The Path to Patenthood

By Jay Vadiveloo

Got an idea for something you think could be the neatest invention since sliced bread? It might be patentable.

IF SOMEONE HAD TOLD ME when I started my career as an actuary more than 20 years ago that someday I would hold the patent to a modeling algorithm, I would have dismissed the notion as pure fantasy. And if I had been told that this patented algorithm would be the happy result of my successfully melding an actuarial career with an academic position in the field of statistics, I would have been even more doubtful.

But dreams do come true. In March 2012, the U.S. Patent and Trademark Office approved two U.S. patents for my replicated stratified sampling (RSS) modeling technique—an algorithm that took more than three years of research and testing to develop.

So how did I get to this place? In hindsight, it's easy to look at the logical steps I followed to make this happen. But the process was far from planned.

The impetus for my invention came in 2008 when I invited the late Hubert Mueller, one of the leading authorities in the field of economic capital (EC) modeling, to speak at an actuarial seminar at the University of Connecticut, where I teach actuarial mathematics. Toward the end of his talk, Mueller mentioned that the single biggest issue in doing EC modeling (or, for that matter, any complex actuarial modeling) was the processing time involved. He said that if someone could find a way to speed up processing time and produce accurate results, it would be a significant breakthrough toward developing a financial modeling management tool.

That caught my interest.

Leveraging Expertise

I'm fortunate to have enjoyed a joint academic-industry position for almost 12 years. As a professor at the University of Connecticut, I manage the Goldenson Center for Actuarial Research. This provides access to talented students and faculty, as well as a modest budget to fund their inquiries. As a consulting actuary for Towers Watson, I engage with real-life industry issues in need of resolution.

Unlike typical consulting projects, the problem posed by Mueller had no defined solution. It required exploratory research with no self-imposed deadlines or billing constraints. This paradigm aligns precisely with academia. And thanks to my joint position, I was uniquely poised to attempt an answer. My natural bias as a statistician by education was to use a sampling approach to speed up processing time. But as a practicing actuary, I had to answer several associated questions as well, including:

- What do I sample—stochastic scenarios or individual policies?
- How do I ensure accurate results?
- How do I convince skeptical actuaries and management that sampling bias can be controlled?
- Is this process general enough to cover any financial modeling application and any range of stress testing? Is it compatible with any actuarial software?
- Will it be easy to explain to actuaries, management, and regulators?

The beauty of exploratory research (and of having a virtually unlimited and ongoing supply of good graduate students) is that you don't need to solve these issues all at once. It took almost three years of investigation before I realized I really was on to something. The three biggest breakthroughs in the process were:

- Sampling individual policies versus stochastic scenarios;
- Deciding based on multiple samples rather than just one sample (hence the name, replicated stratified sampling);
- Developing RSS estimates of changes in a population risk metric versus estimates of a risk metric.

These breakthroughs provided solutions to all the practical issues I needed to address before I could approach Towers Watson and ask it to invest in a patent on the RSS technique.

Some of the breakthroughs came as the result of an arduous trial-and-error process, with my students helping me validate my

conjectures using empirical data. The real patentable breakthrough, however, was the idea of replicating the sampling process. In the world outside financial modeling, this simply isn't practical or feasible. Imagine the Gallup Organization, which specializes in sampling the most representative profile of the U.S. voting population, having to repeat this process 100 times. Or the pharmaceutical industry having to do repeated tests on multiple samples of a new drug before getting approval from the U.S. Food and Drug Administration. Cost and time constraints would make this impossible.

In the world of financial modeling, however, there's no cost or effort required in generating multiple samples. It's simply an application of an Excel random number generator formula to an existing and readily accessible file of in-force policies. I believe statisticians never considered replicated samples because it wasn't practical, and actuaries never considered sampling because of easy access to the underlying population. My involvement in both the statistical and actuarial professions allowed me to bridge the two and formulate a solution that was truly innovative and patentable.

Given the fact that I have a foot in academia and in industry, my approach to academic research generally is experiential in nature. For example, the RSS technique wasn't developed with any underlying theory in mind. It was true empirically based exploratory research using my experiences as a practicing actuary. And the theoretical framework was developed from the findings we obtained.

In this way, I wasn't limited to restricting the RSS technique for certain applications based on some pre-established theoretical constraints. Most of the underlying theory explaining why RSS works so well comes from statistical concepts like the central limit theorem and the law of large numbers. But there also are nuances with the RSS technique, such as the optimal combination of sample size and replications or different ways to combine the RSS sample estimates, which have opened up a huge area of potential research in this new field of multiple sample estimation.

I currently have two Ph.D. students in actuarial science who are researching different aspects of the RSS technique. Given my industry background and my access to the vast consulting resources of my employer, I have been able to focus more on exploring new applications of the RSS technique in many different areas of actuarial modeling.

The Patent Process

One of the most interesting aspects of this experience was securing the patent after the technique was fully developed. As an intellectual property novice, I didn't know that obtaining a patent for RSS would be such a long and grueling process. I've always prided myself on my command of legal jargon, which is based mostly on my industry experience in dealing with insurance regulations, policy filing forms, and the like. But patent legalese is a completely foreign language.

I had to work with an outside patent law firm, and my initial task was to describe the RSS technique in plain English. Of course this was not as straightforward as it sounds, and I had to go through several iterations before the English version was finally understood by and acceptable to the patent attorney. Then the attorney took my words and translated them further into patent legalese. When my application was sent back to me for review, I didn't recognize my own invention from the way it was described. As a result, there was some more back-and-forth—mostly for the patent attorney to explain what he had written. The final painful step was to review other existing patents that had some of the same key words as my RSS patent application to ensure that I hadn't created something that already existed.

Then came the long wait for approval. For technical reasons, we filed for two U.S. patents, based on both a normal and an accelerated process. While the waiting process didn't involve any work on my part, it was an anxious period. I wasn't sure until the very end whether the patent application would be accepted. While the patent process is relatively straightforward for physical inventions, such as innovations in engineering, that's not the case when you are applying for a patent on an algorithm that employs an existing well-established process such as statistical sampling. It was almost two years before I finally received the call from the patent attorney telling me that every obstacle in the patent process had been overcome and that I was the proud owner of two U.S. patents on the RSS technique.

All at once, things sped up. Following the approval of the patents there came publicity and recognition from Towers Watson and the University of Connecticut, awards, and news articles—culminating in the publication of my column "Patents Aren't Only for Engineers" in the May 12, 2012, Sunday *New York Times*.

Since the true value of the RSS invention ultimately depends on the technique's acceptance and use in industry, most of my time now is spent on marketing RSS to clients of Towers Watson, in presentations to industry and academic audiences, and in ongoing testing and refinement of the technique for new applications. This has been a collaborative effort involving several of my colleagues at Towers Watson, as well as students and faculty at the University of Connecticut. I hope that in time the RSS technique and the concept of estimation using replicated samples will transform the way financial modeling is conducted.

Enjoy the Journey

I'm sometimes asked what advice I can give to those who are interested in pursuing a patent. I have some general pointers. If you have an innovative idea, start to explore it unhampered by artificial considerations such as time limits or the idea's marketability. Enjoy the process of bringing the idea to fruition, much as I did during the early years of my exploratory research on RSS.

The future is never certain, but giving yourself the freedom to investigate your idea fully could lead to a patentable invention that will have a lasting impact in your particular niche. Even if it doesn't, the whole process of starting with a creative thought (or dream) and building on it through your collective experience and knowledge is by itself good exercise for your heart, your mind, and your soul.

THINKSTOCK

RSS Case Study

In a pilot study, we applied the replicated stratified sampling (RSS) technique to a variable annuity block of a major life insurance company. We wanted to analyze the impact of an immediate 15 percent drop in equity funds on VACARVM (commissioners' annuity reserve valuation method for variable annuities) and the impact of an immediate 35 percent drop in equity funds on VACARVM reserves.

The analysis was completed for three legal entities both before and after reinsurance. It compared the change in the VACARVM reserve in the population versus using the RSS technique on 50, 100, 150, and 200 samples of 30 policies each.

The error rate was defined as:

$$\frac{|A-B|}{B}$$

Where A=change in VACARVM reserve using the RSS technique and B=change in VACARVM reserve in the population.

TABLE 1

RSS Results—Sensitivity 1

After Reinsurance				
Legal Entity	Number of Samples	RSS Ratio	Pop. Ratio	Error Rate
1	50	1.513	1.615	9.14%
	100	1.615		3.00%
	150	1.640		1.52%
	200	1.667		0.12%
2	50	1.611	1.442	11.73%
	100	1.486		3.10%
	150	1.424		1.25%
	200	1.450		0.59%
3	50	3.015	3.634	17.02%
	100	3.482		4.18%
	150	3.735		2.78%
	200	3.633		0.02%

Source: Towers Watson

Before Reinsurance				
Legal Entity	Number of Samples	RSS Ratio	Pop. Ratio	Error Rate
1	50	2.067	2.113	2.17%
	100	2.124		0.51%
	150	2.106		0.32%
	200	2.110		0.15%
2	50	1.826	1.821	0.25%
	100	1.812		0.49%
	150	1.818		0.17%
	200	1.822		0.03%
3	50	2.853	3.179	10.24%
	100	3.028		4.74%
	150	3.153		0.82%
	200	3.177		0.07%

Source: Towers Watson

TABLE 2

RSS Results—Sensitivity 2

After Reinsurance				
Legal Entity	Number of Samples	RSS Ratio	Pop. Ratio	Error Rate
1	50	2.771	4.236	34.58%
	100	3.783		10.68%
	150	4.071		3.88%
	200	4.216		0.45%
2	50	1.117	1.505	25.75%
	100	1.339		11.00%
	150	1.386		7.89%
	200	1.506		0.10%
3	50	17.574	25.148	30.12%
	100	23.239		7.59%
	150	26.601		5.78%
	200	25.225		0.31%

Source: Towers Watson

Before Reinsurance				
Legal Entity	Number of Samples	RSS Ratio	Pop. Ratio	Error Rate
1	50	5.575	7.322	23.86%
	100	7.043		3.81%
	150	7.099		3.04%
	200	7.330		0.10%
2	50	4.884	4.275	14.24%
	100	5.117		19.70%
	150	4.652		8.81%
	200	4.282		0.15%
3	50	13.845	20.354	31.98%
	100	19.059		6.37%
	150	21.203		4.17%
	200	20.336		0.09%

Source: Towers Watson

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Information about the Goldenson Center is available at www.goldensoncenter.uconn.edu.

Resources

Vadiveloo, Jay, "Patents Aren't Only for Engineers," *New York Times*, May 12, 2012. http://www.nytimes.com/2012/05/13/jobs/an-actuary-proves-patents-arent-only-for-engineers.html