believe this positively impacts our SOA/CAS exam pass rates. Class sizes below six may pose issues with the administration; fortunately, our large sections of developmental and lower-division courses yield acceptable overall
average class sizes. New students not prepared for Calculus or who transfer to us “off track” from our 2-year rotation with some of our upper-division statistics courses are afforded independent studies as needed. Our Actuarial Science recruitment brochure is included in the Appendix.

5. THE ACTUARIAL SCIENCE CURRICULUM

Table 1 encapsulates our requirements, with details as to frequency of course offerings that may benefit those seeking to build or enhance their Actuarial Science programs. Calculus I and II are five-semester-hour courses; all others are three-semester-hour courses. Prerequisite courses are listed in parentheses.

Calculus I, II, and III are offered every semester. Linear Algebra, Mathematical Statistics I, and Regression Analysis are offered every Fall, Applied Statistics every Spring, with the remaining courses on a 2-year rotation. Although an upper-division course, Applied Statistics carries only a 100-level Statistics prerequisite to increase its accessibility to other majors, whether majoring in a mathematics track or not. Since we required an additional upper-division MA-designated course after 2000, we removed the formal FORTRAN or C programming requirement from the actuarial track. Incorporation of SAS and Excel applications in Applied Statistics, Regression Analysis, Time Series Analysis, and the Mathematical Statistics sequence meet

| Course                                | Designation                                      |
|---------------------------------------|--------------------------------------------------|
| Calculus I, II, III                   | MA 151, 152 (151), 153 (152)                      |
| Theory of Interest                    | MA 250 (MA 151)                                  |
| Linear Algebra                        | MA 301 (MA 152)                                  |
| Applied Statistics                    | MA 343 (MA 140 Statistics)                       |
| Mathematical Statistics I, II        | MA 344, 345 (MA 153, 343 for 344)                |
| Regression Analysis                   | MA 346 (MA 140)                                  |
| Stochastic Processes                  | MA 347 (MA 344)                                  |
| Time Series Analysis                  | MA 348 (MA 344 and 346)                          |
| Actuarial Mathematics                 | MA 385 (MA 250 and 344)                          |
| Financial Accounting                  | AC 224 (24 hours college credit)                 |
| Managerial Accounting                 | AC 225 (AC 224 and BU 250)                       |
| Principles of Microeconomics          | EC 200 (24 hours)                                |
| Principles of Macroeconomics          | EC 201 (EC 200)                                  |
| Principles of Risk and Insurance      | BU 374 (54 hours)                                |
| Business Finance                      | BU 381 (AC 225, MA 140 and 54 hours)             |
| Investments                           | BU 483 (BU 381 and 54 hours)                     |
the programming needs. Upper-division courses geared toward a particular SOA/CAS exam require a text recommended by the societies for that exam (see [1], [2], and [3]).

Actuarial science students take eight required courses from our School of Business (course designation: BU). These courses all require students to have completed a minimum of 24 credit hours at the college level prior to enrollment in them. Furthermore, the School of Business requires Management of Information Systems (BU 250) as a prerequisite to the Managerial Accounting course. Some topics in the Business Finance and Investments courses serve as preparation for Exam FM. With one additional BU course beyond the minimum required for the actuarial science track, students obtain a minor in business; students find this valuable, especially if their career path involves management.

Overall graduation requirements at Washburn include a minimum of 124 semester hours, 45 hours of upper-division coursework, and General Education requirements of 9, 12, or 15 hours depending on the degree selected from each of three distributions: (i) Mathematics and Natural Science; (ii) Social Science; and, (iii) Arts and Humanities. Students choosing the BS option must complete 30 credit hours of natural science, with a minimum of 20 hours from one department (Biology, Chemistry, Computer Information Sciences, and Physics). Actuarial students must complete a minimum of 40 credit hours in mathematics and statistics, and 24 credit hours from the School of Business. Although Mathematics & Statistics supports a “for-credit” 4xx-level internship that actuarial students may pursue, the vast majority do internships outside of program requirements (please see Section 8).

6. COMPUTING EXPERIENCE

By 2004, the Mathematics & Statistics department voted to remove the formal programming requirement from the Actuarial Science track, over a concern with the total number of credit hours required in the track. We sought advice from our newly formed advisory board on how to remedy this, without adding a 3-hour programming requirement back into the program. The board suggested that we incorporate SAS programming and Excel applications into the curriculum as much as possible, without sacrificing course content as indicated by SOA/CAS syllabi for our advanced statistics offerings. This suggestion has worked out very well, by all accounts. Every other year in the Fall, the department of Computer Information Sciences offers an upper-division, cross-listed (CM/MA) Excel/VBA applications course that most actuarial students elect to take. Employers of actuarial students for internships or for full-time positions expect strong computing skills, and an ability to further these skills independently on the job. Upon graduation from Washburn, actuarial students are quite skilled with SAS and with Excel applications.
7. SOA EXAM SERIES

As an Advanced Undergraduate Program, we prepare students to pass Exams P/1 and FM/2 by graduation time, with some preparation for Exams MLC, MFE, and C. Our Mathematical Statistics I and Theory of Interest courses closely follow the SOA/CAS syllabi for Exams P/1 and FM/2, respectively. As both of these courses are offered in the Fall semester, ideally, actuarial students will continue their study of the relevant topics over the winter break and into the Spring semester to pass the February exam. In advising students preparing for the exams, we indicate that “the average good actuarial student” requires about 300 hours of preparation to pass each exam. We have two options for formal exam preparation as one-credit courses, offered on-demand when sufficiently many actuarial students need them. One is a 200-level course carrying a Calculus III prerequisite, and focuses on preparing students for Exam P/1. The other is a 300-level course carrying an Applied Statistics or Mathematical Statistics I (or concurrent enrollment) prerequisite, designed to cover additional statistical topics for Actuarial Science students.

National pass rates for Exams P/1 and FM/2 are held to the 30–40% range, in general. Two full-time statisticians who teach the majority of the upper-division statistics courses in the actuarial track spend time outside of class to help prepare actuarial students for Exams P/1 or FM/2. As a result, about 50% of first-time examinees from our program have passed Exam P/1 or FM/2 over the past 5 years. For our 16 graduates finishing their degrees between 2008 and 2012, four passed no exams, seven passed one exam (six passed Exam P/1 only and one passed Exam FM/2 only), and, the remaining five passed both Exams P/1 and FM/2 prior to graduation. Of those who did not pass an exam, all four made at least one attempt at Exam P/1. These graduates all met the degree requirements for the actuarial science track, and all found employment that appealed to their computing skills and their statistical backgrounds. All graduates passing at least one SOA exam found employment as actuaries immediately after graduation, most with employers with whom they had completed successful internships. Students having passed two SOA exams are qualified to receive Validation by Educational Experience (VEE) credit in economics, corporate finance, and applied statistics for grades of B or better in the appropriate Washburn courses. To offer VEE credit, an institution must successfully apply to the SOA for the privilege.

8. WORK EXPERIENCE

Since the program’s inception, actuarial students at Washburn University generally have the opportunity to work as paid interns at one of three major employers in downtown Topeka – Aviva USA, Blue Cross/Blue Shield of Kansas, or Security Benefit Group. (The exception to this occurred between 2008 and 2010 when fewer internship opportunities were available, as a result
of company cutbacks.) Student actuaries typically work 10–15 hours per week as interns, and are paid about $12 an hour. They obtain additional valuable computing experience while handling company financial data and writing reports under the supervision of a senior actuary. Many students work as interns during the academic year, though some continue their internships over the summer. Topeka is the capital of Kansas, and, has state offices for departments of revenue, transportation, corrections, etc. For students not inclined to pursue the rigorous SOA/CAS exam series, many find effective employment with a state agency needing statistical analysis or research.

9. IMPORTANT WEBSITES

To learn more about the actuarial profession, what actuaries do, the actuarial exam series, and finding employment, visit:
http://www.beanactuary.org

For information specific to professional development requirements, actuarial exam syllabi, Associateship or Fellowship (ASA or FSA) requirements, the CERA designation, program requirements needed to qualify a college or university actuarial science program for a particular designation (i.e., an Introductory or Advanced Undergraduate Program), and more, visit:
http://www.soa.org

For those interested in property and casualty, the Casualty Actuarial Society (CAS) is an organization similar to the broader Society of Actuaries; please visit:
http://www.casact.org

Actuarial students preparing for one or more SOA/CAS exams may find useful study materials at the Actex/Mad River publishing company’s site:
http://www.actexmadriver.com

The American Academy of Actuaries publishes “Contingencies,” for those wishing to stay current with the actuarial profession; a digital version of “Contingencies” is available at:
http://www.contingencies.org

For additional information about the actuarial science program at Washburn University, please visit:
http://www.washburn.edu/academics/college-schools/arts-sciences/departments/mathematics-statistics/degree-program/actuary.html

10. CONCLUSIONS

Clearly, it takes talented and committed faculty and strong support from local employers to build and maintain a high-quality actuarial science program.
The program at Washburn University maintains its strength through continued hiring of highly qualified Ph.D. statisticians, who work closely with students to help them pass the first exams and obtain valuable internship experience. Our advisory board guides our program through SOA/CAS changes, and aids in our curriculum decisions; as changes occur in the exam series, we respond accordingly to keep our program current. We publicize our program and offer scholarships to recruit capable students, as the field of actuarial science is not well-known to the general public. Local employers offer numerous student internships, and excellent full-time employment opportunities upon graduation. For those starting or enhancing actuarial science programs at their institutions, we hope that this article has provided a valuable glimpse into the workings of one successful program!

ACKNOWLEDGEMENT

The author wishes to thank Dr. Larry Blumberg for his helpful comments in the preparation of this manuscript.

SUPPLEMENTARY MATERIALS

Supplemental data for this article can be accessed at www.tandfonline.com/upri

REFERENCES

1. Bowers, N. L., Jr., H. U. Gerber, J. C. Hickman, D. A. Jones, and C. J. Nesbitt. 1997. Actuarial Mathematics. Schaumberg, IL: The Society of Actuaries.
2. Frees, E. 2010. Regression Modeling with Actuarial and Financial Applications. Cambridge, UK: Cambridge University Press.
3. Wackerly, D., W. Mendenhall III, and R. Scheaffer. 2008. Mathematical Statistics with Applications. Belmont, CA: Brooks/Cole.

BIOGRAPHICAL SKETCH

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