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The Next Step Forward: Can One Actuarial System Do It All?

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Chairperson's Corner

Bridging Academia and Practice

By Trevor Howes

Quiet courtyards, ivy-covered walls, not a cloth-covered cubicle in sight. The occasion of my visit to the 2015 Actuarial Research Conference held this past August at the Victoria College campus of the University of Toronto was a brief but pleasant reminder of differences in corporate versus academic lifestyles, but also a stimulus to thoughts about what modeling means to actuaries and mathematicians in the academic world.

The gulf between the world of academia and the corporate world is growing wider in many ways, with bridges between us too rare and too narrow for our own good. The main points of contact between practitioners and academia occur fleetingly when we hire a new student who is freshly graduated, or between terms of an actuarial science program, or when we look for guidance from academic research toward solving complex mathematical questions. I view the separation as widening because of the rapid evolution in power and complexity of actuarial financial models needed by life insurance companies and the types of problems that modeling actuaries are increasingly confronting.

Academics certainly don't seek to preserve this separation. Both in managing undergraduate curriculums and choosing areas of graduate research, leading institutions actively seek to prepare their students for real jobs in the business world and value research that has value to today's society and to practicing actuaries. But the business of life insurance, its products and the risks they present, and the modeling power and complexity required to support business decisions and reporting demands are all moving too quickly.

By nature and by training, mathematicians seek to generalize problems, to find underlying order behind chaos, to understand the nature of systems of a common type and, by doing so, offer insights that can have practical value even when reality is much more complex and diverse. But it is not always easy to take the lessons of ground-breaking research on simpler and more general problems and find ways to exploit them to improve our real-life financial models. And there is not a huge incentive to try if confidence in the real benefits to be realized is low.

Let me mention a real-life problem faced by the Modeling Section. A research project has been launched by the Society of Actuaries, with sponsorship by both the Modeling and Financial Reporting sections of the Society, into the troublesome issue presented by nested stochastic modeling and the huge computing resources that may be needed to accomplish it by brute force. The research project will look at various aspects of the problem but is not expected to involve hands-on modeling at this point, according to the proposed project outline on the SOA website. Initially it is very likely the research will be conducted by academics buttressed as much as possible by the benefits of practice experience. I think this approach will have value as an initial investigation of the problem and will provide a broad but useful perspective on potential solutions. However, in my view hands-on modeling involving realistic volumes of data based on typical product portfolios, and, therefore, using modern modeling software platforms will be eventually needed to realistically assess any alternative methodologies or modeling efficiency techniques that come out of such research.

Can researchers from academia lead or participate in such research? Not easily; they have no access to either the advanced commercial modeling platforms and sizable computing infrastructure required or realistic company portfolio data. The only apparent solution is to consider an innovative research approach combining the resources of academics with modeling actuaries of insurance companies and possibly software vendors. This is not an easy approach to translate into a real-life project plan.

Of course, academics will continue their research into modeling problems and will no doubt provide many interesting and potentially valuable insights for the profession and for practicing actuaries in particular, if we can communicate effectively with each other. The annual Actuarial Research Conference can be a useful forum and has produced a wide range of accessible papers on many topics, which are documented for your benefit by the Actuarial Research Clearing House on the SOA website.

Perhaps the Modeling Section can also provide a platform (pun intended) to communicate the nature and extent of our real-life modeling challenges to interested academics? They are certainly welcome to join the section either as members of the SOA or as nonmember affiliates and thereafter to participate actively in our discussions and educational efforts. Let's build more bridges (and lay more high-speed cables) and look for opportunities to collaborate! ■

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The Next Step Forward: Can One Actuarial System Do It All?

By Corey Carriker, Ryan Kiefer and Jason Morton

ACTUARIAL SYSTEMS IN THE UNITED STATES

If an insurance organization were a living organism, actuarial systems would be the oxygen—central to framing strategy, vision, and day-to-day management of the business. The breadth of actuarial model demands, coupled with the increasing complexity of products, has made actuarial models extremely valuable and yet, at the same time, incredibly difficult to manage. Building and maintaining a sound modeling framework should be a priority for insurance companies.

Actuarial System Evolution Is Underway

The actuarial function in most insurance organizations is known for delivering solutions to complex and difficult problems. Typically, actuaries are by their very nature problem solvers, regularly building new or adapting existing tools to address emerging business and regulatory demands.

At the same time, actuarial system solutions have often been designed to address specific needs with limited cross-functional considerations. Duplicative versions of models often exist, each addressing a specific function, product, requirement, or modeling purpose. This patchwork of system solutions has led to a complex systems architecture that can be difficult to efficiently and effectively manage and maintain.

Many companies have been investing significantly, both in hard-dollar spending and in time spent by actuaries and IT specialists, to maintain an environment containing multiple tools, platforms, and technology solutions. Managing multiple platforms is often time-consuming and unwieldy. It can lead to errors stemming from difficulties to reconcile and an erosion of actuarial talent who may have become frustrated that they lack the tools needed to complete their day-to-day tasks. Generally, actuaries should be users of tools, not maintainers of systems.

This phenomenon appears to be specific to the United States, given insurance companies' need to adhere to multiple reporting standards. Elsewhere in the world, many companies have moved toward a single actuarial modeling system that handles business requirements from pricing and financial reporting to projection and risk modeling. After speaking with several United States insurance leaders, it appears that the next evolution of actuarial modeling in the United States will likely push toward a single-system solution as well.

What Is a Single-System Solution?

A single-system solution is the use of one system for all actuarial calculation uses for a given product, line of business, or company, a modeling platform that is shared by all users and supported across functions. The solution shares product configurations, best-estimate assumptions, and the calculation of product cash flows across all actuarial system uses. Specific assumptions, calculations, and outputs for a given purpose are activated as needed via switches.

> The next evolution of actuarial systems in the United States will likely be a move toward a single-system solution.

For millennia, the North Star has guided navigators on their journeys to new destinations. A single-system for all actuarial needs and shared across all actuarial functions is a key component of the "North Star" long-term vision for more and more United States insurance companies.

Common Benefits of a Single-System Solution

The vision of a single-system solution for actuaries in the United States now has the potential to become a reality. A single-system solution can enable companies to realize strategic benefits, such as the following:

- **Increased efficiency.** A common platform should reduce the amount of resource time spent on redundant system development and maintenance. Additionally, analysis processes can be streamlined as different model views are more easily combined into a meaningful, organized output.
- **Flexibility to adapt.** While governance and change control may be more rigorous in a single-system environment, a single-system solution is likely to be more flexible to adapt and respond to tomorrow's needs than the "Frankenstein" patchwork systems that are prevalent.
- **Flexibility to respond.** As demands from external regulators and internal stakeholders increase, a single system has

the ability to quickly and efficiently respond to demands for multiple runs, ad-hoc analyses, and scenarios by quickly adjusting the inputs and model specifications. New analyses and reports can be produced quickly and efficiently.

- **Production/development teams.** Clear separation of duties can more practically be established with separate teams—one responsible for all system development (i.e., coding model changes) and one responsible for reporting and producing official results.

- **More comprehensive and insightful analysis.** Management can benefit from more detailed, timely analysis and increased consistency between internal views and risk decisions. A strong, integrated modeling platform enables detail that previously was not often available, approximated, or well understood.

- **Reconciliation of results.** A single-system solution can simplify and streamline reconciliation between asset liability modeling (ALM), risk management, statutory, and generally acceptable accounting principles (GAAP) results.

- **Enhanced governance.** A single-system solution is likely to drive significant enhancements to model governance and controls all aspects of modeling and will simplify the effort required because having fewer systems means fewer controls to maintain.

- **Talent focus.** A single-system solution can help talented actuaries focus on actuarial analysis rather than system maintenance across a patchwork of systems.

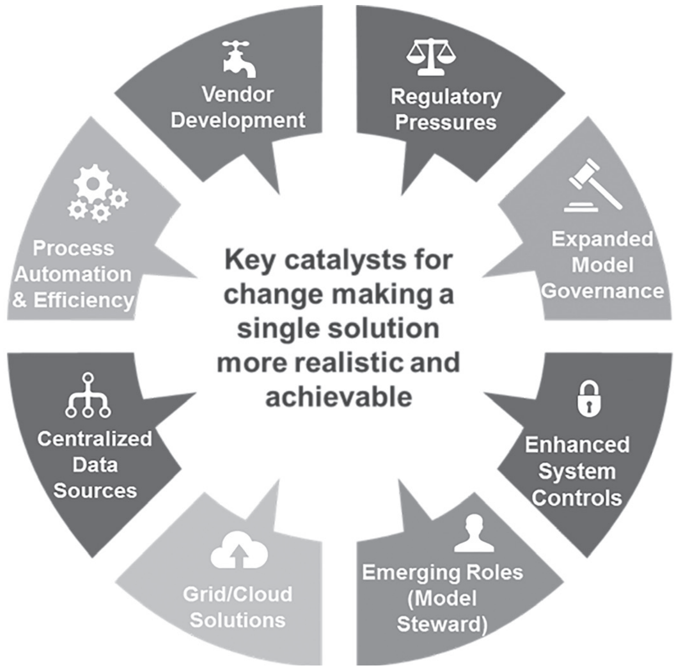
> A common actuarial computing platform can enable insurers to realize strategic benefits, such as increased efficiency, more comprehensive and insightful analysis, and flexibility to respond to emerging demands of stakeholders.

CAN ONE SYSTEM DO IT ALL?

One of the most significant hurdles that have kept some United States insurance companies from considering a single actuarial computing platform has been limitations in the vendor systems available to the U.S. market; in particular, valuation results should stand up to external audit and often must be produced at a seriatim level, but asset-liability systems have historically been lacking in valuation capabilities.

Catalysts for Change

In recent years, several developments have occurred that help make a single-system solution more realistic:



- Some vendors, in response to client demands and in light of emerging technology infrastructure, have invested in refining the functionality of their systems to produce a wide range of analyses capabilities. Models can be designed to address many requirements at once or swap specific data elements or calculations with the flip of a switch.

- Regulatory pressures have helped shift traditional valuation requirements toward a more principles-based approach. This has blended the definition of a projection and valuation system and has driven projection system vendors to offer enhanced valuation controls in their projection models.

- System controls and production environments are more typical and no longer apply just to valuation models. Systems now allow multiple users of a common model and address the need for specific permission sets.

- Controls and governance, once mostly focused on the valuation area, have expanded to other areas of actuarial modeling, such as projections and asset/liability modeling.

Projection-modeling teams are generally now being held to higher governance standards.

- The creation of new actuarial roles such as Model Steward has helped address concerns over consistency complicated by multiple model owners while continuing to promote the importance of governance.
- Enhanced grids and cloud solutions have enabled more complex, dynamic analyses to be produced in a timely fashion. Adopting platforms that are well integrated with technology has helped many insurers become more nimble in their decision making.
- Many insurers have become more conscious of the need to centralize data sources and provide common definitions for key actuarial system inputs. In some cases, this has led to the development of data and/or assumption warehouses, which can be linked directly to source the single actuarial model.
- Many insurers are increasingly focused on process automation and efficiency, including tools that enable scheduled model runs that can maximize run-time efficiency. These tools also offer the opportunity for review and approval at key steps of the process to establish proper controls and limit reruns.

OVERCOMING OBSTACLES

Integration of actuarial systems into a single platform sounds great, but is it realistic? We believe the answer is "yes" when integration acknowledges the potential impact on company culture and includes a fresh look at the operating model, effective architecture design, and expansion of governance standards.

There is often apprehension that a single-system solution will become unwieldy, prompting these common questions:

- Will a single-system solution slow me down?
- Will my pricing function lose the flexibility needed to properly carry out their work?
- How can I trust a model I don't own?
- What if another user impacts my model?

Usage of a single actuarial system is a marked shift in the way that most actuaries are accustomed to working. The biggest hurdle in implementing a single-system solution is often the culture change necessary to give up model ownership to the company.

Culture Change

A single-system solution generally does not lend itself to the way many insurers operate today; however, an effective operating model, organization design, and model governance structure can increase the likelihood of effective implementation. Recognition of company-specific cultural norms is key to developing an implementation and governance plan that can mitigate these concerns.

In many instances, significant investment in, and change management of, model governance and controls will be necessary. With a single-system solution, users must shift from model ownership to a shared actuarial system where the user owns the model requirements rather than the model itself.

Model Development and Architecture Design

Moving to a single-system solution involves more collaboration and more attention to upfront system requirements, integrated design, and focused testing. Some insurers have been reluctant to push their actuaries to move toward an IT-type development approach, because control of system development has historically been considered a key aspect of model ownership. In a single-system solution, the system is truly owned by the company. Business users are responsible for submitting business requirements to a development team that designs, implements, and tests model changes across all business use cases. Model changes can no longer happen on the desktop—they must be controlled through computing environments. All changes must undergo full regression testing, and models must be stored and maintained in a production environment.

> The biggest hurdle in implementing a single-system solution is likely the necessary culture change.

To realize some of the demonstrated benefits of a common model, actuaries should consider the rationalization of methodologies, assumptions, and reporting. Models should also be designed to provide flexibility to change methods, assumptions, and granularity for each model purpose. In addition, models should be designed to be "future-proof" with sufficient flexibility to address both the rigor of valuation and the flexibility needed for pricing and unknown future modeling requirements.

Operating Model and Organizational Design

Effective implementation of a single-system solution may involve a fresh look at the actuarial operating model. New roles and responsibilities can help facilitate the necessary culture change to move toward a shared ownership of models, assumptions, methodologies, and processes. New roles may also be necessary to centralize or standardize model development and change management, as well as to oversee model governance, testing, and documentation.

THE ROAD AHEAD

The opportunity for an insurer to reposition the development, maintenance, and management of actuarial systems starts with insurers taking stock of where they are today versus a "North Star" vision of where they would like to be in the future.

The vision should be free of any current constraints within the company's current models, systems, and processes and should be augmented with an assessment of potential benefits.

Achieving a single-system solution necessitates a well-articulated vision and commitment to collaboration and change, both at the top of the organization and through the ranks. Once all stakeholders support the vision, a roadmap can be defined to help guide the company toward its ultimate goal.

CONCLUSION

As many insurers begin to reevaluate the competitive landscape and assess their ability to deliver against emerging market demands, it is clear that the environment is changing, and multiple platforms with multiple purposes are generally becoming increasingly difficult to manage. Many industry leaders are looking for ways to address this concern through a single-system solution as part of a broader actuarial modernization initiative. Once thought to be unattainable in the United States, a single-system solution is now viable because of the emergence and advancement of actuarial systems, the surrounding governance, and the technology available to support them.

The pursuit and ultimate achievement of a "North Star" vision involves a significant cultural shift that may be a daunting challenge. However, recognizing the complexity of this vision, along with its potential benefits, enables companies to put the proper infrastructure in place to support and ultimately realize the potential of a single-system solution as a market differentiator that can create a significant strategic advantage.

The potential payoff for such an investment is significant and compelling. ■

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Real-World Interest Rate Models in a Low Interest Rate Environment[1]

By Jean-Philippe Larochelle, Francisco Orduña and Marshall Lin

United States Treasury rates have decreased significantly and stayed at historically low levels since the 2008 financial crisis. This has direct implications for interest-sensitive life insurance and annuity products. For instance:

- Sustained low interest rates make it difficult to earn the yields needed to support minimum crediting rate guarantees (interest rate and spread risk).
- Rapidly rising interest rates can lead to a substantial increase in surrenders, forcing the insurer to sell a significant volume of assets at a loss (disintermediation risk).

This article presents a case study that explores the use of real-world interest rate scenario generators with a block of fixed deferred annuities (DAs). We contrast cash flow testing (CFT) results based on New York 7 (NY7) deterministic scenarios to stochastic scenarios generated with the Academy Interest Rate Generator (AIRG), as well as an alternative economic scenario generator (ESG) designed explicitly to capture the risk of:

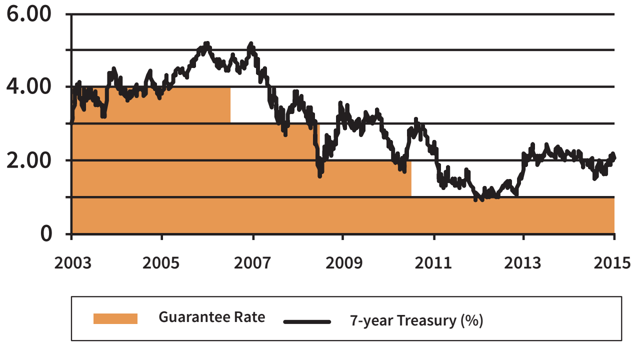
1. A persistently low interest rate environment, and
2. The transition to a rising interest rate environment.

CASE STUDY: PRODUCT OVERVIEW

The hypothetical inforce block in this case study consists of DA policies issued between 2003 and 2015. The following table summarizes the interest rate guarantees by issue year, along with the current weight by account value for each guaranteed rate.

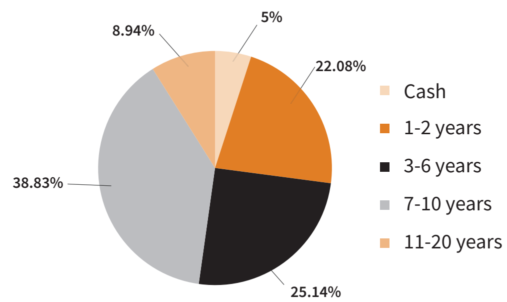
Deferred Annuity (DA) Block of Business		
Issue year	**Weight**	**Minimum guarantee**
2003–06	50%	4.0%
2007–08	28%	3.0%
2009–10	11%	2.0%
2011–15	11%	1.0%
Weighted average guarantee rate		**3.2%**

7-Year Treasury Spot Rate vs. DA Minimum Guarantee Rate (%)

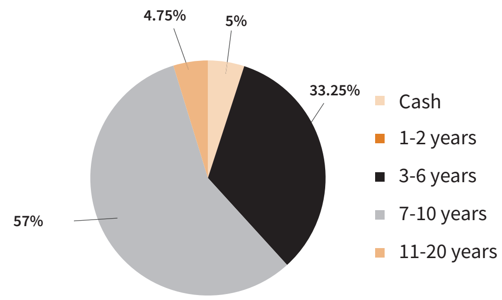


- Crediting rates are based on the current asset portfolio yield less a target spread of 1.0 percent, subject to the policy minimum credited rate. Lapse rates are set dynamically, based on the difference between market competitor rates and the crediting rate. Shock lapses at the end of the surrender charge period are also defined dynamically.
- At the June 30, 2015, valuation date, the starting portfolio consists of bonds across various maturities with 40 percent in NAIC Class 1 bonds and 60 percent in NAIC Class 2. The market-to-book value ratio of the starting portfolio is 106.5 percent.
- Positive cash flows are reinvested to meet the target allocation given below. Negative cash flows are first covered

Initial Allocation by Term to Maturity



Target Allocation by Term to Maturity



with available cash and then with asset sales that minimize incurred capital gains and losses.

DETERMINISTIC SCENARIOS: NY7

Actuaries typically look at NY7 scenarios as an umbrella that covers a wide spectrum of interest rate movements. Using the June 30, 2015, yield curve and starting reserves of $12.4 billion, the NY7 results are summarized in the following table.[2]

CFT Results: 30-Year Projections		
NY7	**Description**	**PV of ending surplus[a] ($ millions)**
1	Level	397
2	Increasing	599
3	Up/down	451
4	Pop up	689
5	Decreasing	(280)
6	Down/up	269
7	Pop down	(320)

[a]Discounted at the pretax portfolio yield rate.

The decreasing scenarios (5, 6, and 7) present the most significant profitability/reserve adequacy risk because of the inability to support the guaranteed rates. For the increasing scenarios (2, 3, and 4), the benefit of higher portfolio yields is partially offset by realized capital losses due to higher lapses.

STOCHASTIC SCENARIOS: AIRG

We further tested the DA block under stochastic scenarios produced by the AIRG. We used the latest version available at the time of this study (7.1.201406), only updating the starting yield curve to the selected valuation date.[3]

The Value at Risk (VaR)[4] and conditional tail expectations (CTE)[5] of the present value of ending surplus are summarized in the table below.

PV (Ending Surplus) ($ Millions)		
Level	**VaR**	**CTE**
50.0%	475	364
70.0%	407	311
80.0%	370	272
90.0%	297	207
95.0%	230	146
99.0%	97	7
99.5%	47	(54)
99.9%	(23)	(277)

Commonly used ESGs may not fully address the unique challenges presented by the current low interest rate environment.

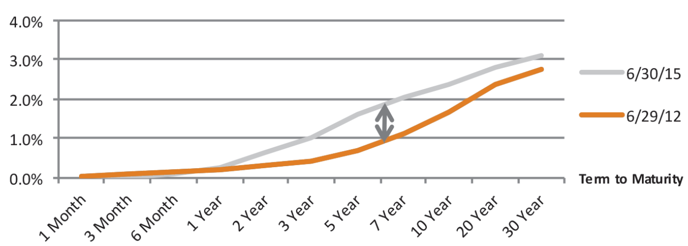
Because asset adequacy analysis is performed to test "moderately adverse" conditions, an appointed actuary might conclude that no additional reserves are required with the results shown above. However, certain risks exist that the appointed actuary needs to consider that are not explicitly covered by the AIRG scenarios:

1. Changes in the Curvature of the Yield Curve

As shown in the chart below, the short- and long-term rates have both remained relatively the same, but the medium-term rates (3 to 10 years) have increased between 2012 and 2015.

As noted in the prior article of this series, the AIRG does not model curvature stochastically and therefore does not introduce butterfly shifts to the yield curve in the simulated scenarios.

U.S. Treasury Yield Curve



2. Transition Out (or Prevalence) of the Current Low Interest Rate Environment

General consensus holds that interest rates will likely eventually revert to historical levels, but there are disagreements regarding when and how this will happen.

The AIRG model assumes that interest rates will revert to the selected mean reversion point (MRP) over approximately 50 years but does not allow users to explicitly define how long they believe low interest rates will persist and how the transition to higher rates will occur. For example, if users believe interest rates will remain low for an extended period of time before rapidly rising to the MRP, they will not be able to specify this path to MRP using AIRG's model parameters.

STOCHASTIC SCENARIOS: ALTERNATIVE ESG

To explicitly capture the view of extended low interest rates discussed above and evaluate the potential impact on CFT, we created an alternative ESG designed as follows:

- A key-rate model form[6] based on the Cox-Ingersoll-Ross (CIR) model to project each point on the Treasury yield curve
- A regime-switching process to model transition explicitly from the current low interest rate environment to a rising interest rate environment. The regime-switching process explicitly captures cases with sustained low-interest rates, as well as the transition to rising interest rates.

$$dr_{3M}(t) = a_{3M}^{I(t)}\left(b_{3M}^{I(t)} - r_{3M}(t)\right)dt + \mu_{3M}(t)dt + \sigma_{3M}^{I(t)}\sqrt{r_{3M}(t)}dZ_{3M}$$
$$dr_{6M}(t) = a_{6M}^{I(t)}\left(b_{6M}^{I(t)} - r_{6M}(t)\right)dt + \mu_{6M}(t)dt + \sigma_{6M}^{I(t)}\sqrt{r_{6M}(t)}dZ_{6M}$$
$$\dots$$
$$dr_{30Y}(t) = a_{30Y}^{I(t)}\left(b_{30Y}^{I(t)} - r_{30Y}(t)\right)dt + \mu_{6M}(t)dt + \sigma_{30Y}^{I(t)}\sqrt{r_{30Y}(t)}dZ_{30Y}$$

$$f(dZ_{3M}, dZ_{6M}, \dots, dZ_{30Y}) = C[f(dZ_{3M}), f(dZ_{6M}), \dots, f(dZ_{30Y})]$$

$$\boldsymbol{P} = \begin{bmatrix} P(I(t)=1|I(t-1)=1) & P(I(t)=2|I(t-1)=1) \\ P(I(t)=1|I(t-1)=2) & P(I(t)=2|I(t-1)=2) \end{bmatrix}$$

where $\{r_{3M}, r_{6M}, \dots, r_{30Y}\}$ are the modeled key rates,
$\{a_{3M}^{I(t)}, a_{6M}^{I(t)}, \dots, a_{30Y}^{I(t)}\}$ the mean-reversion speed,
$\{b_{3M}^{I(t)}, b_{6M}^{I(t)}, \dots, b_{30Y}^{I(t)}\}$ the mean-reversion level,
$\{\mu_{3M}(t), \mu_{6M}(t), \dots, \mu_{30Y}(t)\}$ an additional drift component that reflects the impact of the level of each key rate relative to one another,
$\{\sigma_{3M}^{I(t)}, \sigma_{6M}^{I(t)}, \dots, \sigma_{30Y}^{I(t)}\}$ the volatility factors, and
$\{Z_{3M}, Z_{6M}, \dots, Z_{30Y}\}$ the associated Wiener processes for each rate.
The joint distribution of the instantaneous change in Wiener processes, $f(dZ_{3M}, dZ_{6M}, \dots, dZ_{30Y})$, is defined using a correlation matrix.

$I(t)$ denotes the regime at time t, which follows a Markov chain process with transition matrix $\boldsymbol{P}$. Note that each set of parameters $\{a_T^I, b_T^I, \sigma_T^I\}$ is unique for a given term to maturity and each regime.

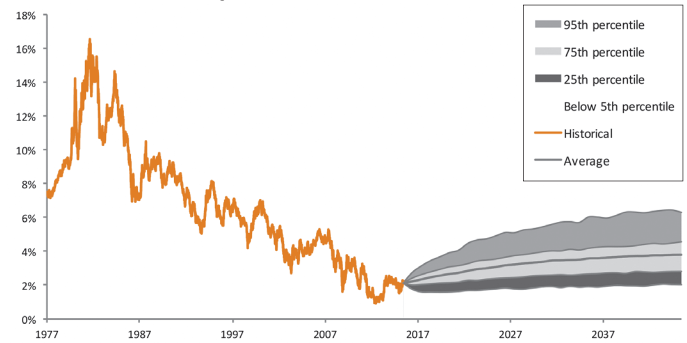
We calibrated the regime-switching CIR (RSCIR) model parameters with maximum likelihood estimates (MLEs) using historical treasury rates from 2009 to 2015 for the low interest rate environment (the "low regime") and from 1977 to 2008 for the interest rate environment observed before the 2008 financial crisis (the "high regime"). The transition probability between the low regime and the high regime is based on the user's explicit view of how long he or she expects the current (low) interest rate environment to persist. The parameters used in our runs are summarized in the following table.

Annual Transition Probability	To low regime	To high regime
From low regime	85.0%	15.0%
From high regime	2.1%	97.9%

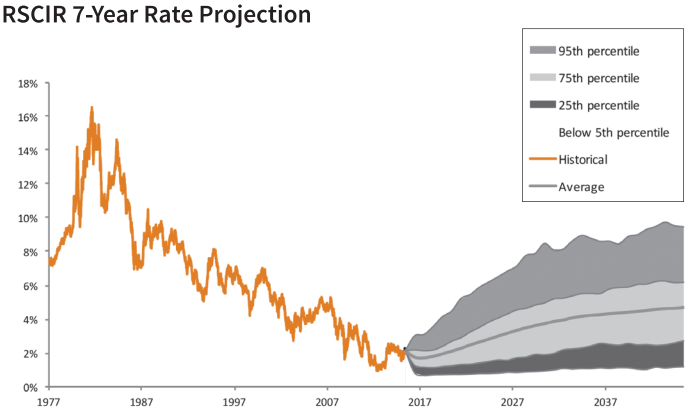
In other words, a 15 percent probability exists in a given year that there will be a transition from the low regime to the high regime. This translates to an average of 6.6 years to exit the low interest rate environment. Given the nature of a two-regime model, the convergence toward the weighted average MRP takes longer than 50 years.

We generated 1,000 scenarios using both the AIRG and RSCIR models.[7] The distribution of the 7-year rate under each model is shown in the following figures.

AIRG 7-Year Rate Projection



RSCIR 7-Year Rate Projection



The CFT results with 1,000 scenarios are summarized in the following table.

PV (Ending Surplus) ($ Millions)				
ESG	**AIRG**	**RSCIR**	**AIRG**	**RSCIR**
Level	**VaR**		**CTE**	
0%			455	336
50.00%	475	353	364	167
70.00%	407	235	311	84
80.00%	370	166	272	26
90.00%	297	55	207	(63)
95.00%	230	(28)	146	(147)
99.00%	97	(202)	7	(316)
99.50%	47	(275)	(54)	(398)
99.90%	(23)	(364)	(277)	(610)

The main drivers of the differences between AIRG and RSCIR are the following:

1. The RSCIR generates a higher number of scenarios that show low interest rates for an extended period of time (i.e., staying in low regime) and cases where interest rates had sharp increases after transitioning into the high regime.

2. The MRPs between RSCIR and AIRG are different. The RSCIR defines an MRP under each regime using historical data, placing the same weights on each historical rate. The AIRG places more weight on recent experience when defining the MRP.

Depending on how the appointed actuary defines moderately adverse conditions, using an alternative ESG may lead to a different conclusion on whether additional reserves are needed.

As this case study illustrates, capturing interest rate risk using stochastic models poses additional challenges to actuaries, but allows us to better understand the risks embedded in our portfolios. This analysis was focused on asset adequacy, but the choice of ESG is also relevant in other business applications, such as asset-liability management and risk management. Actuaries should understand both the explicit assumptions they make when calibrating an ESG and the implicit assumptions they make when selecting an ESG. ■

ENDNOTES

1 This discussion follows from the previous article in the July 2015 issue of *The Modeling Platform*, “Real-World Interest Rate Models and Current Practices,” where we discussed common uses of real-world interest rate scenario generators in the life insurance industry and different approaches to building such generators.

2 Rates are subject to the proportional shift floor, in which the curve is never allowed to be lower than half of the initial curve at valuation date.

3 In practice, although some companies do recalibrate the AIRG, we often see companies update only the starting yield curve and the MRP of the long-term rate, based on the Academy’s recommended formula (“MRP Formula and Seed Volatility 2007-09-30.xls,” published on the Academy’s website).

4 Value at Risk at level q—VaR(q)—in this context is the (1−q) quantile of the empirical distribution of surplus.

5 Conditional tail expectation at level q—CTE(q)—is the average of the surplus values that are lower than VaR(q).

6 As described in our article in the previous issue of *The Modeling Platform.*

7 The stochastic scenarios used in this study passed AAA’s calibration criteria.

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System Access and Change Controls

By Michael Failor

For many reasons, the insurance industry is paying increasing attention to the control of actuarial systems. Although each organization has its own current level of controls (some more developed than others), model-based valuations will be increasing model complexity and will require higher levels of actuarial systems control to reduce model risk. This increased focus has led many actuaries to realize that their company's actuarial systems require upgraded access and change control processes similar to those followed by their IT counterparts.

Many companies in the industry have fallen behind the controls curve, and those who have recognized their predicament are now seeking workable solutions. This article discusses effective control processes that can help get actuarial systems back on the controls track. One thing is certain—times have changed and new habits are needed to keep pace with the new direction that modeling has taken. Actuaries will soon be expected to apply higher levels of due diligence in actuarial systems management. In fact, we are heading into an environment where documentation and process will be receiving as much focus as the modeled results.

SYSTEMS VERSUS MODELS

The first thing to clarify is what I mean by "system" versus "model." This is a gray area; some models may evolve into full-blown systems, and some systems may be reduced to individual models. But the terms need to be put into context in order to capture the essence of a system and how it is differentiated from a model. Some key defining characteristics of each are shown below.

Characteristics of Actuarial Systems:

- Often contain a myriad of options and settings in which to build and execute actuarial models.
- Provide the underlying code (actuarial formulas) needed to execute projection models. "Open systems" allow users to modify system code and formulas, whereas "closed systems" prevent user-level changes to underlying system code.
- Coding errors can affect every model built on the system (similar to DNA coding errors).

Characteristics of Actuarial Models:

- Are often executed on actuarial projection systems.
- May be defined by selecting options, settings, and inputs accommodated by an underlying projection system (similar to genes in DNA).
- May be independent of each other.
- Are dependent on underlying system calculations.

With these characteristics in mind, we can address the increased need for system controls.

REASONS FOR SYSTEM CONTROLS

There has been an increase in systems development efforts to accommodate changing modeling demands. Some major drivers are stochastic modeling, Solvency II, VM-20, systems consolidations, and continued product creativity. Code development to accommodate these drivers is taking place across many applications and programming languages, including the following:

- Vender-provided "open code" projection systems
- Excel (VBA)
- C++
- SAS
- And many others

Modeling is also increasingly reliant upon larger volumes of data, prompting an increase in SQL code development and utilization of database interfaces. This is happening in addition to new applications of big data analytics.

Given the large amount of code development taking place, there is naturally a greater chance of systems-generated modeling error. However, the model flexibility afforded through coding changes cannot be at the expense of model integrity.

It should be clear that actuarial modeling and systems have evolved—but have our system controls actually kept pace with the changes? The answer to this question can be found in the SOA-sponsored survey conducted by Deloitte, "Actuarial Modeling Controls: A Survey of Actuarial Modeling Controls in the Context of a Model-Based Valuation Framework" (December 2012; a second updated survey on actuarial modeling controls is currently under development.) This survey compared the then-current state of controls against those expected to be in

Modeling Governance Theme	Score	Current State Synopsis
Governance Standards	3	While many companies employ a variety of model governance policies, few companies have a holistic, formal and documented model governance structure.
General Modeling Process	3	Many companies have multiple models and modeling platforms and few companies incorporate a model steward role in the modeling processes.
System Access and Change Control	4	Model changes are not generally governed by a formal change process.
Model Assumption Management	3	Assumptions are regularly reviewed and updated, but with few controls in place to ensure assumptions are approved and input appropriately.
Model Input Management	2	Many companies use automated feeds from admin systems for model inputs of liabilities. Other model inputs are often less automated.
Model Output Management	2	Model output used for financial reporting purposes is generally well controlled, while model output for analysis and other purposes is generally less controlled.

Of the six governance themes analyzed by Deloitte, System Access and Change Control was rated the worst in the industry. (Source: "Actuarial Modeling Controls: A Survey of Actuarial Modeling Controls in the Context of a Model-Based Valuation Framework." SOA, December 2012.)

place for model-based valuation approaches, including an analysis of controls surrounding system coding changes. On a scale of 1 to 5 (1 being the best), System Access and Change Control received a 4—the worst score of all the categories. Note that controls for system coding changes fall into this category.

The majority of survey respondents had no formal systems change control process. Because of this finding, the report accompanying the survey results strongly recommends that companies "implement a formal change management process for governing model code changes and model updates." To create such a change control process, it is important to understand some typical components.

SYSTEM ACCESS AND CHANGE CONTROL COMPONENTS

Actuarial system code changes are typically performed by actuarial staff, because they best understand the theory and actuarial mathematics underpinning insurance products. However, good code management practices (a hallmark of IT professionals) are often underappreciated or inconsistently applied in actuarial units. Many actuaries view systems controls as overbearing and unduly burdensome. In some instances this sentiment is justified. Nevertheless, good control processes pay off in the long term. Whether achieved through direct IT departmental oversight or more independently managed within the actuarial units, companies should have customized control processes designed for efficient execution.

Some important components to consider when developing a control process are addressed below.

Code Comparison Tools

When actuaries make code changes, or compare different versions of an open code application, they can use code comparison tools to make the job easier and provide valuable documentation of system changes. Vender-supported actuarial systems may contain integrated code comparison tools. However, when working with Excel VBA or other coding platforms, many third-party code comparison tools are available (e.g., UltraCompare). Most IT departments maintain well-tested code comparison tools available on your network.

Systems Peer Review

Not only should actuarial models be peer reviewed, but changes to actuarial systems should be peer reviewed as well whenever system code changes are made. (See Reviewing and Validating Actuarial Models, "Systems Peer Review" presentation at the SOA 2013 Valuation Actuary Symposium.) Peer reviewing actuarial system modifications can be a significantly different task

than validating an individual actuarial model. In fact, many (if not most) system errors that I have seen could have been discovered in a proper systems peer review.

Model and System Stewards

For model and system stewards to remain effective, top-down management support is crucial. These roles can be staffed by one or many individuals throughout the organization. But, if the authority of any steward is undermined by weak or faltering management support, then the control process may lose its footing as hurried modelers push for procedural shortcuts or the "quick fix." Although flexibility has its place, procedural controls should be explicitly defined to expedite small, isolated system changes without foregoing critical control steps. Not every scenario can be anticipated, but reducing the number of procedural "exceptions" is best achieved through an effective change request classification system. Alternatively, overly broad and unduly cumbersome control processes are more likely to be circumvented, thus reducing the steward's effectiveness.

The following are examples of some of the potential duties of a steward:

- Secure production models and systems
- Archive models and systems when changes are made
- Apply system versioning controls
- Ensure that control processes and procedures have been properly followed
- Assign system access levels
- Manage system and model documentation
- Communicate with modelers and update procedures
- Participate in model governance committee
- Coordinate testing and peer reviews
- Obtain approvals
- Schedule new system releases and software upgrades

System Access Controls

Access to system files, data, and models should be restricted to users, modelers, developers, testers, stewards, and others demonstrating a need. Access should be granted at the appropriate levels and reevaluated on a regular basis to remove or modify access levels as individual roles or processes change. In general, it is best to limit a user's access to the lowest level needed for them to perform their duties (e.g., read, write, copy, or run). Access should be set separately for production grids versus testing servers. Without proper access controls, the other control processes and procedures may be circumvented—either purposefully bypassed or by accident. The time-honored adage is "If something is not locked down, then you do not have control over it."

Test Beds (or Test Packs)

Whether you are modifying existing system code, converting to a completely new system, or upgrading to a more recent version of actuarial modeling software, test beds are a must for your testing arsenal. Test beds help to identify errors and inconsistencies among different software implementations by running identical input (e.g., seriatim policies, interest rates, mortality tables, and product settings) through each system and then comparing the results. Test beds are usually a subset (or complete set) of your organization's business modeled on the systems under comparison. When new products or features are modeled, test beds should be updated accordingly so that future test bed comparisons will be sensitive to errors associated with these new enhancements.

When a test bed is run through a system, the results should be archived along with any supporting files and system settings. This will aid in future analysis when unexpected discoveries need to be traced back to their origins. Although test beds are a vital component of a system change control regime, they cannot be expected to catch all errors.

Management/Departmental Approvals

Whenever proposed system changes are made, those who directly use the system or the system's output may take close interest. Depending on the extent and nature of a systems change, interdepartmental approvals may be required along every step of the process—from the development of the initial business requirements through testing and setting an implementation rollout date. The actual approval process will need to be fleshed out and will depend heavily on the modeling environment.

Communication and Documentation

The value of system documentation cannot be overstated as more parties become involved in modifying, analyzing, peer reviewing, and testing actuarial systems. Also, as systems become more interconnected, sufficient documentation may be expected for use in downstream systems analysis. Customers (including other systems) that rely on system output will benefit greatly from well-organized and detailed descriptions of their upstream sources.

System documentation should not be relegated to an end-of-project exercise. It should be a continual process starting at the beginning of a systems project and continuing through the final implementation steps. As the systems project morphs in scope or design, the documentation should be updated accordingly. A good systems actuary will not only document high-level descriptions but also provide helpful comments in the actual code. Documentation should also be archived and linked to production models, test results, and corresponding rollout schedules.

Modeling Environment Considerations

The modeling control process goes hand-in-hand with the modeling organizational structure. Gaining in popularity are organizational structures having a single centralized modeling environment where the actuarial models are built and maintained on one actuarial system. Organizations with centralized modeling environments often maintain a single "model of record" for each modeled block of business that serves as a base model for pricing, valuation, capital, and risk management modeling endeavors. In contrast to the fully centralized approach, a decentralized modeling environment disperses model development and maintenance among the respective functional actuarial units. Decentralized environments are often supported by different actuarial software systems that best satisfy the modeling demands of the respective actuarial unit.

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Although the centralized modeling environment incorporating models of record may be preferred, it requires a modeling system that can accommodate changing requirements in features and functionality typically demanded by different functional actuarial units. In addition, because the model of record may undergo an increased number of simultaneous changes in response to ongoing change requests, a formal code aggregation process may be required to ensure that simultaneously modified code works as intended when combined. Additionally, whenever simultaneous changes are made to a system, a formal code module check-out/check-in process can help prevent specific code modules from being modified at the same time. Even with a code check-out process, integration testing is still required because simultaneous changes to interdependent modules may produce unintentional effects.

Decentralized modeling environments present their own issues. For example, duplication of effort may occur when maintaining duplicate models and supporting multiple actuarial systems. Modeled results for a given portfolio may also differ between models, often requiring additional cross-validation.

LEADING PRACTICES

The results from the SOA Actuarial Modeling Controls survey included a number of leading practices pertaining to system access and change control. These practices typically contain the following four high-level steps:

1. Establishment of a procedure to identify and prioritize model changes (i.e., a change request process).
2. Evaluation of coding changes in a test environment and analyzing any impacts on financial results.
3. Performing additional testing on the model code changes. Depending on the nature of the changes, this can include regression testing, sensitivity testing, and peer reviews.
4. Producing proper documentation and seeking formal approvals.

If the final tested changes have been approved for use, then a system release should be scheduled for production. Note that implementation of new production code should be coordinated well in advance of any reporting close dates (e.g., quarterly or annual closes).

The creation of modeling teams and IT involvement is also recommended. Modeling teams responsible for managing and prioritizing change requests and determining change request procedures may be new to many organizations. However, these well-chosen teams are crucial, because they will also be expected to publish and maintain required system documentation and change request logs. IT involvement in the code change process will leverage their expertise and increase control and code consistency—which is of greater concern for the open code actuarial systems and centralized models.

SYSTEM DEVELOPMENT LIFE CYCLE

Although the SOA-sponsored survey covered much ground, this article would be incomplete without mentioning one of the major topics in system controls: the System Development Life Cycle (SDLC).

SDLC really merits its own article, but it is worthwhile to note that SDLC methods provide a clearly defined process for planning, creating, testing, and deploying systems and systems modifications. SDLC benefits include model risk reduction, well-defined roles and responsibilities, improved communication and documentation, and an auditable process. Lest one think that SDLC methods are just for IT professionals, be aware that the Institute and Faculty of Actuaries in the UK has included an SDLC method as part of their best practices since 2009.[1]

STRENGTHENING OUR PROFESSIONAL PRACTICE

Actuarial systems control is a multifaceted endeavor requiring an organizational structure that orchestrates skill sets and processes into a well-controlled yet highly efficient modeling environment. Because of their increasing importance, many systems control components will continue to take hold within the actuarial profession as we more fully recognize and adopt the tenets of the system development life cycle. Although processes and organizational structures do not change overnight, continued progress in actuarial systems controls will reinforce confidence in our modeling and ultimately add value to the profession.

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ENDNOTE

1 Institute and Faculty of Actuaries, "Report from the Actuarial Processes and Controls Best Practice Working Party—Life Insurance," May 31, 2009, *http://www.actuaries.org.uk/research-and-resources/documents/report-actuarial-processes-and-controls-best-practice-working-party.*

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Results of the First Modeling Section Survey

By Teresa Branstetter

The results are in from the first Modeling Section Survey. Thank you to the 254 respondents who provided invaluable insights and feedback into the composition and interests of our section. Based on your feedback, we now have many great ideas and potential volunteers for future newsletters and educational sessions for our members.

SUMMARY OF RESULTS

As actuaries, we have a strong desire to boil things down to a simplified representation of reality, so I will do my best to uphold this tradition. The average respondent is a North American life practice manager with 15 years of modeling experience, who uses models for a variety of analysis and reporting. As a collective group, we think the generalized definition of modeling is a simplified representation of reality, which encompasses the development, maintenance, and use of a combination of data, assumptions, and algorithms to produce a predictive, quantitative estimate for various business insights. However, generalizations can't begin to cover this diverse and enthusiastic group. Below are the tables to show the responses to the survey.

Table 1
What Is Your Primary Practice Area?

Primary Practice Area	No. of Respondents
Academic	1
Accounting and Finance	31
General Insurance/Property and Casualty	8
Health	43
Investment/Asset and Liability Management	32
Life	163
Retirement	16
Risk Management	49
Retired Actuary	1
Other	21

Table 2
How Many Years of Experience Do You Have Modeling (e.g., Designing, Developing, Operating, Maintaining, or Controlling Actuarial Models)?

Years of Modeling Experience	No. of Respondents
0–2 years	11
3–5 years	25
6–10 years	56
11–15 years	41
16+ years	92

Table 3
Which of the Following Best Reflects Your Work in Modeling?

Type of Modeling Work	No. of Respondents
Vendor/Consultant	37
Actuarial Systems Model Developer—System Code Updates	41
Manager/ Senior Actuary—Use Model Results	69
Model User—Run Models and Update Data and Tables	45
Auditor—Model Vetter and Model Risk Oversight	11
Academic	4
Other	18

Table 4
Which of the Following Types of Modeling Software Do You Use?

Type of Model Software Used	No. of Respondents
Vendor Platform, Open Source Code	89
Vendor Platform, Closed Source Code	70
Microsoft Office	88
Home-Grown or Other	31

Table 5
Check Each Ultimate Application of the Models with Which You Currently Work or Are Most Interested in as a Vendor, Consultant, Auditor, or Academic

Ultimate Model Application	No. of Respondents
Financial Reporting	23
Pricing	16
Risk and ALM	23
Hedging	5
Asset/Reserve Adequacy	15
Capital	14
Corporate Planning	13
Other	12

The group that responded to the survey is involved in a wide variety of modeling work and activities. Model uses include the following:

- Valuation on Multiple Accounting Bases
- Asset Adequacy Analysis
- Solvency and Capital Analysis
- Planning and Forecasting
- Asset Liability Management
- Own Risk and Solvency Assessment (ORSA)
- Policy Illustration and Regulatory Testing
- Pricing and Rate Setting
- Ad-Hoc Analysis
- Dividend Scale Setting
- Underwriting
- Predictive Modeling
- Stress Analysis
- Mergers and Acquisitions (M&A)

Modeling functions include the following:

- System Conversion
- Model Development and Maintenance
- Validation, Audit and Review
- Assumption Setting
- Scenario Generation

FUTURE TOPICS OF INTEREST

The most informative questions were related to topics of interest for our members. The Modeling Section Council has been reviewing the responses and reaching out to individuals willing to speak on these areas of interest. As seen in the following table, the top choices were Model Validation, Modeling Best Practices, Model Governance, Assumption Development, and Data Management; however, many other areas of interest are being explored as special interest topics as well.

Table 6

Check All Topics That Most Interest You for Future Articles/ Presentations

Future Topic Interests	No. of Respondents
Model Governance and Controls	138
Data Management	111
Best/Leading Practices on Modeling (Including ASOPs)	141
Model Efficiency—Cell Reduction	98
Model Efficiency—Scenario Reduction	83
Model Validation	160
Assumption Development	110
Production Modeling	70
Product-Specific Modeling Challenges	79
Mortality/Longevity Modeling	47
Scenario Generation	73
Predictive Modeling	101
Other	7

The first survey was a success because of the thoughtful responses of our members. For those of you who provided contact information during the survey, we appreciate your willingness to volunteer your time and knowledge to speak at meetings or write articles to help us make this a successful section. For anyone who did not respond but would like to volunteer or offer additional suggestions for topics of interest, please contact a member of the Modeling Section Council. The list of the section members can be found under the SOA Modeling Section webpage: https://www.soa.org/Professional-Interests/modeling/2015-modeling-leadership.aspx. We are so excited for the future of this section and in bringing more insights into the fascinating world of Actuarial Modeling.

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