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Timely Curriculum Changes to an Undergraduate Actuarial Program

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INTRODUCTION

In the last decade mathematics departments in many universities around the country have established actuarial science as a major, concentration, or area of study. The profitable career choice of becoming an actuary has become well-known to parents and high school students, who are interested in mathematics, which at least partially drives a school to develop a program. Not all schools house the actuarial major in a mathematics department, but the number of universities, offering actuarial courses, has grown significantly in the last few years. At this time there are approximately 160 universities in the US alone offering this course of study (Society of Actuaries, 2016). Bryant University was one of the first schools in the country to start an undergraduate actuarial program in 1982. The program has grown from its first graduating class in 1986 of 5 students to a current total student enrollment of 170 (164 majors, 4 minors and 2 concentrators). This major represents 29% of all students in the College of Arts and Science students and approximately 5% of all undergraduate students currently at the University. A detailed description of how the Bryant University program was initiated and developed over the years can be found in a previous paper by Kennedy and Schumacher (2014).

All university programs must frequently examine the actuarial coursework required for completion of a degree within the field. The two leading actuarial organizations in the US are the Society of Actuaries (SOA) and the Casualty Actuarial Society (CAS). These two organizations develop and administer the actuarial professional exams, and all university programs must keep the curriculum up to date to conform to the ever-changing requirements for the SOA/CAS. This paper highlights some of the most recent changes implemented by the Bryant University program and how the results of these changes have helped our students continue on a path to success.

CURRICULUM CHANGES

When the actuarial program was initiated in 1982, the department was not overly concerned with students passing the professional exams before graduation. Over time, the job market for actuarial students has changed and the importance of passing exams has become apparent. In order to help our students secure an actuarial position upon graduation, we now maintain a goal that our students should pass two exams before leaving Bryant, and we support our students for up to 5 exams. Again a detailed description of how the curriculum incrementally changed since 1982 can be found in previous works by Bishop and Schumacher (2000) and Kennedy and Schumacher (2014). Up until 2014, the students had no electives within the

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actuarial program, and they were academically prepared to sit for Exam P/1 (Probability) and FM/2 (Financial Mathematics). To sustain our strong exam pass rates, changes in the curriculum were necessary to conform to the ever-changing requirements for the SOA/CAS.

In 2014 the department implemented a significant change to the curriculum to enable all students to take academic courses covering the material for four preliminary actuarial exams. One main change was to introduce electives, so students would begin to think about whether they would choose the Life or the Property and Casualty side of the actuarial world.

The first elective developed was to cover in depth material for Exam MFE/3F (Models for Financial Economics). The SOA provides a set of learning outcomes for their examinations and for MFE and they can be found on the SOA website: http://www.soa.org/education/exam-req/edu-exam-mfe-detail.aspx. This elective titled: Actuarial Mathematical Models and Stochastic Calculus, was specifically designed to meet the learning objectives of the SOA and CAS by preparing them for Exams MFE/3F. The underlying foundation of this course is the mathematics and economics of the pricing of financial options. Specifically, this course introduced topics in derivative pricing and stochastic calculus including binomial models, Black-Scholes formula, and lognormal stock price models, Brownian Motion, volatility, exotic options and interest rate models. The class material is based on the classic text, Derivative Markets by MacDonald, which is endorsed by the SOA for Exam MFE.

The second elective development was re-vamping a course that originally was required for the major, Advanced Probability. This course was given a more statistical emphasis, by replacing content on stochastic processes with material on model fitting with censored or left truncated data. The course now covers advanced probability techniques such as conditioning and mixture distributions, as well as their application in the context of model fitting using non-parametric methods, maximum likelihood estimation, and Bayesian analysis (including credibility based approximations). Currently, the course covers approximately two thirds of the topics on the SOA Exam C syllabus.

Flipped classrooms have been used for different courses of study. For example, Missildine et al. (2013) illustrated how the flipped classroom provided higher examination scores for nursing students. Likewise Berret (2012) reports on how classrooms have been flipped in a variety of courses as evolutionary biology, calculus, and physics. Similarly, Advanced Probability is taught using a flipped class room format, utilizing both on-line videos to deliver mathematical content, and on-line problems for homework. The on-line materials are provided by The Infinite Actuary. Class time is used for brief summaries, working difficult problems, and exploring how to apply the model fitting techniques to larger data sets using R. One of the biggest benefits of using pre-recorded videos for content delivery is that it allows for enforcing the pace, while still making time for helping students with individual questions that they may have. In addition, the on-line homework system automatically tracks students' efforts and thus holds them accountable for engaging with the on-line content. With the content delivery on guided "autopilot", there is room to explore the application of the mathematical concepts to realistic actuarial datasets.

The third elective expansion was a new course on Reserving. The original program curriculum was heavily skewed to the Life side of the field of actuarial practice. The first elective explicitly designed to introduce students to the Property and Casualty (P&C) side of actuarial practice was Fundamentals of Property and Casualty Reserving. The reserve for unpaid claim liabilities is a major item on the balance sheet of every P&C insurer and estimating this quantity is a core responsibility of actuaries. The course covers deterministic reserve projection methods (LDM

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and Bornhuetter-Ferguson) in detail, and introduces students to General Linear Model (GLM) based stochastic reserving methods. The course is both Excel driven and writing intensive, requiring students to prepare a technical report that introduces students to professional documentation standards.

The final overall elective change was to design a host of seminar courses. The original curriculum had one seminar course that was created to prepare students for the first exam, Exam P, and this was a required course. Although students had covered the material for Exam P in previous courses, the students needed to mature their study habits for exam preparation, which would improve their chances for success on the professional exams. It became apparent that more actuarial mathematics seminars were needed as pedagogical tools to help our students synthesize knowledge from multiple courses and to help them solve practical actuarial problems using techniques taught in previous courses. Compared to the existing exam preparation seminar, the new actuarial seminars were deliberately designed to raise the academic bar. All of the seminars emphasize developing the tacit knowledge needed to proficiently deal with a range of problems encountered as a practicing actuary.

As of 2014 a student could choose one seminar from the following electives:

- Applied Actuarial Mathematics Seminar: Exam P/1 (2 credits)
- Applied Actuarial Mathematics Seminar: Exam FM/2 (2 credits)
- Advanced Actuarial Mathematics Seminar: Exam MLC/LC (2 credits)
- Advanced Actuarial Mathematics Seminar: Exam MFE/3F (2 credits)
- Advanced Actuarial Mathematics Seminar: Exam C/4 (2 credits)

Again, the methodology of "flipping the classroom" worked nicely for these seminars. The students independently study video lectures and other on-line content provided by The Infinite Actuary (TIA) or Coaching Actuaries (CA), and they work on problems during class time, the time normally appropriated for lectures. Again, one of the biggest benefits is maintaining the pace of content delivery, while making time for individual trouble shooting.

Assessing Results From the Curriculum Changes

Over the years the department tracked information concerning the student pass rate on professional exams and collected noteworthy artifacts regarding student success in general. The graduating class of 1986 had 5 students, and by their junior year, 2 had successfully completed the first actuarial exam. Statistically, that was a pass rate of 40% in the first class!

The following tables highlights the pass rates from 2013 – 2015, since the changes were made in 2014. This information was gleaned from a survey administered to the majors within the department. Some of the students in the survey may not have been an actuarial major. The other major within the department is the Applied Mathematics and Statistics major, and a few students do attempt the first exam although they are not Actuarial majors.

2013: All Survey Respondents:

Exam	P/1		FM/2		MFE		MLC
# Taking	57		20		2		0
# Passing	32		17		2		0
% Pass	56%		85%		100%		0%

2014: All Survey Respondents

Exam	P/1		FM/2		MFE		MLC
# Taking	59		23		3		0
# Passing	33		17		3		0
% Pass	56%		74%		100%		0%

2015: All Survey Respondents

Exam	P/1		FM/2		MFE		MLC
# Taking	56		22		4		1
# Passing	33		19		3		1
% Pass	59%		86%		75%		100%

Bryant University allows all students to pursue a degree in Actuarial Mathematics, although a student may have difficulty in passing a professional exam. At least one major university requires that a student, with low grades, must pass at least one exam to be in the major (Ohio State, 2016). Thus we do not expect to achieve a pass rate of 100% on either of the first two exams. The reasoning for a pass rate of 100% on MLC in 2015 is obvious. However, it is clear to see that since 2014, more students are taking more exams while they are still in their undergraduate program. That is a direct achievement of the new curriculum change since 2014.

FUTURE GROWTH

The Society of Actuaries published a list of skills that are needed for someone to be successful as an actuary (SOA, 2009). Analytic problem solving is certainly important, but they also list other necessary skills such as communication, interpersonal collaboration, leadership, professional values, and others as well. Bryant University offers a unique undergraduate curriculum in that any student who graduates from the College of Arts and Sciences must also have a minor in business from the College of Business. Through this crossing of both colleges, the Bryant students are well educated in the analytics necessary to become an actuary, but they also develop important business qualities. Furthermore, the students have ample opportunity to sharpen their communication skills both in the College of Arts and Sciences as well as the College of Business. As stated by Roth, there is a need for two types of actuaries. One is a person who is very technical and is very capable of creating new mathematical models to measure risk. The other is a person who is technically savvy or astute, but is someone who also understands business models and concepts that influence a business decision (2016).

In the future university actuarial curriculum will need to expand to embrace many business models as well as assuring that the student is well founded in actuarial mathematics. A working knowledge of a foreign language would certainly be important as students look forward to working in a global environment.

As indicated in the 2014 Economist Intelligence Unit report on the actuarial job market, there are now more graduates seeking entry into the actuarial career than there are openings for entry level positions. In this climate bigger employers very much get to choose which job applicants will be given further consideration. The number of exams passed while in college is an obvious and easily quantifiable criterion for narrowing the candidate pool. Many employers also consider actuarial internship experience a "must have" attribute. Actuarial programs interested in the placement rate of their graduates are therefore well advised to foster formal and informal relationships with potential employers. Actuarial programs should approach such relationship building with confidence and negotiate arrangements (e.g. a commitment to provide a certain number of internships to students from the program) that benefit the

program as a whole in exchange for giving employers early access to students that allows them to cherry pick the best candidates before they even enter the open job market.

In the last several years, some of our graduates have chosen to go on to graduate school rather than going straight to work as an actuary. Also some have chosen to work in a research "think tank" to prepare for future graduate work. Furthermore, some of the faculty have started research work with undergraduates. In the graduating class of 2015, one of our graduates worked on a manuscript on "Comparison of simulation techniques for the sampling distribution of reserve estimates based on development triangle GLMs" that was presented at the 2015 Actuarial Research Conference in Toronto. We expect that dual type of research to expand in the next few years. Again, this is a direct result of the curriculum changes. Students are now being exposed to both Life and Property and Casualty, and they are obtaining the academic tools to work on higher level research while still at the undergraduate level.

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