THE Actuary

56
MAKING SENSE OF THE UNEXPECTED

Using system dynamics modeling to understand complex systems

SOCIETY OF ACTUARIES®

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DEPARTMENTS

Risks: Here now, closing fast or detected just over the horizon

BY RICH BERGER

"The thing that hath been, it is that which shall be; and that which is done is that which shall be done: and there is no new thing under the sun."

—Ecclesiastes

"In the beginner's mind there are many possibilities, but in the expert's there are few."

—*Zen Mind, Beginner's Mind*

"The work of science is to substitute facts for appearances and demonstrations for impressions."

—John Ruskin, Motto of the Society of Actuaries

As reported by *The Economist*, Stanislav Petrov died on Sept.18, 2017, at the age of 77. After his graduation in 1972 from the Radio-Technical College in Kiev, he worked at the secret Serpukhov-15 early warning facility near Moscow. He monitored satellite surveillance of U.S. missile launch sites to detect a missile attack on the Soviet Union. On Sept. 26, 1983, shortly after midnight, the wall screen flashed a message: "START." A missile launch had been detected. Petrov reported a fault in the system to his superiors amid the panic that had seized the staff. But the system detected more missiles, five in all, which almost certainly meant an attack had been launched. If there were an actual attack, ground radar would pick it up in 10 minutes; two minutes later the missiles would hit. Petrov continued to believe that the warning was due to a malfunction and again reported it as such to his bosses. An agonizing 15 minutes passed and there was no attack—the sun's rays reflecting off clouds high above the American launch site had been interpreted as missiles on their way.
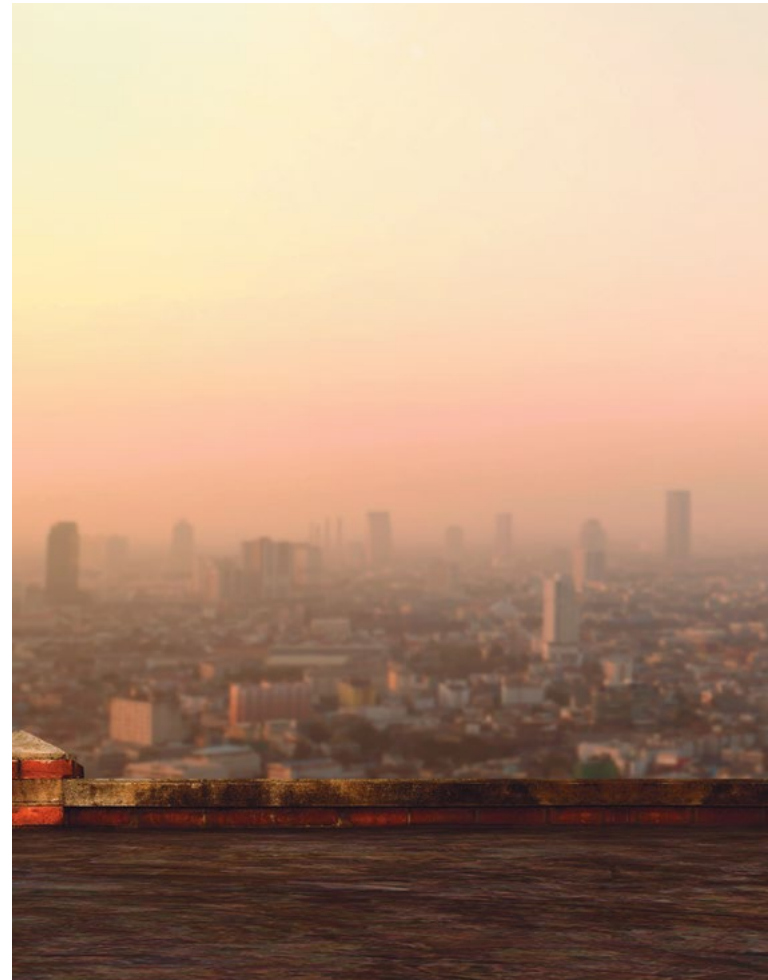
We should remember how Petrov's courage under extreme duress prevented the deaths of (potentially) millions in a nuclear battle. Had he simply reacted to the screen's message, the Soviet Union would have (apparently) launched a first strike against the United States. Since there was no effective anti-missile defense in 1983, the United States likely would have counterattacked, and an all-out war could have occurred in minutes. One man's

skepticism about what his machines were telling him saved the day.

But what if no human were involved in the process? On May 7, 2016, the first fatal crash of a Tesla under control of its autopilot occurred in Florida. The Tesla was driving at 74 mph along a highway when a truck traveling in the opposite direction made a left turn across its path. According to Tesla, the autopilot was unable to recognize the white side of the truck against a bright sky and failed to brake the car.

The relatively primitive systems of the 1980s are being replaced by more sophisticated designs. As people rely on them, disasters occur.

Mark Birdsall, the contributing editor of this issue of *The Actuary*, has identified and enlisted authors who write about emerging risks from a variety of angles. These are not existential risks like nuclear war—at least not yet—but they can be serious, with substantial financial harm to insurers and policyholders. Some of the risks have been

there all along (operational risks) and are just recently being recognized and factored in calculations. Others are beginning to be measured and monitored in the hopes of detecting changes that could have a significant financial impact (the Actuaries Climate Index). In other articles, our authors scan the horizon for new risks whose potential dangers are still being identified and assessed. Several articles in this issue describe methodologies for quantifying risks and building safety margins into firm operations.

Not every risk that is identified will turn out to be dangerous (recall the Y2K alarm). Some calamities arise from a mixture of the complacency and greed of human beings with complex modern financial contracts (the panic of 2007–2008, aka the Financial Crisis). Some arise because of a change in the regulatory environment, and the formerly irrelevant or benign becomes a problem. The introduction of a new technology, such as genetic modification or artificial intelligence, or the internet, triggers a cascade of effects. Demographic changes may shift the ground around us after a few decades.

The human mind struggles to make sense of changes in the fundamental framework of our lives. In one sense, it is an impossible task, but it is a task that must be taken up. The evaluation of emerging risks requires a different mindset than that which is used for normal actuarial work. You must leave behind the data that have been collected on known risks and temporarily put aside your experience studies. You should let your mind become receptive to different patterns. You might be advised to read a few classic science fiction stories or novels to understand how a new world is formed as a consequence of a few fundamental changes.

Read all of the articles in this issue for the total experience! Don't forget to thank Mark for putting the issue together, and Jacque Kirkwood of the Society of Actuaries for keeping everything on track. ∎

Richard Berger, FSA, MAAA, spent 35 years as a consulting actuary advising pension clients. He is currently hip-deep in small town politics as the treasurer for his homeowners' association. He and his spouse are gradually working their way across the United States in their Phoenix Cruiser motor home with their two dogs, Rosie and Jeep.

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Shaping the profession's

To kick things off, I want to ask a very important question. Is there a future in the actuarial profession?

I am sure you've been asked that question at least once in your life by teenagers or young students seeking career advice. We should all be asking ourselves that question with a new sense of urgency. If we ignore it, we do so at our peril. Let me explain …

Anyone familiar with travel agencies, banks and manufacturing plants can see that robots, automation and software can replace people. In these industries, productivity is at record levels, but we have fewer total jobs. A less dramatic but similar change is taking place in professional services. Artificial intelligence, big data and improved analytics are automating more and more complex tasks.

So much for tasks—and what about our softer skills?

As actuaries, we get high marks as skilled subject matter experts, but our stakeholders do not consider us particularly business savvy or great communicators. While we know actuaries who are great business leaders, we also know actuaries who fit the negative stereotype as well.

The challenge we face in the years to come is an existential one. Will we as a profession dwindle in numbers and importance? Or will we succeed in renewing our skill sets and our unique capabilities, rapidly enough and in harmony with emerging technology in order to preserve and expand the role and value of the actuary?

Complacency is not an option.

We need to do more, much more, to tackle these threats to our relevance and value—and by "we," I mean all of us globally. Regardless of our home country or practice areas, we are members of the same profession and face the same challenges. It's up to us, both as individuals and as leaders of actuarial organizations, such as the Society of Actuaries (SOA), to make sure we focus our efforts on achieving that brighter path.

Relevance of the profession will remain the overarching issue and the key litmus test for action and decision-making. This year, I will focus on three related themes:

❶ | Collaboration with other actuarial organizations
❷ | International growth
❸ | Expansion of actuarial opportunities

However, in a larger sense, responding to the challenges goes well beyond me—and well beyond the SOA Board. You, too, have a key role. To move forward, we need your help. I am asking you to lend a hand so that together we can shape our common future.

Let's discuss the importance of collaboration—with each other and also with other organizations.

BY MIKE LOMBARDI

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from the PRESIDENT

future

COLLABORATION

Successful collaboration includes frequent communication, relationship building, and mutual trust and respect. We need to be reaching out to our key stakeholders and other centers of influence, communicating our key message.

We want to increase awareness of the value of the SOA credentials, and to promote actuaries as trusted advisers and leaders in the measurement and management of financial risks.

We are building bridges and working together with other actuarial organizations to ensure the continuing relevance and success of the actuarial profession.

Building a bridge means listening with intent. Not to respond, but to really hear what the other side is saying, and to appreciate what they desire and what they know. Bridges are actively built from both sides. Ultimately, it is about building trust.

So how can you as members lend a hand? It is linked to volunteer efforts. Volunteers are the lifeblood of nonprofit organizations and a way for all of us to give back to the profession.

We owe a huge debt of gratitude to our volunteers for their contributions—11 percent of you serve as members on our committees, on task forces or in sections. That's an incredible amount of talent and expertise in the service of our profession.

Volunteerism is important. So, too, is the expertise we bring to our companies and clients. And we enhance our expertise through continuing education and by asking the right questions.

I encourage you to check the SOA volunteer database for opportunities to work on collaborative projects. I also encourage you as members to tell us what you think, to send us your feedback and to share your questions.

INTERNATIONAL DEVELOPMENT

We need to stay ahead of the changing global economy and ensure our members have a relevant global perspective. We are a global actuarial organization with a rapidly expanding international member base in more than 80 countries.

As a premier provider of education and research, we have much to offer. And we recognize that our mission is to work collaboratively with local organizations, not supplant them.

What is the rationale for international growth? International growth provides more opportunities for actuaries to work with global companies both here and abroad, it promotes the value of our FSA and ASA designations and the CERA credential, and it facilitates the mobility of actuaries by expanding their opportunities and geographic reach.

It may surprise some of you that five of the top 10 SOA exam centers are now in Asia.

from the PRESIDENT

To remain effective, we need to tailor our services to our international members and stakeholders, and foster a sense of community with all members, regardless of specialty, practice area, section membership or country.

We strive to provide services to those members locally. We have hosted and will continue to host professional development events, from webinars to live meetings that are specific to those locations. Recently we added new requests for research proposals in China and Asia Pacific. The local offices in both Hong Kong and Beijing help address and reinforce our connections.

China is an important market for insurance and for actuaries. The SOA is very active in China. We train thousands of candidates, and we organize key events such as the China Annual Symposium and the recent 30th anniversary event with Nankai University.

What about other parts of the world? The demand for insurance, pensions, health care and actuaries in Latin America is beginning to grow. Through our Latin America committee, we have been reaching out to local insurance associations, universities, regulators and employers in countries such as Argentina and Brazil, in order to explore how we might engage in those markets.

EXPANDING ACTUARIAL OPPORTUNITIES

We need to significantly step up our efforts to deal with our rapidly changing environment. The challenge for any profession is to remain relevant to its key stakeholders. That applies to the actuarial profession as well. We address the question of relevance both individually and collectively. Individually, we do so by committing to lifelong learning and continuing education, which replenishes our skills and ensures we can meet the needs of our future employers and clients.

We also remain relevant by:

- Developing skills outside of our areas of expertise.
- Working on our weaknesses as well as our strengths.
- Improving our "soft skills."

Actuaries are and should be the leading professionals in the measurement and management of financial risk. When employers think of actuaries, I want them to think of us as more than technicians. I want them to think of us as

leaders, as problem-solvers, as an essential part of the team, contributing meaningfully and directly to company success.

Those we serve are undergoing tremendous change. Our future depends on adapting to that change and serving our customers well. In the SOA strategic plan, we have identified a number of key strategic initiatives, such as enhanced environmental scanning, strategic research and education in predictive analytics for both new and existing members.

The ultimate goal of our strategy is simple and resolute:

- We want to be relevant to employer and client needs.
- We want to serve a large and growing profession, and in turn provide meaningful work for current and future members.
- We want to be recognized and seen as credible with our stakeholders.
- We want to expand the frontiers of the actuarial profession though ongoing strategic research.

We need to make sure we remain highly sought-after professionals, and that stakeholders continue to seek out our members for their unique skills and high ethical standards. Let me conclude with a question and a challenge to you:

- What can you or any one person do to help shape the future—can you make a difference?

Commitment is the best way for you to help shape our future and make a difference. Let us:

- Work together to keep the actuarial profession vibrant.
- Focus on attracting the best and brightest to our profession.
- Collaborate with other organizations to advance our profession.
- Expand actuarial opportunities in emerging fields.
- Sharpen our actuarial skills and at the same time enhance our business acumen and communications skills.
- Prove the relevance of our credentials.

Together we will make a difference. I ask you to join us and lend a hand to shape our future. ■

Year-end review

A ROUNDUP OF NEWS FROM THE GLOBAL COMMUNITY

Whether you travel the world or never leave your home country, you are affected by global organizations, international requirements and the increasingly international nature of the actuarial profession itself. Here is some news from around the world.

The Society of Actuaries (SOA) participated in many global events during 2017. On Feb. 22, 2016–2017 SOA President-Elect Mike Lombardi, FSA, CERA, FCIA, MAAA, and other SOA members attended the 24th Annual Chinese New Year Meeting celebrated during the dinner hosted by the Pacific Rim Actuaries Club of Toronto.

EVENTS IN ASIA

In the spring, the SOA and the China Association of Actuaries (CAA) held the second Executive Education Exchange program in China. The program, designed to facilitate information exchange and strengthen the profession in both countries, included meetings with insurance regulators, university representatives and insurance companies.

During the summer months, the SOA participated in and hosted four major events in Asia.

The 2017 SOA China Annual Symposium took place June 29–30 in Shanghai, China. The symposium provided a platform for attendees to meet with industry leaders and share their experiences in the fields of actuarial science, finance and insurance in the region.

2016–2017 SOA President-Elect Mike Lombardi offered welcome remarks and was followed by two keynote speakers: Songchen Sheng, former head of statistics and survey department at the People's Bank of China, and Yulong Zhao, general director of the finance and accounting solvency department for the China Insurance Regulatory Committee.

On July 3, representatives from the SOA, including Lombardi and SOA Executive Director Greg Heidrich, attended the celebration to commemorate the 30th anniversary of the SOA-Nankai University program. The SOA and Nankai University in Tianjin, China, established an actuarial science program that has continued to grow and evolve over the years, and it now offers undergraduate and master's degrees in actuarial science.

The SOA was honored to receive support from the Actuarial Society of Malaysia (ASM) and Persatuan Insurans Am Malaysia (PIAM) for the 2017 SOA Asia-Pacific Annual Symposium, July 6–7 in Kuala Lumpur, Malaysia. Jeremy J. Brown, 2016–2017 SOA president, attended this event. The event, under the theme "Beyond Traditions—A World of Opportunities," included welcome remarks from Gary Hoo, FSA, FCAS, president of ASM and delegate of PIAM, followed by keynote speaker Yew Khuen Yoon, FIA, FASM, director of insurance and development of the Bank Negara Malaysia.

The 8th China Risk Management and Actuarial Forum took place on July 8 at the University of International Business and Economics (UIBE) in Beijing, China. The event included more than 200 faculty members and industry experts and 100 UIBE students. SOA Lead China Representative, Jessie Li, FSA, acted as the moderator during one of the afternoon sessions.

INTERNATIONAL RESEARCH

In the area of research, LIMRA and the SOA published the final results of their research on the current state and future opportunities of the retirement market in China. This research project focused on a series of six reports that examine consumer attitudes, beliefs and behaviors on various retirement issues. These issues include retirement goals and objectives, retirement risks, retirement savings, available retirement options, use of financial advisers and strategies for managing retirement risks.

LATIN AMERICA FOCUS

Representatives from the SOA's Latin America Committee (LAC) attended the 6th International Actuarial Symposium in Bogotá, Colombia, Oct. 26–27, held by the Colombian Association of Actuaries (Asociación Colombiana de Actuarios). This is the main actuarial event in the country, and it focused on predictive analytics, risk management and regulation.

The LAC was formed in 2016 to promote the actuarial profession in Latin America and foster closer relationships in the area through joint projects. ∎

RISING RISKS

Here's your source for industry briefings and SOA news. Important headline information, section highlights and current stories—in short, news to note.

JOINT RISK MANAGEMENT SECTION UPDATE

BY DAVID SCHRAUB AND C. IAN GENNO

The Joint Risk Management Section is a collaborative initiative that brings together the experience and perspectives of the Casualty Actuarial Society (CAS), Canadian Institute of Actuaries (CIA) and Society of Actuaries (SOA), focusing on both the actuarial aspects and the broader applications of risk management. In concert with other collaborative work (such as the North American Actuarial Council, various inter-organization research projects, etc.), it offers the CAS, CIA and SOA an opportunity to do more of what our members say they want us to do: Find ways for actuarial organizations to cooperate and collaborate on issues of common interest to our profession.

While all areas of actuarial practice are based on a set of underlying principles, in many areas the ability to practice is also based on detailed knowledge of specific local regulatory requirements. By contrast, risk management tends to be less country-specific, which further enhances this section's ability to serve the needs of members in countries around the world. For example, Own Risk and Solvency Assessment (ORSA) rules have been adopted in every developed country, and they follow consistent principles that an actuary practicing in risk management in the United States, Canada, Europe or Australia would understand.

Our section currently is sponsoring a number of interesting initiatives. In addition to helping organize sessions related to risk management at various actuarial meetings, our flagship meeting is the Enterprise Risk Management Symposium, held each year in the spring.

We sponsor a variety of research initiatives—including the periodic Emerging Risks Survey, research on the impact of continuing low interest rates and our collaboration on the Actuaries Climate Index—to help address the modeling and pricing of catastrophic risk coverage.

We're also interested in research on approaches for quantifying operational risk, and applications of predictive modeling in risk management and InsurTech.

To provide section members access to relevant, in-depth reading material, we maintain an e-book library with a selection of books and articles, which we review and update on a regular basis.

Research reports related to risk management are available to anyone on the SOA's website. But some of the benefits, such as our e-book library and notices about risk management webcasts and research reports, are exclusively for section members.

Section membership is part of branding yourself as a risk manager. Membership offers ample opportunities to volunteer on various initiatives. It is a key element in providing funding for our work, and it demonstrates your support of finding ways for the CAS, CIA and SOA to work together. So if you're not already a section member, please consider joining! ■

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LOOKING FORWARD WITH CLARITY
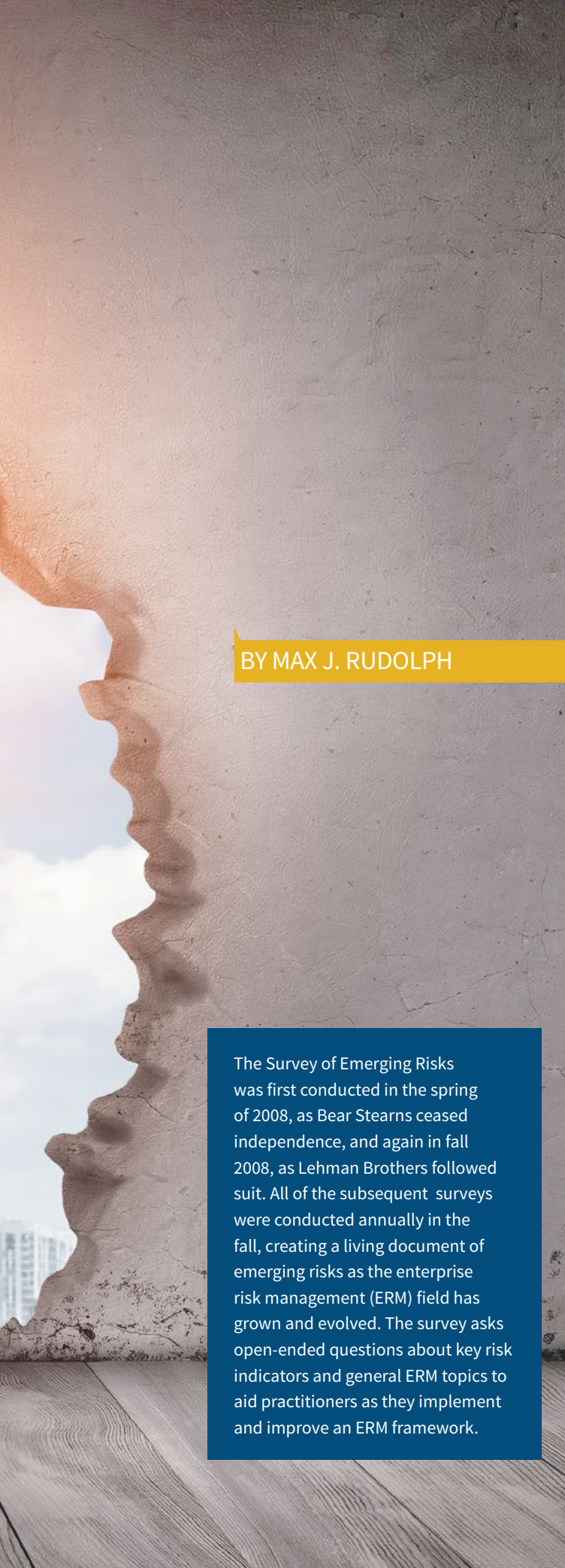
"
It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so."

—Mark Twain

BY MAX J. RUDOLPH

THE 10TH SURVEY OF EMERGING RISKS HELPS ACTUARIES IMPROVE FORWARD-LOOKING PROJECTIONS

Actuaries often are accused of creating a process where we drive a car using only the rearview mirror to observe our surroundings. Jokes about driverless cars notwithstanding, one of the hardest parts of projecting the future is figuring out when historical data is no longer predictive. While unknown unknowns (thanks to Donald Rumsfeld) have led to the study of Black Swans (Nassim Taleb[1]) and Gray Rhinos (Michele Wucker[2]), unknown knowns typically become a battleground where politics and forward thinkers skirmish. Awareness of emerging risks, and anticipating their positive and negative effects, gives risk managers a head start in developing mitigation strategies.

Some risks evolve slowly over time, requiring statistical techniques to extrapolate based on recent trends. This might include flood risk due to climate change, or auto insurance as seat belt usage became prevalent. Some risks occur infrequently, allowing practitioners to make a bet to ignore tail events like pandemics and extreme earthquakes. When risks shift, prior data is harmful if used to describe the future. Insurance risks related to driverless cars, cyberattacks, severe hurricanes and opioid use fall in this category. While evolving risks sometimes occur slow enough for adaptation, those that move quickly increase

The Survey of Emerging Risks was first conducted in the spring of 2008, as Bear Stearns ceased independence, and again in fall 2008, as Lehman Brothers followed suit. All of the subsequent surveys were conducted annually in the fall, creating a living document of emerging risks as the enterprise risk management (ERM) field has grown and evolved. The survey asks open-ended questions about key risk indicators and general ERM topics to aid practitioners as they implement and improve an ERM framework.

background

solvency risk and could be systemic. Risk managers who seek emerging risks and develop contingency plans increase firm resiliency.

THE 10TH SURVEY

The Survey of Emerging Risks[3] tracks the trends of thoughts of risk managers across time. The results presented in this article are from the 10th survey.[4] Responses were received primarily from North American actuaries involved with risk management, although some responses were from risk managers working in government and other industries across the globe. Trends are as important as absolute responses, helping risk managers contemplate individual risks, combinations of risks and unintended consequences of actions and inactions.

Past highlights of the surveys include recency bias, the increasing importance of cyber risks, and the prominence of risk culture in long-term results. This year is no different. The rise of populism in developed countries resulted in the Brexit vote, where U.K. voters expressed a desire to leave the European Union, and the election of Donald Trump as president of the United States. The survey's timing, just weeks after the 2016 American national election, reflects this as seen by increases in the *retrenchment from globalization* risk across questions about current and emerging risks. One trend recognized this year is the prevalence for geopolitical risks to have higher responses in even-numbered years corresponding to the American election cycle.

Risk management practices continue to evolve. The year 2016 saw limited geopolitical risk breakouts, but the Middle East, Venezuela, Ukraine and North Korea all remain hot zones. Hackers have become a constant threat, but the public quickly is lulled into complacency until a shock occurs. A lack of natural disasters in the United States had lulled some into complacency prior to Hurricanes Harvey, Irma, Maria and Nate. This year's Survey of Emerging Risks, the 10th in the series, attempts to capture these trends.

In addition to the top five and top emerging risks, the survey also looks at the top current risks and risk combinations.

SURVEY OF EMERGING RISKS

In the Survey of Emerging Risks, respondents select from 23 risks in five categories. When a chart shows 24 risks, the last one is *other*, and the survey asks specifically which risks are missing so they can be considered for future surveys.

ECONOMIC RISKS

1. Energy price shock
2. Currency shock
3. Chinese economic hard landing
4. Asset price collapse
5. Financial volatility

ENVIRONMENTAL RISKS

6. Climate change (includes space weather)
7. Loss of freshwater services
8. Natural catastrophe: tropical storms
9. Natural catastrophe: earthquakes
10. Natural catastrophe: severe weather (except tropical storms)

GEOPOLITICAL

11. Terrorism
12. Weapons of mass destruction
13. Interstate and civil wars
14. Failed and failing states
15. Transnational crime and corruption
16. Retrenchment from globalization
17. Regional instability

SOCIETAL

18. Pandemics/infectious diseases
19. Chronic diseases
20. Demographic shift
21. Liability regimes/regulatory framework

TECHNOLOGICAL

22. Cyber/interconnectedness of infrastructure
23. Technology

FIGURE 1   **EMERGING RISKS BY CATEGORY (UP TO FIVE RISKS CHOSEN PER SURVEY)**
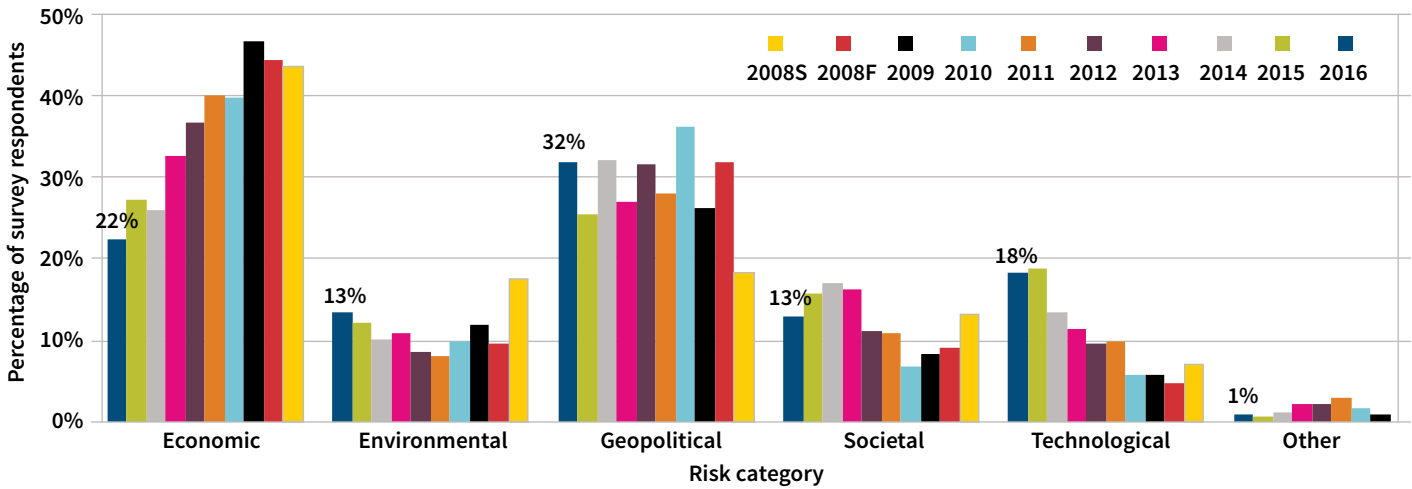
Source: Survey of Emerging Risks, 2008–2016.

TOP FIVE EMERGING RISKS

The survey combines 23 individual risks into five categories—economic, environmental, geopolitical, societal and technological. (See the "Background" sidebar for more details.) In the primary survey question, respondents were asked to choose up to five emerging risks. The geopolitical category of risks gained ground (**FIGURE 1** shows percentages from the current survey for each category), reclaiming the top category, as the economic and societal categories dropped from the previous survey. The economic category has trended lower as we move further from the global financial crisis, and the technological category has grown as cyber risks and other technologies receive more attention from risk managers.

Cyber continued in its position at the top of the list of emerging risks. But for the first time since its entry as a risk in 2009, it did not rise, falling from 65 percent to 53 percent of respondents selecting it.

The uppermost choices (in the top five) in the geopolitical category were *terrorism* (40 percent of respondents choosing it in their top five) and *retrenchment from globalization* (up from 6 percent to 31 percent). Risks with new highs across the survey history were *climate change*, *natural catastrophe: earthquakes*, *retrenchment from globalization* and *technology*. A new low was recorded by the

Chinese economic hard landing risk for the sixth consecutive year. Risk managers must adapt rapidly in this quickly changing environment.

The evolution of the top five risks provides evidence that trends can be relied on in this survey, and the general continuity between survey iterations adds credibility. In this survey, *financial volatility* has overtaken *cyber* as the top current risk, but *cyber* remains the top emerging risk both when choosing five or the single top risk. (See **FIGURE 2**.)

Three risks increased materially from the previous survey when respondents were asked to choose their top five emerging risks. *Transnational crime and corruption* doubled

FIGURE 2   **RANKINGS FOR TOP FIVE EMERGING RISKS**

Rank	2013	2014	2015	2016
1	Financial volatility	Cyber	Cyber	Cyber
2	Cyber	Financial volatility	Financial volatility	Financial volatility
3	Asset price collapse	Terrorism	Terrorism	Terrorism
4	Demographic shift	Regional instability	Asset price collapse	Technology
5	Failed and failing states / Regional instability (tie)	Asset price collapse	Regional instability	Retrenchment from globalization

FIGURE 3 EMERGING RISKS: 2015 VERSUS 2016
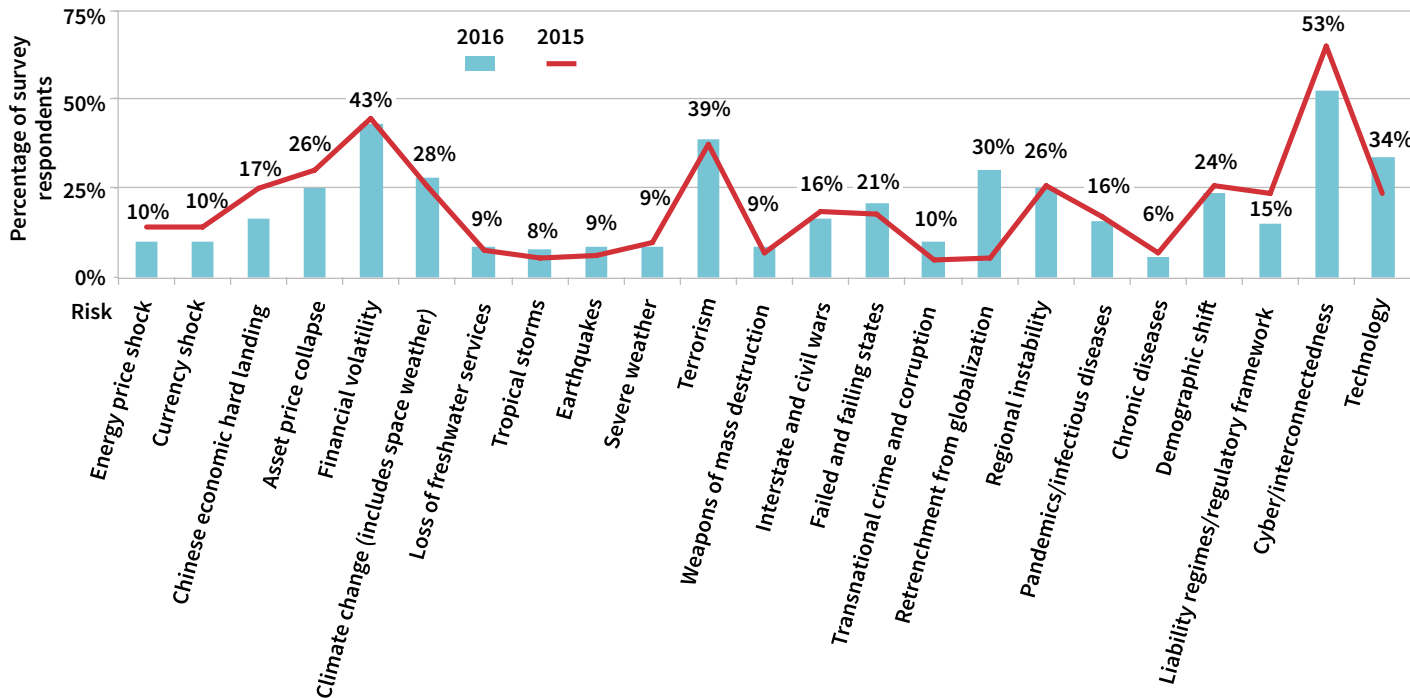
Source: Survey of Emerging Risks, 2015 and 2016.

from 5 percent to 10 percent. *Retrenchment from globalization* and *technology* each rose by double digits. Quite a few risks were materially lower, led by those in the economic category. The individual risks included *Chinese economic hard landing*, *asset price collapse*, *liability regimes/regulatory framework* and *cyber*.

FIGURE 3 shows results for the top five emerging risks from the most recent two surveys, showing how risks can move materially between iterations.

TOP EMERGING RISK

When asked for a single emerging risk from the respondents' top five, the results are similar.

The results for the top emerging risk were recorded as follows:

1 | *Cyber*
2 | *Financial volatility*
3 | *Asset price collapse*
4 | *Retrenchment from globalization*
5 | *Technology*

Chinese economic hard landing, *terrorism* and *liability regimes/regulatory framework* dropped out of the top five. Interestingly, *asset price collapse* and *retrenchment from globalization* both had much higher responses when considering the top emerging risk.

RISK COMBINATIONS

This year's survey again asked about concerns due to combinations of emerging risks. The top risks chosen include *financial volatility*, *cyber*, *terrorism*, *asset price collapse*, *retrenchment from globalization* and *regional instability*.

The top five combinations of two risks were:

➔ *Terrorism* and *cyber*
➔ *Cyber* and *technology*
➔ *Financial volatility* and *retrenchment from globalization*
➔ *Asset price collapse* and *financial volatility*
➔ *Chinese economic hard landing* and *asset price collapse*

RETRENCHMENT FROM GLOBALIZATION

Each year it seems that at least one risk has a breakout response. This survey reflected concerns about uncertainty due to populist topics in the United States and Europe. This was reflected in the survey, with higher responses being recorded for *retrenchment from globalization* in each of the surveyed categories: current risk, top five emerging risks, top emerging risk and risk combinations. Together with *financial volatility*, this risk was ranked third among combinations. While impossible to determine exactly why a specific risk goes up and down, for this risk it is notable that it had gone down in the previous survey before it sky-rocketed. **FIGURE 4** shows the progression of this risk since 2009 across all metrics.

GEOPOLITICAL CATEGORY RISKS WERE HIGHER IN 2016, HIGHLIGHTING A PATTERN OF EVEN-NUMBERED YEAR INCREASES POSSIBLY TIED TO THE U.S. ELECTION CYCLE.

FIGURE 4 ▶ **RETRENCHMENT FROM GLOBALIZATION**
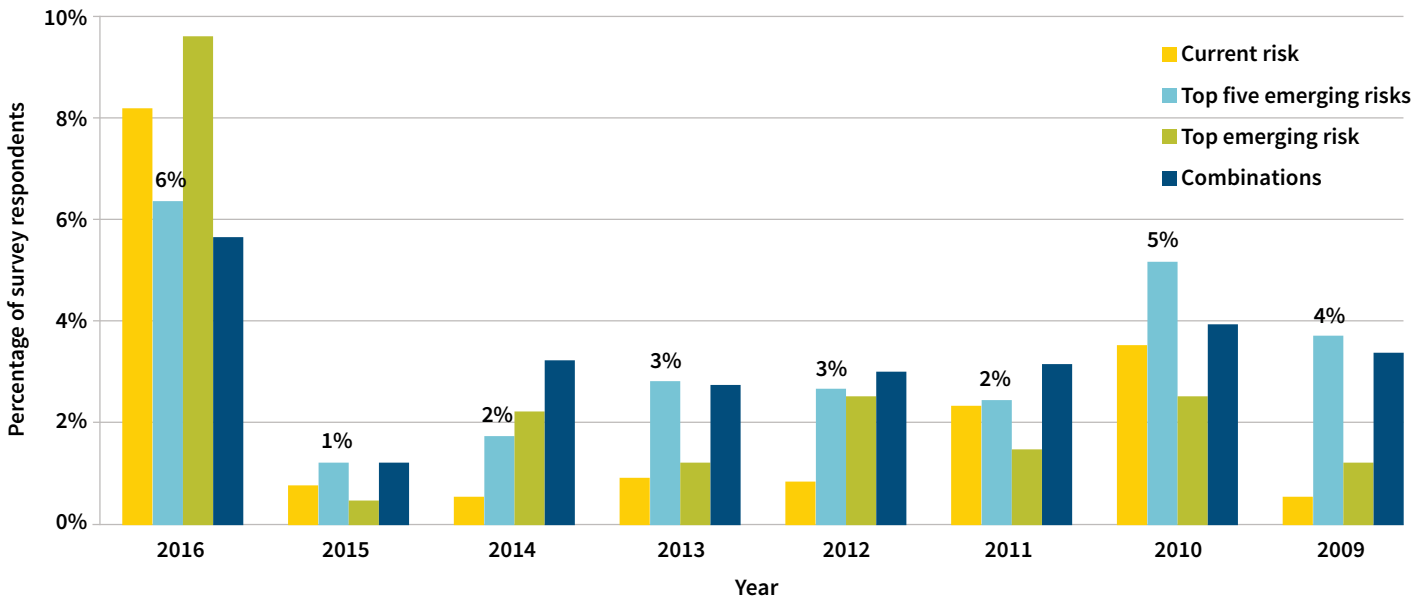
Source: Survey of Emerging Risks, 2009–2016.

CONCLUSION

Emerging risks are a great challenge for management teams. How do you manage risks with lengthy time horizons, some of which are not yet on the radar for many, while incentives are set over much shorter spans? How can a CEO keep the focus on intermediate and long-term decisions when short-term fires are so distracting?

Environmental scans are a key component as risk managers attempt to embrace emerging risks. Several consulting firms and magazines share their knowledge, and the World Economic Forum annually releases its Global Risks survey. The collection of surveys described in this article is unique in that it attempts to trend the same risks over time, leaving it to the readers to incorporate this information into their risk framework.

How can modelers incorporate emerging risks when historical data may not be similar to future results? Unknown unknowns will affect everyone in unique ways, and stress scenarios are hard to develop. Unknown knowns, where past historical data fails to be predictive, should be tested as thoroughly as possible.

Emerging risks are a key component of an Own Risk Solvency Assessment (ORSA) filing for an insurer, describing how they are considered and acted on. These can be built into stress tests through specific scenarios like a pandemic or Category 5 hurricane, or through stochastic modeling by adding risks like cyber or driverless cars to the operational risk model.

Those who look inward for risk management will fall short of goals and be surprised by discontinuities. Those who look outward will not anticipate every emerging risk, but they will turn the odds in their favor. This will clarify their vision and improve forward-looking projections. ■

References

[1] Taleb, Nassim. *The Black Swan*. New York: Random House, 2007.
[2] Wucker, Michele. *The Gray Rhino*. New York: St. Martin's Press, 2016.
[3] All articles and reports associated with the surveys can be found at *https://www.soa.org/research-reports/2015/research-emerging-risks-survey-reports*.
[4] The survey is sponsored by the Joint Risk Management Section and is a collaboration of the Canadian Institute of Actuaries (CIA), Casualty Actuarial Society (CAS) and Society of Actuaries (SOA).

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> "
> Risk managers who seek emerging risks and develop contingency plans increase firm resiliency."

findings

WHAT RISK MANAGERS ARE THINKING

➡ *Cyber* risk concerns are stabilizing but remain strong.
➡ Geopolitical category risks are higher, highlighting a pattern of even-numbered year increases possibly tied to the U.S. election cycle.
➡ *Retrenchment from globalization* spiked as populism increases were noted in the United States and Europe.
➡ *Technology* risk continues to move up the rankings and is now in the top five for both emerging risks and the top emerging risk list. This risk highlights the insurance industry's unique role in risk management, not only managing its own risks but seeking out and accepting the risks of others to help businesses increase resilience.

ACCELERATION OF TECHNOLOGICAL CHANGE AFFECTING JOBS AND INSURANCE

BY MARK BIRDSALL

We live in an age of rapid change that has the potential to impact all aspects of society, both in the United States and internationally. Some of these changes could significantly affect insurance companies, both in their operations and in the coverages they provide. Successful adaptation to these changes begins with a realization of the potential extent and speed of what is coming.

Gen Re published several thought-provoking articles on emerging technologies and the potential impact on both jobs and insurance products. The articles referenced in this sidebar are "The Speed of Disruption and Impact on Business—The Fourth Industrial Revolution Has Begun" and "The Drive Towards Fully Automated Vehicles Continues," both by Charlie Kingdollar of Gen Re.[1]

THE FOURTH INDUSTRIAL REVOLUTION

In this article, Kingdollar presents a review of the scope and speed of disruptive changes both in the United States and globally that includes the following:

❶ | Different studies by the University of Oxford, the Boston Consulting Group and McKinsey & Company indicate that 40–50 percent of U.S. jobs are at risk of being replaced by some form of automation. Though the degree of risk varies by economic sector, both blue collar and white collar jobs are vulnerable to replacement.

❷ | Regarding driverless vehicles, several automobile and truck producers plan on selling fully automated vehicles by 2020. This could result in an estimated 3 million lost jobs for truckers, taxi drivers and other similar occupations.

❸ | In warehousing, Amazon already has 45,000 robots working in 20 of its warehouses, representing a 50 percent increase in 2016 from the previous year. It has been estimated that warehousing and logistic robot shipments will be about 15 times greater in 2021 than they were in 2016.

❹ | In agriculture, CNH Industrial and Kinze have developed prototypes of driverless tractors. Harvesting, leaf pulling and weeding equipment is replacing workers and increasing productivity at farms and vineyards.

❺ | In construction and mining, Caterpillar and Komatsu are selling driverless bulldozers. Demolition robots can replace workers for the most dangerous conditions.

❻ | In manufacturing, a Chinese mobile phone producer reduced the number of workers at its plant from 650 to 60 by installing robotics.

❼ | In white collar jobs, the health care sector has increasing demand for surgical, rehabilitation and hospital logistics robots. Artificial intelligence (AI) is being used by scientists and doctors to read X-rays, analyze gene mutations, make better use of scientific studies and expand doctors' knowledge beyond their own experiences. AI may be applied to tasks affecting wealth management advisers, paralegals, journalists, accountants, bookkeepers, financial service employees and even technology employees.

With respect to insurers, Kingdollar asks us to consider various ways in which robotics and AI will change the risks associated with various categories of insurance, such as increased property values for farms and enterprises, higher costs of business interruption insurance related to higher
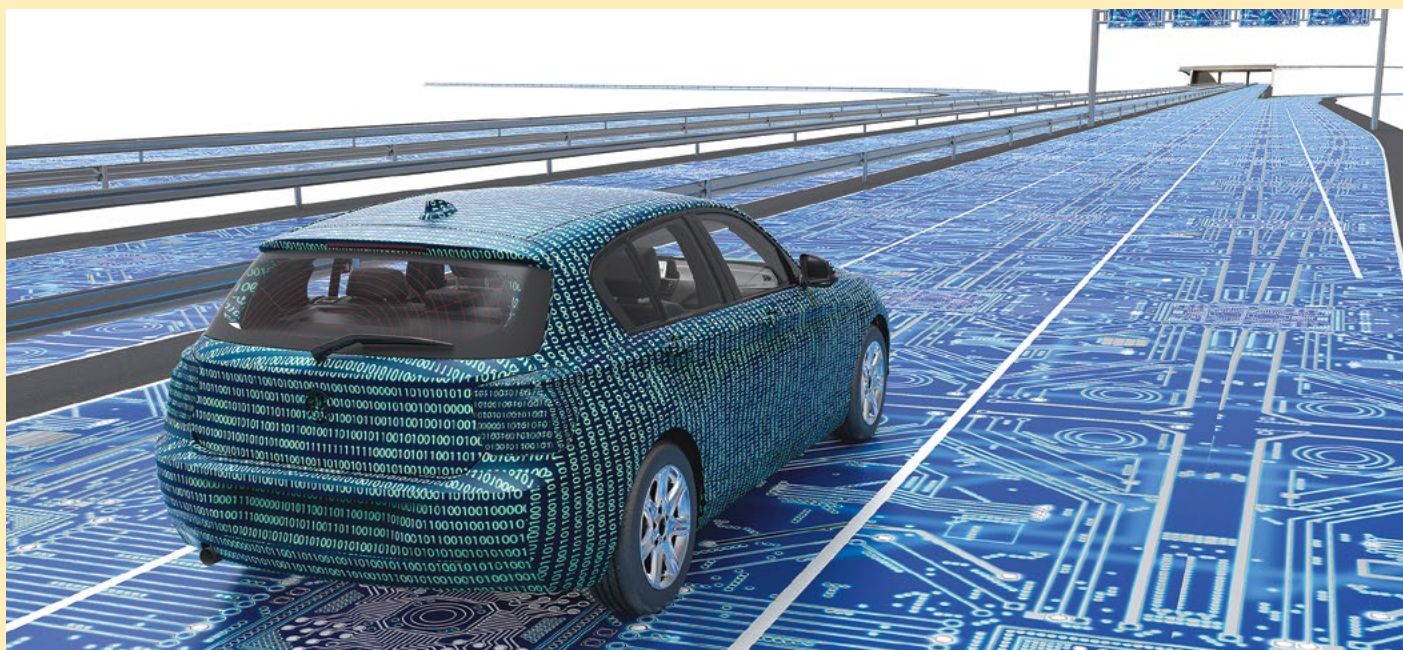
levels of productivity, lower workers' compensation costs and repetitive stress injuries, and the impact of robotics on product liability.

While outside the scope of this sidebar, replacing 40–50 percent of current jobs with robotics and AI would have significant effects on unemployment, basic education, reeducation and retraining, the social safety net, investments and other areas. Traditional actuarial tasks such as pricing, valuation and even report writing may become more automated. The drive and flexibility to embrace change and engage in continuous learning may be essential characteristics for actuaries to continue to contribute and thrive as a profession.

DEVELOPING FULLY AUTOMATED VEHICLES

Kingdollar points out in this article that a number of accidents involving driverless vehicles have been reported. While no one knows for certain how this will affect the movement toward fully automated vehicles, he points to several announcements that occurred after a May 7, 2016, fatal accident in Florida involving a partially automated vehicle, including:

❶ | BMW plans to have a driverless car available for sale by 2021.
❷ | In 2018, Audi plans to launch a self-driving car that can handle up to 80 percent of driving situations.
❸ | In 2019, auto parts suppliers Delphi and Mobileye plan to sell a self-driving system that automakers can put in their vehicles.

In Kingdollar's view, the potential benefits of reducing the current levels of deaths and injuries due to auto accidents outweigh the setbacks experienced in developing the technologies and will not curtail their emergence.

RISK MANAGEMENT AND SYSTEMS DYNAMICS

This sidebar provides a glimpse of the potentially profound changes due to the increasing applications of AI and robotics. However, it is only a glimpse of a much larger landscape of change. The disruptive potential of these changes is increased if we don't see them coming. There may be nothing more common than to assume that current conditions will continue indefinitely. Risk management functions within insurance organizations and elsewhere need to consider these changes in

their environmental scanning and planning. While the timing of these developments is uncertain, Mr. Kingdollar emphasizes that the speed of change appears to be faster than forecasted previously and may be unprecedented in history. The article "Making Sense of the Unexpected" on page 56 of this issue of *The Actuary* provides an additional framework to analyze and model the behavior of complex systems, such as the ripple effect of these profound changes. One particularly useful aspect of this systems modeling is the explicit consideration of the actions of competitors and other stakeholders in the system. ∎

Reference
[1] *http://www.genre.com/knowledge/blog/contributors/charlie-kingdollar.html*

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IDENTIFYING EMERGING RISKS

BY MARTIN WEYMANN AND RAINER EGLOFF

EARLY ANTICIPATION OF THE FUTURE RISK LANDSCAPE

For public and private institutions alike, a key ingredient for success is the ability to navigate a dynamic risk landscape—one that changes ever more rapidly and often materializes in unexpected ways. These changes modify known risks, create new ones and open opportunities for the insurance industry to reduce, mitigate and transfer risk. Globalization and de-globalization trends, fragmented value chains throughout the entire world, and the growing integration and interaction of digital systems are all drivers of increasing complexity. To protect their clients and themselves against undue uncertainties, insurers and reinsurers need to monitor the evolution of the risk landscape on a continuous basis.[1] So as a central part of their foresight activities, they need to scan the horizon for future risks. This entails the implementation of a broad-based enterprise risk management (ERM) framework, which includes the detection and assessment of emerging risks and thinking in scenarios.

EMERGING RISKS

The International Risk Governance Council (IRGC) defines emerging risks as "new risks or familiar risks that become apparent in new or unfamiliar conditions."[2] Their sources can be natural or human, and often are both.

Emerging risks may include new technologies—for example, artificial intelligence (AI), nanotechnology or genetic engineering—as well as economic, societal, environmental, regulatory or political change. While some emerging trends are developing at a slow pace (like demographic changes, societal preferences or cancer research), others can be fast-changing with disruptive potential (like the development of smartphones over the past decade, alternative currencies right now or AI in the future). Slow-moving emerging trends, too, may gain momentum quickly (e.g., medical breakthroughs).

Often, emerging risks are about unclear or changing framework conditions, such as regulatory developments or litigation trends. Thus, while we may think of emerging risks as being primarily entirely new risks (as is much the case with a new technology, such as blockchain or the gene editing method CRISPR[3]), some are known and familiar risks, but they become new or (re)emerging, as their contextual conditions change. A field like nanotechnology qualifies as an emerging risk, because some risks have been known for quite some time, but they haven't yet materialized fully. We therefore consider it a latent emerging risk. Some risks are changing their character dynamically. Consequently, they continue to count as emerging risks—the ever-evolving complex of cyber risks is a case in point.

Usually, emerging risks are as of yet unquantified, even though they may have a high impact potential for (re)insurers and for society. The lack of comprehensive data is one aspect of emerging risks' general nature. That's to say they are mostly not yet fully understood or researched, and might lead to surprises or shocks. Consequently, the early identification of potential changes to the risk landscape is important. In this context, scenario planning can be a helpful tool to discuss plausible future outcomes as a basis for risk dialogue, risk mitigation measures and business opportunities. To ensure the most encompassing risk culture for emerging risk detection and assessment, it is often necessary to conduct a broad dialogue involving different stakeholders.

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Since risk perception varies across geographies, cultures, societies and educational backgrounds, it is only sensible to involve a diverse group of individuals in the emerging risk identification process."

Since risk perception varies across geographies, cultures, societies and educational backgrounds, it is only sensible to involve a diverse group of individuals in the emerging risk identification process.

SWISS RE'S SONAR APPROACH

As a risk knowledge company with many risk specialists, Swiss Re places the internal expert dialogue at the center of its emerging risk detection and assessment process. More than 10,000 employees have access to a dedicated intranet dialogue platform where they can post and discuss potential emerging risks. By posting a so-called "risk-notion," employees discuss a certain observation, formulate a concern or raise a question to which other colleagues can react. Such "crowd-sourced" signal detection among experienced and knowledgeable employees is a powerful tool. Moreover, automated web analysis can complement it. That said, this latter method is best suited to monitoring and analyzing risk trends already known or their context already well understood.

As part of group risk management, Swiss Re has a dedicated emerging risk management team that hosts the SONAR process.[4] This task entails moderating, collating and reviewing the risk notions. So the team acts as a catalyst for emerging risk identification and assessment. In concert with a broad network of experts, it clusters the SONAR posts and discussions from colleagues, enriches them with further research, and develops encompassing emerging risk themes and trends. It then folds in inputs from universities, think tanks and other relevant organizations. One of the results is the annual publication of *Swiss Re SONAR: New emerging risk insights*. This report

is a compilation of emerging risks relevant to the (re)insurance industry.

The emerging risk process encompasses the following steps: risk identification, risk assessment, risk implementation (split into risk dialogue, risk mitigation measures and business opportunities), as well as risk monitoring and control.

To deepen the understanding of a particular risk, interactions with external stakeholders are most important. Discussions with clients, political authorities and non-governmental bodies are essential. Independent organizations like the IRGC are valuable partners. One platform to exchange information with industry peers is the Emerging Risk Initiative of the Chief Risk Officer's Forum, which so far includes mainly Europe-based insurers and reinsurers. A broad, diverse and robust risk dialogue helps to overcome blind spots, fosters risk awareness, and supports adequate risk assessment and mitigation.

At the time an emerging risk theme is highlighted, it is often not yet clear how relevant it will become from an insurance standpoint. This may be due to the nature of a risk, the uncertain development of contextual conditions, or merely because the risk assessment proves inadequate in the longer term. If a risk has been highlighted early enough, timely risk mitigation is possible and business opportunities are enabled. When Swiss Re's SONAR report was published for the first time in 2013, it featured important vulnerabilities, including supply chains or the potential for prolonged power blackouts. Today we can see the relevance of early detection of these emerging risks for effective risk mitigation. Hence, scanning the horizon to monitor the dynamic risk landscape and detecting new

or (re)emerging risk trends has become a key element of ERM in the (re)insurance sector.

THE 2017 SONAR REPORT—OUTLOOK AND ANALYSIS

What emerging risks does this year's SONAR report see developing on the horizon? See **FIGURE 1**.

Risks related to the business environment combine both high impacts and short timelines. These risks include financial market risks, market access restrictions, regulatory fragmentation and digital infrastructures.

The Return of Inflation—The Effect on Insurance Business

A pick-up in inflation is noticeable in important markets such as the United States or the United Kingdom, potentially reducing investment returns of insurance businesses, as well as affecting long-term liabilities in casualty and life on the claims side. Unclear development of monetary policies means there is a lot of uncertainty tied to this issue.

Reduced Market Access—Protecting Your Own Backyard

National protectionism is growing significantly—recently also in mature markets. Free trade, open markets and financial globalization are increasingly under pressure, while governments are favoring local markets and national champions. This affects operations of multinational (re)insurers, which find risk diversification, fungibility of capital and growth plans undercut.

FIGURE 1 ▸ EMERGING RISKS THEMES BY POTENTIAL IMPACT AND TIME FRAMES

0–3 years

The return of inflation—the effect on insurance business

Reduced market access—protecting your own backyard

The perfect storm—cloud risk accumulation

Island solutions—regulatory fragmentation

Man-made epidemic—opioid medication and popular health

The human factor—stress and fatigue in safety-relevant jobs

Sensors as weapons—Internet of Things invites cyberattacks

Eroding rationality—the information challenge

Pros and cons of work in the gig economy—another kind of digital risk

Hijacked money—political risk of forced investment

> 3 years

Bugs on the march—underestimated infectious diseases

The big drying—growing water stress

Danger in unexpected places—carcinogens in artificial turf

Blame your robot—emerging artificial intelligence legislation

Too much of a good thing—antimicrobial overuse in animal farming

Cancer treatment revolution?—liquid biopsy and immunotherapy

Shifting land use—uncertainties for real estate values in the new economy

Dangerous games—risks of e-sports

Cash repression—the paper money squeeze

Good things in your gut—advances in precision medicine

Key
Timeframe 0–3 years
> 3 years

Potential impact
█ High
█ Medium
█ Low

Source: *Swiss Re SONAR: New emerging risk insights*, June 2017. This list is not a comprehensive list of emerging risks. It reflects emerging risks relevant to the insurance industry and discussed within Swiss Re during the past year.

Island Solutions—Regulatory Fragmentation

As regulatory coordination activities among G20 countries become increasingly difficult, multinational insurers increasingly are facing regulatory fragmentation, including a lack of international standards. This, in turn, increases operational costs and the compliance burden. This makes it harder to provide inexpensive insurance covers, and it becomes more difficult to close protection gaps.

The Perfect Storm—Cloud Risk Accumulation

Tech vulnerability—the more widespread use of information technology (IT) server solutions based on cloud and cloud-of-clouds services—comes with a variety of risks: cyberattacks, technical failures, prolonged outages, data inaccessibility and significant accumulation risks (due to a small number of providers). This may affect insurers' operations, but more important, it will affect operations of insured parties. Given the volumes of data involved, service interruption poses potentially significant and catastrophic risks.

With high impact, but a time frame of more than three years, the SONAR report identifies the spread of infectious diseases and growing water stress as significant emerging risks. These risks have increased in complexity and become more dynamic, tying environmental and social dimensions with technological and economic factors.

Bugs on the March—Underestimated Infectious Diseases

Risk factors of infectious diseases, triggered by changes in land use or agricultural practices, changes in human demo-graphics and society, international travel and trade, poor population health, medical procedures, pathogen evolution or climate change, are altering and interacting with one another more. This development facilitates an outbreak and proliferation of infectious diseases. For insurers, life and health pricing becomes more challenging. A major epidemic or pandemic also would affect financial markets and property and casualty insurers.

The Big Drying—Growing Water Stress

Farming, industrial use and household consumption exacerbate water shortages in a growing number of regions (e.g., California, the U.S. Midwest, Southern Europe and Mediterranean, South Africa). Severe water shortages also have an adverse impact on food production and can undercut oil and gas production from hydrofracking. The insurance consequences can range from increased loss burden in agricultural and energy lines of business to a surge in property and casualty losses caused by wildfires. In extreme cases, water shortages also can destabilize the political and social fabric, leading to more civil unrest, war and migration.

There also are many relevant risk topics mentioned among medium- and low-impact risks that might become more important developments in the future. We highlight two additional emerging risks here.

Too Much of a Good Thing—Antimicrobial Overuse in Animal Farming

Already highlighted in previous years as an emerging risk of antibiotics overuse, antibiotic resistance is a well-known worldwide problem, primarily caused by excessive use of antibiotics, for both human and animal health. Extensive proliferation of antimicrobials in the production of live-stock and in aquaculture is a key factor in the spread of antimicrobial resistance (AMR). AMR in livestock and aquaculture could lead to higher-than-expected losses from animal diseases.

Cancer Treatment Revolution?—Liquid Biopsy and Immunotherapy

Rapid advances in cancer screening and treatment method-ologies promise benefits to cancer patients, and they also mean that more cancers are detected at an earlier stage. As such, liquid biopsy allows for much earlier detection, while immunotherapy allows for better immunization against cancer. Better screening and detection methodologies increase the risk of anti-selection for insurers, making risk pooling more challenging and increasing pricing risks.

EMERGING RISK INSIGHTS MORE SIGNIFICANT FOR ERM

It lies in the nature of emerging risks that not all of those identified will actually materialize. By reviewing previous work on emerging risks, one can keep track of how certain risks became relevant over time or not. Looking back, cyber risks or sovereign debt crises were spotted as emerging risks almost a decade ago. And these risks are still evolving in many ways. Such "backtesting" can be useful to improve an organization's methods to identify, assess, mitigate and monitor emerging risks.

(Re)insurers use emerging risk insights for their risk mitigation strategies within the wider risk management, underwriting and asset management departments, but also as a basis for the exploration of future risk pools and client solutions. While most such analysis is still done on a qualitative basis, the impact of certain emerging risk scenarios also can be estimated quantitatively. In many companies, emerging risks are becoming not only an integral part of a proactive risk management culture, but also an integral part of firms' ERM capabilities. ∎

References

[1] Raaflaub, Patrick. "Risk Detection by Employees." *Vontobel Portrait*. 2016.
[2] IRGC Guidelines for Emerging Risk Governance. 2015.
[3] CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats. CRISPR technology has been discovered and developed as gene scissors. This molecule is able to target and cut the genetic material of any organism in a precise and efficient way. This technology is expected to have a major impact on life sciences.
[4] SONAR stands for Systematic Observation of Notions Associated with Risk. The SONAR process facilitates the identification and assessment of emerging risk notions in order to reduce surprises, enable risk mitigation actions, seize opportunities and foster risk awareness.

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RISK OF disru

PUTTING AN OPERATIONAL RISK CHARGE INTO RISK-BASED CAPITAL

BY ALAN SEELEY

The risk of losses from operational mistakes and disruptions, long considered a significant risk in the banking industry, has become an emerging concern for the insurance industry and its regulators, particularly in light of the increasing number of cyber breaches revealing sensitive consumer data held by insurers. Insurers are increasingly including operational risk in their risk mitigation programs and their internal capital models. An operational risk charge is included in the regulatory capital requirements of Solvency II, Bermuda, Canada, Australia, Japan, Singapore and other advanced regulatory regimes, and is expected to soon be explicitly included in U.S. risked-based capital (RBC).

WHAT'S IN OPERATIONAL RISK?

The National Association of Insurance Commissioners (NAIC) and Solvency II define operational risk as "the risk of loss resulting from inadequate or failed internal processes, people and systems, or from external events." This definition, which was developed by the Basel Committee on Banking Supervision, is considered to be sufficiently broad to apply to the insurance industry.

It's worth noting that this definition does not include strategic risk, which is the risk that management pursues business strategies that produce adverse results. It also doesn't include reputational risk, which is the risk that an insurer loses market share due to bad publicity.

Legal risk, which is the risk of an insurer facing major lawsuits, is included in operational risk. Obviously, there are situations that can result both in legal risk and in reputational

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> 66 Operational risk is the risk of loss resulting from inadequate or failed internal processes, people and systems, or from external events."

or strategic risk, so the lines between what does and doesn't constitute operational risk are not always clear.

OPERATIONAL RISK CHARGES IN THE UNITED STATES

Life RBC has always had a charge for "business risk" that implicitly includes operational risk. Property and casualty (P&C) RBC and health RBC don't have a charge for operational risk per se, but they do have a charge for excessive growth, which is recognized as a cause of both operational risk and underwriting risk.

Efforts are well underway, through the NAIC's Operational Risk Subgroup (Subgroup), to formally introduce an operational risk charge into U.S. RBC. This charge, which would equal 3 percent of an insurer's Company Action Level RBC, is anticipated to go into effect with the 2018 RBC reports that companies will file in March 2019. Hence an insurer with an RBC of $100 million would, after including the operational risk charge, see that amount rise to $103 million.

HOW OTHERS DERIVE OPERATIONAL RISK CHARGES

Solvency II allows insurers to either model their capital needs for operational risk or use a standard formula. The standard formula computes a provisional operational risk charge based on a percentage of premium writings and another provisional charge based on a percentage of reserves, with the larger provisional charge being used.

Bermuda applies a factor to an insurer's required capital. The factor varies from 1 percent to 10 percent, depending on the regulator's assessment of the insurer's quality of management and operations. It's worth noting that this method is not feasible for U.S. RBC, which needs to

be based solely on accounting items and be free of judgment in order to avoid litigation over the authority of regulatory intervention.

Canada's charge is the sum of two components: One is based on business volume and the other is based on the required capital for credit, insurance and market risks, and for ceded business. Australia and Singapore use proxy methods similar to Solvency II, while Japan uses a factor applied to required capital.

NEED FOR AN OPERATIONAL RISK DATABASE

One of the difficulties that all regulatory regimes have faced in developing a statistically based operational risk charge is a shortage of operational loss and risk data from insurers. The only operational risk databases for insurers the Subgroup is aware of are from two European-based consortiums: ORIC and ORX. ORIC, which has been in existence since 2005, has the most extensive database. ORX, whose focus historically has been on operational risk in the banking industry, has recently expanded its scope to include insurance. While both of these consortiums include some U.S. insurers, their membership and databases are derived primarily from European insurers and are therefore considered to be inappropriate for use in deriving an operational risk charge for the United States.

One option under consideration is the establishment of a voluntary operational risk consortium of U.S. insurers. Insurers that join this consortium would comingle their operational risk data with that of the other consortium members and would, along with regulators, have access to the aggregated data. The NAIC or a qualified third party could administer this consortium. Once a

sufficient volume of operational risk data has accumulated in the consortium's database, the data could be used to refine the methodology and factors used to derive the basic operational risk charge in RBC.

It's worth noting that U.S. regulators have been gaining some insight into insurers' operational risk exposures and mitigation efforts through their review of insurers' Own Risk and Solvency Assessments (ORSAs), although how such qualitative knowledge could be used in the design and refinement of an operational risk charge is not clear.

OPERATIONAL RISK EMBEDDED IN OTHER RISK CHARGES

Another challenge the Subgroup has faced in developing an operational risk charge is the fact that much of an insurer's operational risk is embedded in other risk charges currently in RBC, particularly in the underwriting risk charges of P&C and health RBC. Examples of embedded operational risks include fraudulent claims, flaws in pricing and reserving models, and failures to follow investment guidelines.

Due to the difficulties in isolating and removing embedded operational risks, the operational risk charge developed by the Subgroup is intended to account for all operational risks that are not embedded in other risks. Examples of unembedded operational risks include cyber risk, contractual performance risk, political risk and outsourcing risk.

METHODS EXAMINED

In determining the methodology to be used in deriving the charge, the Subgroup considered methods currently used in other countries for deriving regulatory capital charges for operational risk. Two methodologies

IT'S WORTH NOTING THAT U.S. REGULATORS HAVE BEEN GAINING SOME INSIGHT INTO INSURERS' OPERATIONAL RISK EXPOSURES AND MITIGATION EFFORTS THROUGH THEIR REVIEW OF INSURERS' OWN RISK AND SOLVENCY ASSESSMENTS.

that are commonly used include a "proxy" method, which applies factors to measures of business volume (such as premiums and reserves), and an "add-on" method, which applies a factor to total required regulatory capital.

The proxy method assumes an insurer's operational risk is proportional to the volume of its writings or unpaid liabilities, while the add-on method assumes that an insurer's operational risk is proportional to its overall risks. Neither method fully satisfies its assumptions since an insurer's operational risk is not strictly proportional to either its business volume or its regulatory capital.

The Subgroup tested both methodologies to see what their effects on the industry and on individual insurers would have been had those methods been in place the last few years. Its tests found that the add-on method produced less volatility in RBC levels

from year to year, on both an industry and an individual company basis, than did the proxy method. The Subgroup's tests also revealed that the add-on method was more effective at identifying soon-to-be troubled companies. For these reasons, the Subgroup chose to use an add-on methodology.

While embedded operational risks partake in the diversification credits of the risks in which they're embedded, the Subgroup does not consider operational risk itself to be independent of other types of risk. It therefore put the operational risk charge outside of the square root in RBC's covariance formulas where it will not be subject to a diversification credit. The operational risk charges of Solvency II, Canada, Bermuda, Australia, Singapore and Japan, as well as the business risk charge (C4a) in life RBC, are also not subject to diversification credit.

GROWTH RISK

Growth risk is the risk that an insurer's volume of business grows more rapidly than it can prudently handle, resulting in deterioration in services to policyholders, claimants and beneficiaries, or in deterioration of underwriting results, particularly when growth results from loosening underwriting standards or entering new markets without adequate research. Growth risk therefore has elements of both underwriting risk and operational risk. Solvency II, Canada and Australia have charges for excessive growth, as do P&C and health RBC. P&C RBC accounts for excessive growth within its loss reserve and premium risk charges, R4 and R5. Health RBC accounts for it within its business risk charge, H4.

The Subgroup has examined both the P&C and the health growth risk charges. It has found that the P&C

growth risk charge appears to be performing adequately and as originally intended. The formula for the health growth risk charge is more complex and has not been adapted to reflect the Affordable Care Act's impact on market growth. Therefore, the Subgroup may recommend that the existing health growth risk methodology be examined for potential revision.

Life RBC has never included a growth risk charge. The Subgroup is investigating whether there is merit in introducing a growth risk charge into life RBC, particularly in light of the distortions in premium growth created by irregular single premium deposits, pension risk transfers and other circumstances unique to life insurers.

BUSINESS RISK CHARGE FOR LIFE INSURERS

Of the three types of RBC (life, health and P&C), life is the only one with a specific risk charge that's closely related to operational risk. Labeled as the "C4a" component of life RBC's business risk charge, it's based on direct written premium and serves as a proxy for a life insurer's liability for guaranty fund assessments.

These C4a business risk charges average between 6 percent and 7 percent of industrywide Life Company Action Level RBC, although some insurers that file life RBC report little or no C4a charges. If one assumes that at least half of "business risk" is operational risk, then this provides further justification for using a 3 percent factor.

Since most life insurers are already being charged for operational risk through their C4a charge, the Subgroup decided to introduce a "C4a offset" and waive the operational risk charge for life insurers whose C4a charge exceeds 3 percent of their

Company Action Level RBC. The operational risk charge for those life insurers whose C4a charge is less than 3 percent of their Company Action Level RBC will be equal to the amount that their C4a charge falls short of that 3 percent benchmark.

DOUBLE-COUNTING ISSUES

One of the concerns raised by insurers and other interested parties is that because the basic operational risk charge is based on an insurer's RBC, it will "double-count" any operational risk already contained in RBC. This would include embedded operational risk, growth risk charges (if any) and, for life insurers, the C4a charges of their subsidiaries.

The Subgroup and various interested parties recognize that a double-counting of embedded operational risk is unavoidable with the add-on method. Furthermore, given the immaterial impact of growth risk charges on overall RBC results and the complexity of removing their embedded diversification credits, the Subgroup decided not to extract growth risk from RBC when calculating the operational risk charge.

The Subgroup has eliminated a source of double-counting of affiliate operational risk by excluding subsidiaries' operational risk charges from the parent's C0, R0 and H0 affiliated risk charges. A remaining issue is whether a residual double-counting of affiliate risk occurs when the 3 percent operational risk factor is applied to the parent insurer's net affiliate risk charges.

ADJUSTMENTS FOR LIFE INSURERS WITH SUBSIDIARIES

Prompted by the Subgroup's deliberations, the American Academy of Actuaries (the Academy) launched a Life Operational Risk Work Group to

examine operational risk issues related to life insurers. One of the work group's concerns was the differing effect of the C4a offset on a life insurer's operational risk charges when its business is written through subsidiaries.

The Academy's work group is focused on eliminating this difference for life RBC filers. Proposed solutions include allowing the parent insurer to take credit for its subsidiaries' C4a charges, and excluding part of the C0 affiliated risk charge when deriving the parent's operational risk charge. Other interested parties have proposed methods to address this issue for all types of parent insurers.

The Subgroup is currently deliberating among these methods, including the question of whether a holding company structure increases the operational risk of business written, and is exposing these methodologies for comment from interested parties.

NEXT STEPS

The Subgroup, in collaboration with the Academy's work group and other interested parties, will attempt to resolve the affiliate double-counting issue by early 2018.

Two issues will then remain for the Subgroup to resolve. One is whether and how to implement a growth risk charge for life insurers. The other is the creation and eventual use of a database of the operational losses and risk indicators of U.S. insurers. ∎

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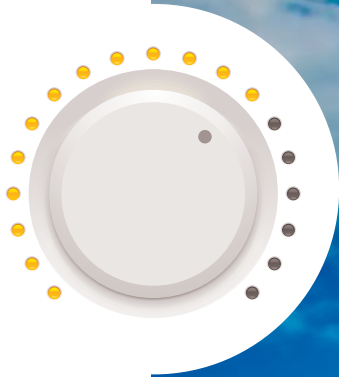
TURNING UP THE heat

UNDERSTANDING THE RISKS AND POTENTIAL IMPLICATIONS OF A CHANGING CLIMATE

BY RONORA STRYKER

Hello. My name is Ronora Stryker, and I am a weather addict.

In the morning as I get ready for work and before I go to bed each night, I tune in to the local news and watch the latest forecast. I also monitor the local weather radar throughout the day and have severe weather alerts on my phone. If there is a threat of severe or extreme weather, I turn to The Weather Channel 24/7 until the threat dissipates. During this heightened threat level, I am interested in knowing what the various computer models are showing. Forecasting the weather is difficult. We all know there are times when the forecasts are wrong and the actual weather and/or severity is much different than predicted. I seek out different forecasts to look for consistencies because I think the more consistent various forecasts are, the more likely the predicted weather events will occur.

I obsess about the weather because I want to be prepared. Adverse and extreme weather, as well as extreme climate events, are disruptors with varying consequences from being a minor inconvenience to creating catastrophe. On a personal level, I want to develop strategies to protect myself and my family from the associated risks.

From my years of monitoring the weather, it seems the frequency of extreme weather/climate events is increasing. In the 30 years that I have lived near Chicago, there have been at least **four** rare and damaging flood events, a deadly heat wave, and record cold and snow. Recently, the American Academy of Actuaries (the Academy), the Casualty Actuarial Society (CAS), the Canadian Institute of Actuaries (CIA) and the Society of Actuaries (SOA) launched the Actuaries Climate Index (ACI), which tracks changes in climate extremes for the United States and Canada. Based on data from the government and other neutral sources, the ACI provides an objective resource on climate trends by measuring changes in extreme weather and sea levels. Let's examine the ACI data to see if the number of extreme weather events is increasing.

ACTUARIES CLIMATE INDEX: OVERVIEW

The ACI has six components:

❶ | **Warm temperatures**—the frequency of temperatures above the 90th percentile
❷ | **Cold temperatures**—the frequency of temperatures below the 10th percentile
❸ | **Heavy precipitation**—maximum five-day precipitation each month
❹ | **Drought**—maximum number of consecutive days in a year with less than 1 mm of precipitation
❺ | **High wind**—the frequency of wind power above the 90th percentile
❻ | **Change in sea level**

Currently the ACI is limited to the continental United States and Canada. In addition to measuring the entire region, analysis also is provided by country and for 12 subregions. Canada is divided into five regions, while the United States is partitioned into seven regions. The regions are:

Canada—CAN

➡ CAR—Central Arctic (Northwest Territories and Nunavut)
➡ NEA—Northeast Atlantic (New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island)
➡ NEF—Northeast Forest (Ontario and Québec)
➡ NPL—Northern Plains (Alberta, Manitoba and Saskatchewan)
➡ NWP—Northwest Pacific (British Columbia and Yukon Territory)

United States—USA

➡ ALA—Alaska
➡ CEA—Central East Atlantic (Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Washington, D.C., and West Virginia)
➡ CWP—Central West Pacific (Washington, Oregon and Idaho)
➡ MID—Midwest (Iowa, Illinois, Indiana, Michigan, Minnesota, Missouri, Ohio and Wisconsin)
➡ SEA—Southeast Atlantic (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Virginia)
➡ SPL—Southern Plains (Kansas, Montana, North Dakota, Nebraska, Oklahoma, South Dakota, Texas and Wyoming)
➡ SWP—Southwest Pacific (Arizona, California, Colorado, New Mexico, Nevada and Utah)

The frequency of extreme events measured by the ACI is relative to the average frequencies during the reference period of 1961–1990, with the index values expressed as standardized anomalies—for instance, the difference between the observations in each season/month and its average in the reference period, divided by the standard deviation of the observation in the reference period.

Higher index values indicate an increase in the occurrence of extreme weather events. When the index value is greater than 1, it can be considered outside the bounds of normal variability. The standard deviation of each component during the reference period is equal to 1. Therefore, in the figures within this article, the vertical axis scale of each ACI component is in standard deviations.

INDEX TRENDS

Besides monthly and seasonal index values, five-year moving averages are provided to identify trends in the index results. In looking at the most recent temperature results through winter 2017 (available at *actuariesclimateindex.org)*, the five-year moving average warm temperatures values for all of the regions shown in **FIGURE 1** are at least 0.5 standard deviations from the base period mean, with the majority of regions nearing 1.5 standard deviations from the base period mean in 2016 and 2017. This indicates there has been an increase in the frequency of extreme heat compared to the 30-year reference period. This has been very consistent since 2010. The Midwest region is the exception, with results near the base period mean for the recent period.

FIGURE 1 FIVE-YEAR AVERAGE WARM TEMPERATURES (NORTHERN REGIONS)
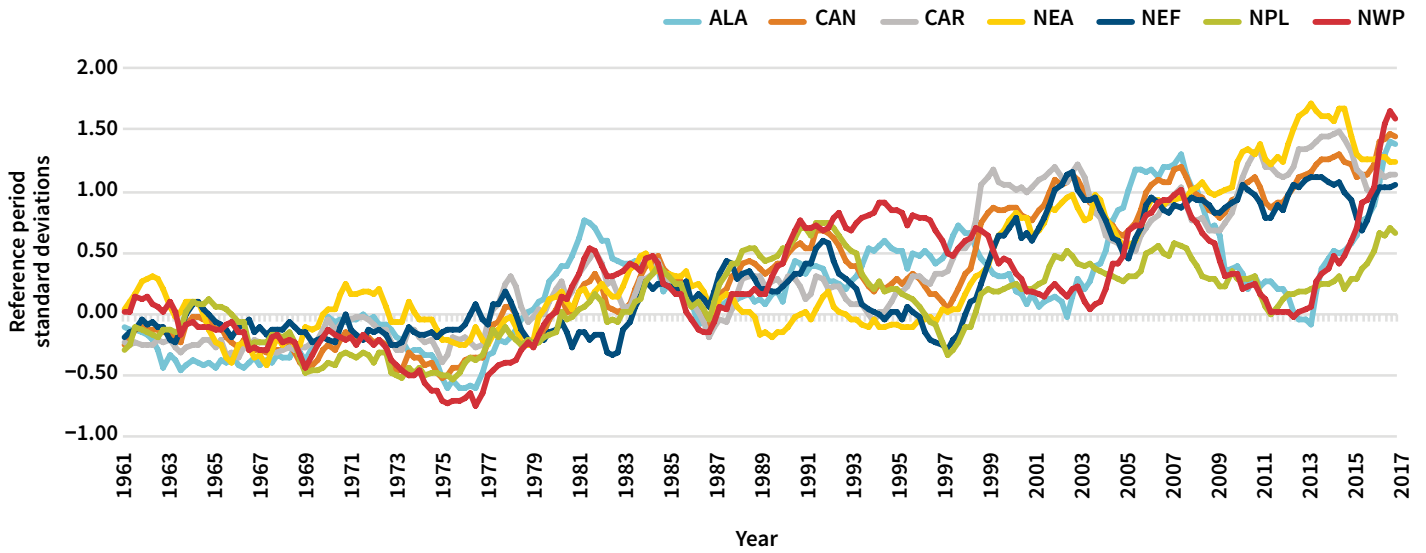
FIVE-YEAR AVERAGE WARM TEMPERATURES (SOUTHERN REGIONS)
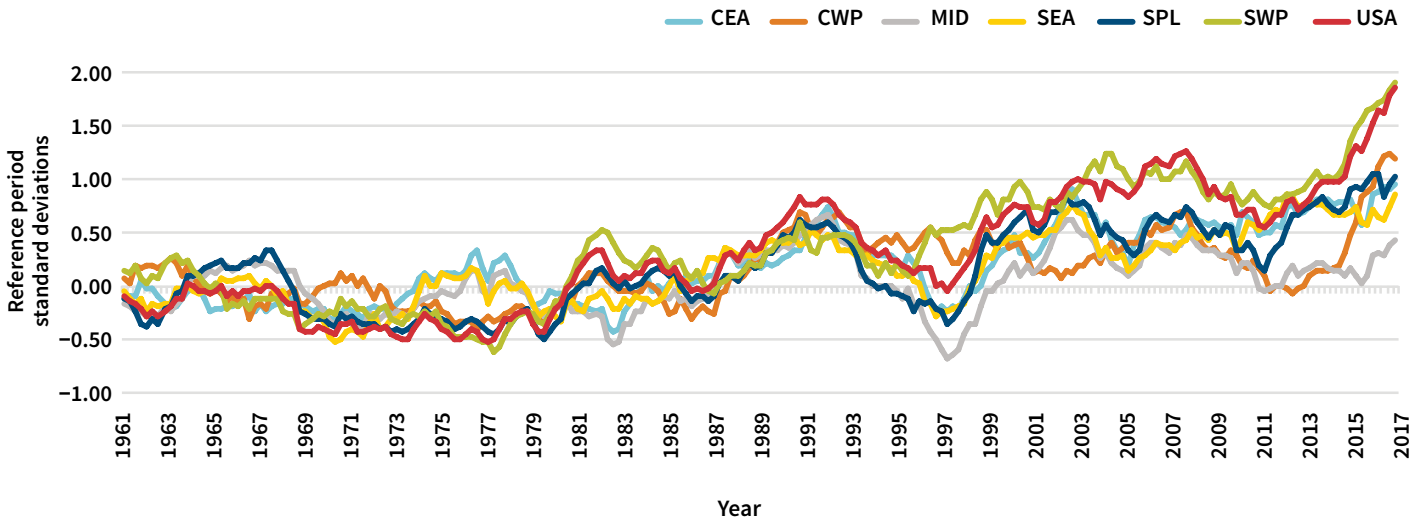
Source: Actuaries Climate Index
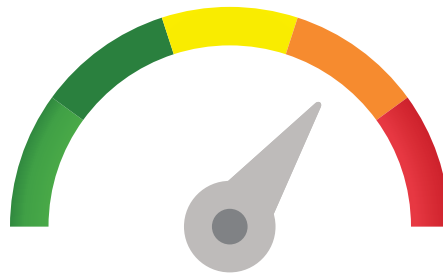
FIGURE 2 FIVE-YEAR AVERAGE COOL TEMPERATURES (NORTHERN REGIONS)
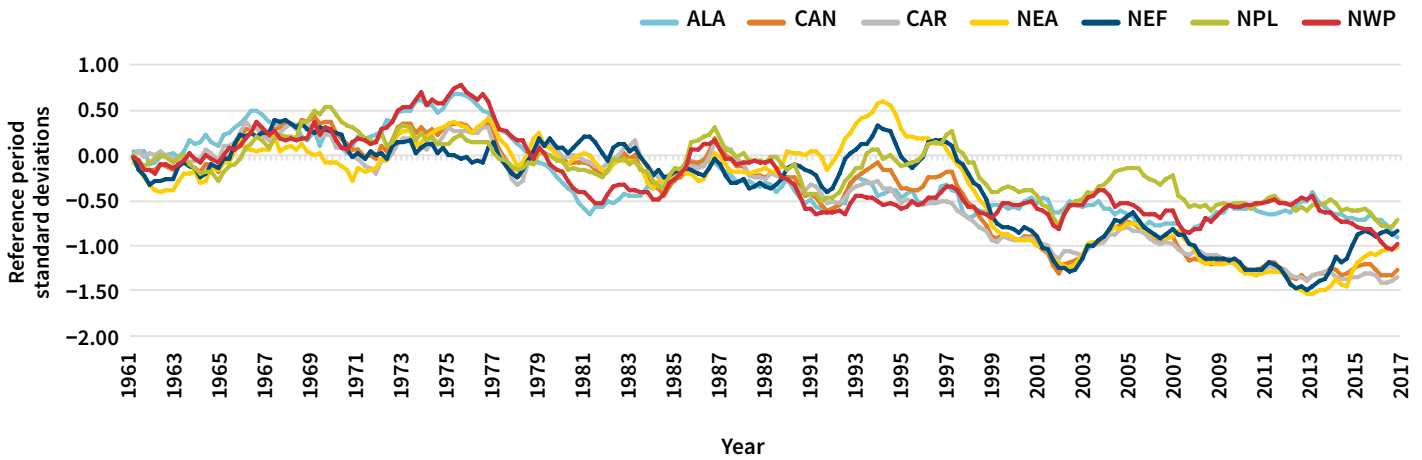
FIVE-YEAR AVERAGE COOL TEMPERATURES (SOUTHERN REGIONS)
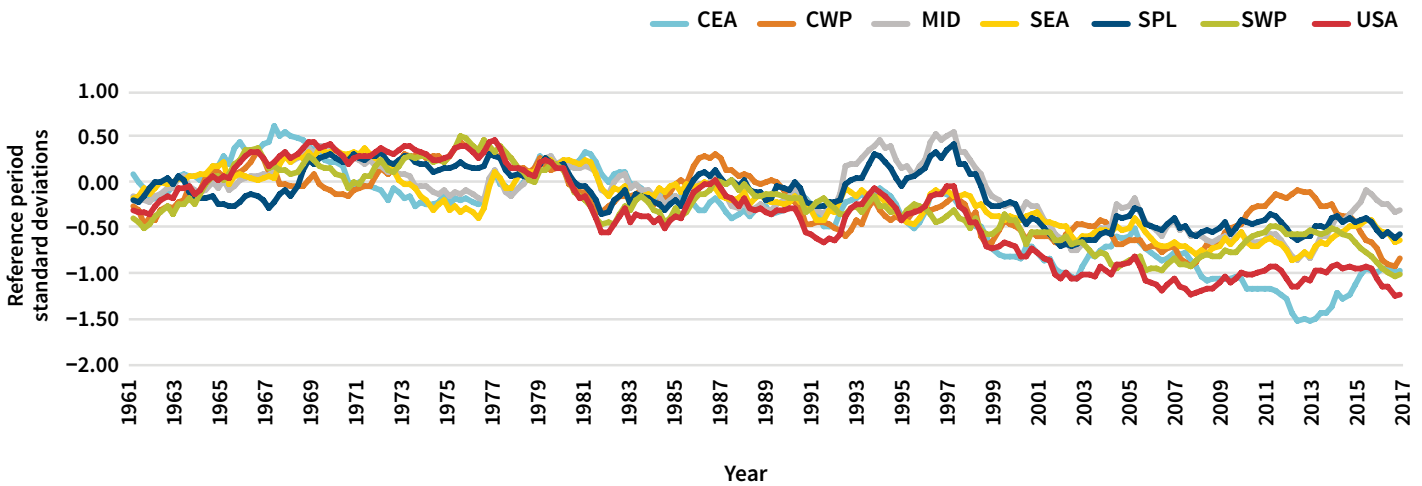
Source: Actuaries Climate Index

This warming pattern also can be seen in the five-year moving average cool temperatures values. In **FIGURE 2**, most regions by 2016 have reached at least –0.5 standard deviations from the base period mean, meaning that there are not as many extreme cold events as in the reference period. The area that shows the lowest drop in the frequency of cooler temperatures is the Midwest region, indicating that this region has not warmed as much as other regions.
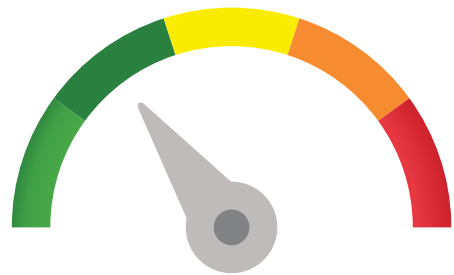
FIGURE 3 **FIVE-YEAR AVERAGE SEA LEVELS (NORTHERN REGIONS)**
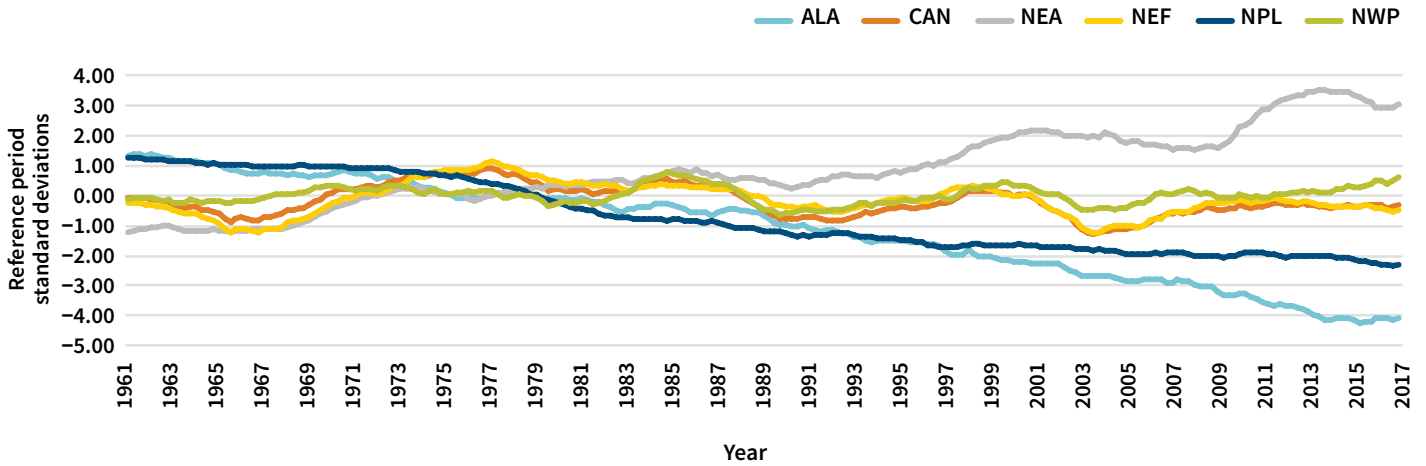
FIVE-YEAR AVERAGE SEA LEVELS (SOUTHERN REGIONS)
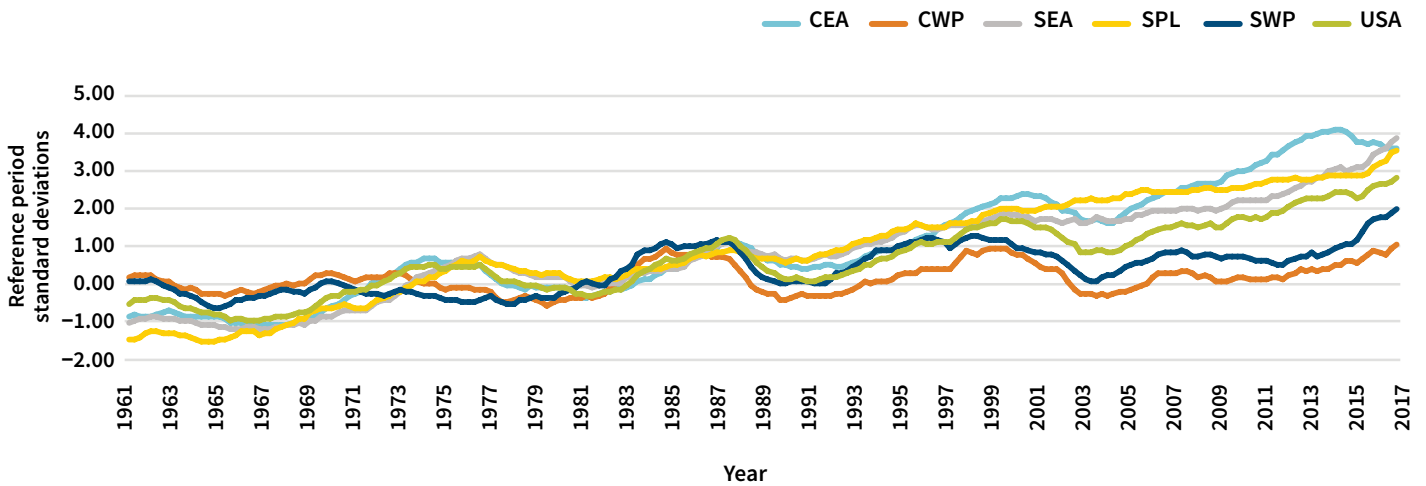
Source: Actuaries Climate Index

Sea level is another component for which the ACI shows clear trends (see **FIGURE 3**). For the southern regions, sea levels have been increasing relative to the 1961–1990 reference period. However, that is not the case for the northern regions. In looking at the analysis, only the Northeast Atlantic region has an increase in sea level. The ACI also shows a decrease in sea level for Alaska, where the land has been rising to offset the increased volume of sea water.

FIGURE 4 WIND POWER, PRECIPITATION AND DROUGHT IN THE UNITED STATES AND CANADA
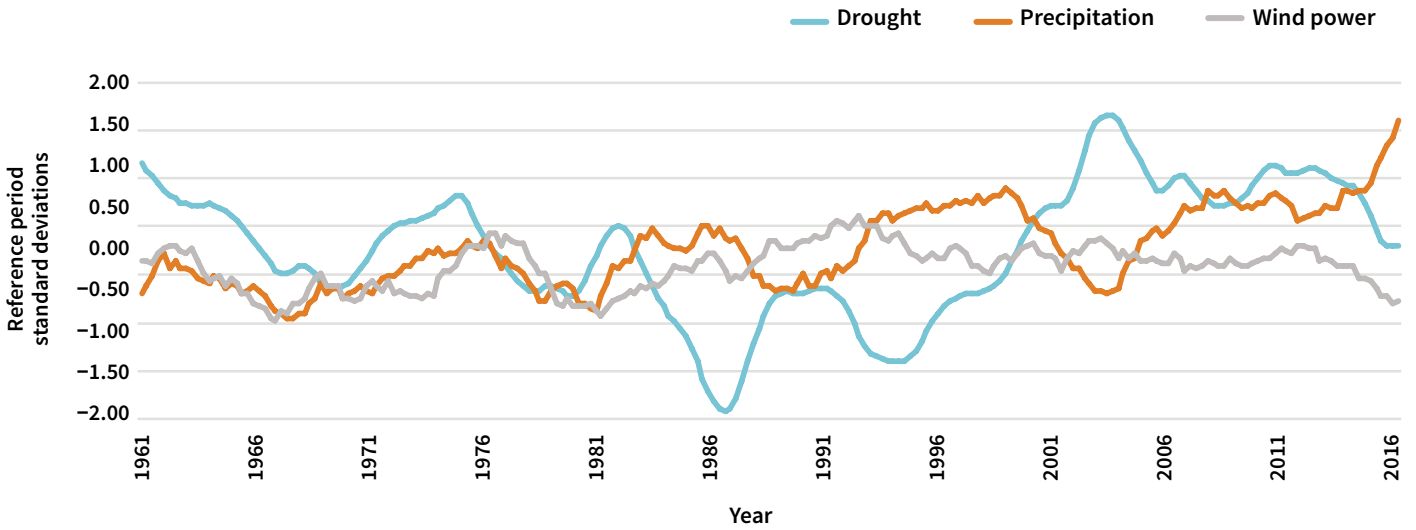
Source: Actuaries Climate Index

FIGURE 5 ACTUARIES CLIMATE INDEX—UNITED STATES AND CANADA
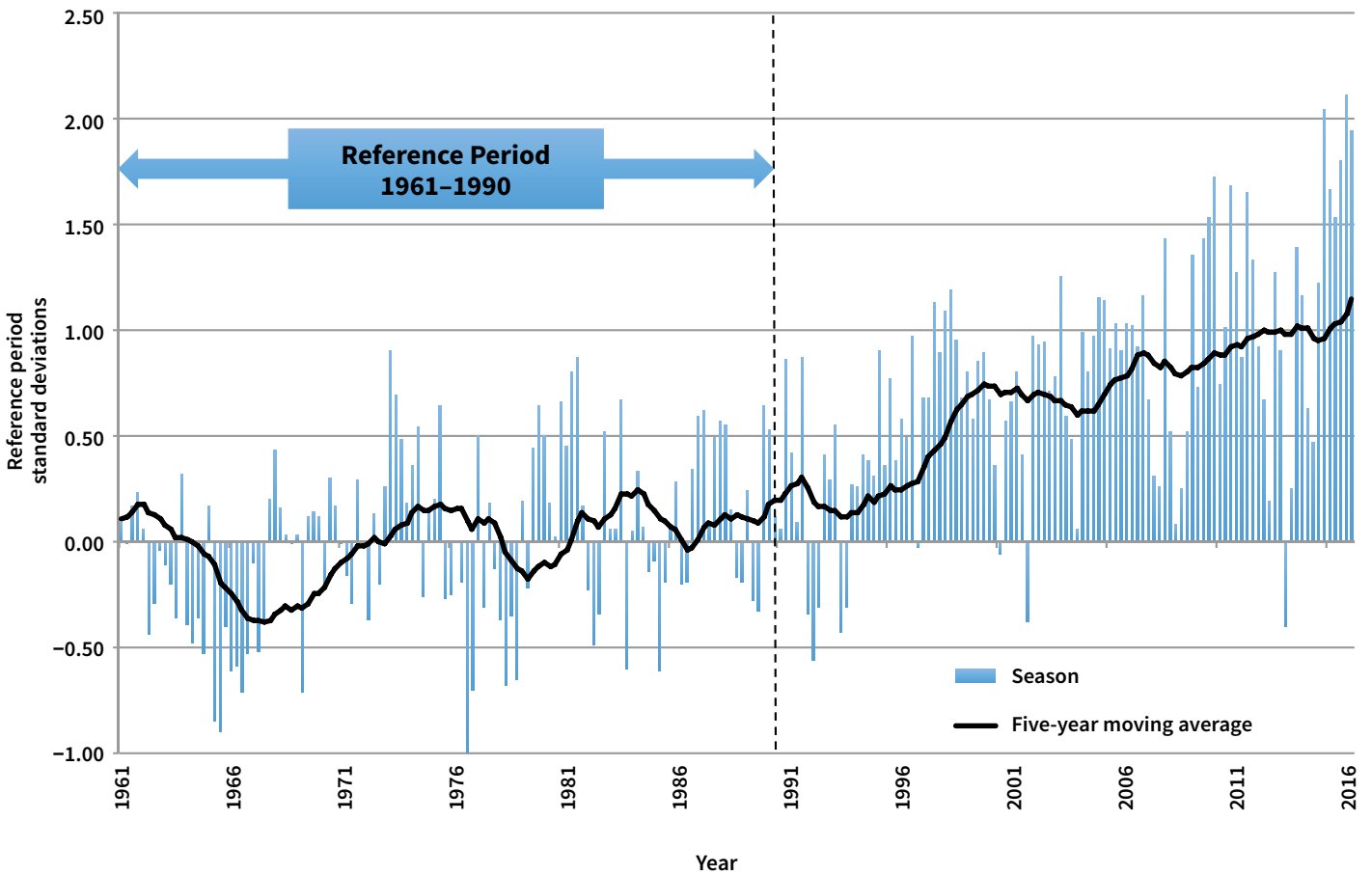
Source: Casualty Actuarial Society

For the other weather components, a few regions stand out. However, in general, there are no particular patterns revealed by the ACI for all regions or a group of regions. **FIGURE 4** shows the five-year moving average values for the United States and Canada combined for wind power (W), precipitation (P) and drought (D) components. The frequency of extreme precipitation has been increasing in the last few years. In addition, the drought component values have been on the rise since the late 1990s, but recently have declined. However, there are no clear trends for these components overall.

The composite ACI is an average of the six individual components. The cold temperatures component is subtracted in the formula as the decreasing frequency of cool temperature extremes is indicative of general warming, as is the increase of the frequency of warm temperature extremes. Adding the two temperature component values together would have masked the shift to higher temperatures. **FIGURE 5** shows the seasonal standardized anomalies for the ACI along with the five-year moving average trend line steadily increasing. The current five-year moving average value, winter 2017, is the highest value to date at 1.14, and it also falls outside the bounds of normal variability. As we have shown in the figures presented in this article, the main drivers for the increase in the composite ACI—especially in the latter years—are warm temperatures, sea level changes, precipitation and drought.

CONCLUSION

Given the increasing frequency of extreme climate and weather, and the potential for systemic consequences, there is an increasing need for actuaries to quantify, mitigate and manage the associated financial risks for our employers and clients—just like we do for ourselves and our families. The data underlying the ACI graphs are available for download from the ACI website for actuaries and others to perform analysis to help assess risk and provide insights to enhance pricing, product design, underwriting, marketing and claim strategies. There are also sample calculations and a development and design document to provide a better understanding of the ACI and its potential uses.

In addition, the SOA formed a new research committee, the Climate and Environmental Sustainability Research Committee, to produce research that expands the boundaries of the actuarial profession in this emerging area of practice. Included in the committee's work to date are summary papers of existing sources to help actuaries in measuring, mitigating and managing risks associated with climate, weather and environmental changes. On the horizon are projects that:

- Identify methods actuaries currently are using in practice for considering environmental risks.
- Educate actuaries on integrated assessment models and the social cost of carbon.
- Examine modeling, measuring and pricing flood risk.

So, the next time you watch the weather on the local news, think beyond how to prepare yourself and your family for the next day. I challenge you to think more broadly about how to apply the information as an actuarial professional to protect your friends, employers and clients. An example is analyzing life and health claims data during or after an extreme weather event to investigate the relationship between these events and insured mortality and morbidity. Dig into the models, methods and data that are publicly available and form the framework for the forecasts to enhance your understanding of the risks and potential implications of a changing climate. Become a weather addict! ∎
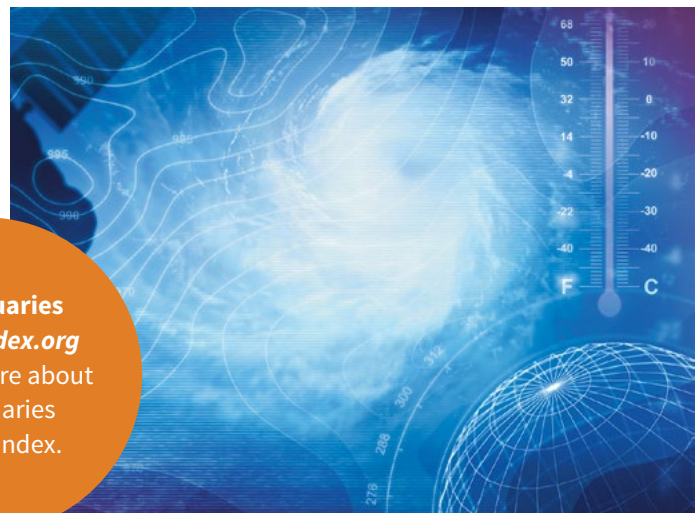
ONLINE!

Visit **actuaries climateindex.org** to learn more about the Actuaries Climate Index.

Ronora Stryker, ASA, MAAA, is a research actuary at the Society of Actuaries and supports the Actuaries Climate Index.

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WE SHOULD ALL BE SKEPTICAL

EXPLORING THE COMPLEXITIES OF EMERGING PRODUCT RISKS WITH ACTUARIAL CONSULTANT MARTIN SNOW

Through the years, life insurance and annuity products have become more complex. For example, customers can benefit from the upside of the stock market without participating in the down-side by purchasing certain types of life insurance and annuity products, and customers can obtain very inexpensive guaranteed premium permanent death-benefit-only life insurance. These features place increased risk on the insurer—both for market risk and insurance risk. In addition, customers can now buy policies that combine life and health ben-efits, and companies are starting to rely more heavily on artificial intelligence (AI) and machine learning in the underwriting process. All of these changes bring increased risk that a good pricing actuary needs to know how to consider.

Risks associated with valuing the guarantees provided, including the development of new experience studies and models, marketing issues related to agent and policyholder understanding of new policy provisions and their interactions, and the risks associated with administering complex policy provisions and providing accurate customer service to policyholders, are all concerns that companies must address with respect to these products.

To examine the topic of product risk more fully, *The Actuary* asked Martin Snow, FSA, MAAA, several questions about product risks.

***The Actuary*:**
What emerging risks do you feel are most significant for product actuaries?

SNOW: The list of emerging product risks is fairly long. One important issue is product and distribution relevance, which refers to the degree to which potential customers understand what our products can do for them and can relate to our methods of distribution. We must find ways to balance this relevance to potential customers with the risks we are accepting.

The potential impact of big data to disrupt our industry is significant. Will we choose to find ways to improve our company processes and products using new data and methods, or will we adopt a "wait and see" approach? Are the roles of the actuary, data scientist and statistician clearly delineated in our companies? Do our companies have a comprehensive strategy about how to use and efficiently integrate big data?

Speed to market has long been a concern of companies. Have we identified the primary impediments to getting products out there more quickly? What are we doing to improve our company's speed to market?

Theoretically, nonguaranteed elements (NGEs) in a contract provide a company with greater flexibility and less risk. However, do customers understand the implications of nonguaranteed elements? Do our companies review NGEs as frequently as our contracts or procedures say we will? What risks are our companies exposed to by our current NGE practices?

For many years now, there has been talk of the inevitability of the return of high interest rates. To date this has not happened in a significant way. Companies may wish to explore whether our product portfolios are well-positioned for a sustained low interest rate environment. Additionally, companies that priced products over the last decade or longer assuming that interest rates will rise should analyze what the impact on the embedded value or other profitability measure is likely to be. Similar thoughts would apply to companies that assumed significant mortality improvement at ages where it may not be emerging as anticipated.

For companies that are making a big push into the longevity business, have we adequately assessed the potential impact that longevity emerging differently than anticipated may have on our portfolios?

Other product risks on the list include whether certain risks are insurable, the potential impact of principle-based reserves (PBR) on pricing and reinsurance, the emerging changes in the life risk-based capital factors and calculations, the ability of our models to accurately measure the emerging risks, the appropriate balance between expense management and having the resources necessary to do the pricing work, if the models and assumptions have been validated, and the credibility of individual actuaries and the profession. Do we have the influence we need in our companies to properly measure and price the risks our companies are accepting? Will regulators gain greater confidence in our professionalism to move to simpler, yet viable and sound, regulation?

In the Chief Actuary PBR Survey I recently completed, one chief actuary stated: "I believe the actuarial profession has a tremendous opportunity to demonstrate its competence and integrity with PBR. I hope we collectively live up to it and further distinguish ourselves as trustworthy and highly capable professionals."

Producers are experts at finding the situations where a product is particularly competitive (or underpriced). We should be skeptical when the assumed sales distribution cannot be readily supported, especially if cells with higher profitability have a higher assumed concentration of business. Another statement that should be viewed with caution is when we are told that an unprofitable feature is highly unlikely to result in any sales.

We also need to be on the lookout if the company is lending too much credence to anticipated improvements in experience (without strong evidence).

The Actuary:
What advice would you give to a company that discovers that pricing assumptions are not being realized and a product has been underpriced?

SNOW: It depends on the relative volume of sales. If it's a major product, it certainly needs to be repriced expeditiously for new issues going forward. For policies already sold, it depends on how much was sold and what the impact on profitability is. The company also needs to quickly identify where there was a failure in controls (if this is the result of an error) and tighten them before the next pricing, or why the assumption was approved yet changed so quickly. The company might wish to review its assumption-setting procedures and put tighter assumption governance rules in place. For example, the company could require that:

➡ Assumptions be well-justified, documented based on emerging experience and sensitivity tested.
➡ The impact of assumption changes be quantified.
➡ The assumptions be reviewed more frequently.
➡ The assumption oversight be at a higher level in the organization or otherwise strengthened.

The Actuary:
What factors raise red flags for you about the possibility that a product has been underpriced?

SNOW: Certainly, a dramatic and unexplained improvement in competitive positioning should be examined closely. If the company's competitive position is one or two, it should be examined closely as well.

Independent third parties can provide useful feedback on pricing. If reinsurers, finance providers or competitors have exited a market, then their evaluation of product risks may be significantly different than the risks shown in company pricing.

Sensitivity testing is a key tool for evaluating the risk profile of a product. If sensitivity testing results cannot be readily explained, or small changes in assumptions result in big swings in profitability, then careful examination of the assumptions and models is warranted. Similarly, there should be concern if we are unable to produce a change flow showing the impact of each major assumption change on the new price.

The Actuary:
How could the risk of underpricing be reflected in a company's risk management program?

SNOW: Any major product change (e.g., new product, introduction of new policy feature) and assumption change should be reviewed from a risk management perspective as part of the company's formal risk management processes. Significant changes in the external environment (economic and regulatory) should also be reviewed regularly to see what effect they may have on product risk.

It is important for the company to have a clear delineation between the actuary and risk manager roles, and for the actuary and risk manager to work closely together where their respective roles overlap.

In addition, companies need to be comfortable that their actuarial software and administrative platforms are equipped to effectively and—in a scalable and controlled manner—appropriately handle the complex features of emerging products.

The Actuary:
What have been the main drivers of additional complexity?

SNOW: Some of the chief drivers of additional product complexity have been the desire of companies to gain a competitive edge, the availability of financial instruments to support product designs and the regulatory environment.

The Actuary:
How has product complexity affected pricing methodologies?

SNOW: At some companies, riskier products are required to have higher returns. There is always the question as to whether this should be established at the corporate level or at the line of business (LOB) level, and whether this is at the marginal level or at the fully allocated level.

It is also important to ensure that the pricing models can adequately handle products as they become more and more complex. One example where this might be particularly relevant is in products with both death benefits and living benefits, such as chronic illness benefits. Is your pricing software able to effectively model a product that has both of these benefits?

The Actuary:
What has been the impact of more complex products on sales illustrations and other initial client communications?

SNOW: Sales illustrations are extremely difficult to read. Many policyholders may not fully understand them (perhaps an understatement). Industry, regulators and professional groups need to work together to ensure that the right information is presented to the customer in a way that the customer understands and absorbs. With complex products, this can be a very difficult task.

The Actuary:
Do you see any reversal in trend to products becoming simpler in certain markets?

value. Companies will need to exercise care to ensure that consumers are compensated adequately and are not taking undue risk by agreeing to the buy-back.

Some companies are educating consumers about what is in their policies. From customer service and fairness perspectives, this is clearly the right thing to do. These companies need to be careful to ensure their pricing anticipates this approach early on so there are not big profitability and risk surprises. ■

SNOW: Companies would certainly like for this to happen. Whether it will happen and how quickly is another question. Perhaps getting potential customers to return to our industry through the use of AI will enable the development and sale of simpler yet comprehensive products.

The Actuary:
If a company has an economic incentive not to have policyholders exercise product options efficiently, how can the company appropriately balance the interests of the company and the policyholder?

SNOW: Some companies are using AI to help develop buyback programs. These programs should factor in both what it will take to get the customer to agree to the buy-back as well as ensuring that it is truly based on a fair

SPOTLIGHT

SUBJECT MATTER EXPERT
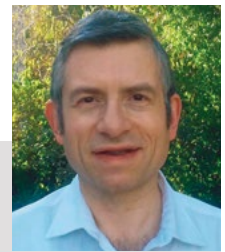
Martin Snow, FSA, MAAA, consults for insurers, software developers and startup companies, and he is a member of the Advisory Board of Atidot, an agile machine learning InsurTech company.

He is a seasoned insurance industry executive with key roles at MetLife, TIAA and Prudential. He has extensive pricing, valuation, reinsurance and regulatory experience for life, annuity and long-term care products. In addition, Snow is an expert in principle-based reserves (PBR). He led the development of the industry's first universal life policy with secondary guarantees (ULSG) priced with PBR and the conversion of the pricing models to a new platform.

Snow is a member of the ASOP 11 Task Force of the Actuarial Standards Board and is a frequent speaker at Society of Actuaries (SOA) meetings.

He is also a member of the Big Data Task Force of the American Academy of Actuaries (the Academy). In this capacity, he is leading the preparation of the portion of the Academy's Big Data Monograph related to Current and Emerging Practices for Life Insurance.

Martin Snow, FSA, MAAA, is an independent actuarial consultant.

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CALCULATED

USING STRUCTURED SCENARIO ANALYSIS FOR AN EFFECTIVE OPERATIONAL RISK MANAGEMENT AND STABLE CAPITAL REQUIREMENTS DETERMINATION

BY RAFAEL CAVESTANY, ETIENNE HOFSTETTER AND DANIEL RODRÍGUEZ

RISK

For financial institutions, operational risk (OpRisk, or the risk of a change in value caused by the fact that actual losses—incurred for inadequate or failed internal processes, people and systems, or from external events [including legal risk]—differ from the expected losses) might not be the most material risk from a capital perspective. However, recent events and history show that single OpRisk events may cause the bankruptcy of a financial institution or significantly deplete its capital base and reputation. The recent cases of Société Générale[1] (rogue trader Jerome Kerviel lost $7.2 billion in unauthorized trading positions) and BNP Paribas[2] (paid a $9 billion penalty for breaking U.S. money laundering laws by helping clients dodge sanctions on Iran, Sudan and other countries) demonstrate the potential damaging impact of OpRisk events from a capital and reputational perspective.

Moreover, many of the drivers of last decade's subprime crisis can be traced to operational risk events, including mortgage frauds, model errors, negligent underwriting standards and failed due diligence combined with inadequate governance for new financial instruments. This crisis resulted in a dramatic increase in government debt to record levels and the rescue of several international financial sector participants, including the $182 billion bailout of AIG,[3] the world's largest life insurer at that time.

Despite the potential extreme impacts of OpRisk events, current practices suffer from significant issues hindering robust risk measurement and a fully effective risk management framework.

ISSUES WITH OPERATIONAL RISK MEASUREMENT AND MANAGEMENT

OpRisk management is frequently thought to be insufficiently driven by empirical loss evidence and dominated by qualitative management tools, such as risk and control self-assessment (RCSA), scenario analysis or key risk indicators (KRIs), often based mainly on expert judgments (see **FIGURE 1**). Many financial institutions often do not establish a statistical link between losses and capital requirements with such qualitative tools.

► FIGURE 1	STANDARD OPERATIONAL RISK MANAGEMENT TOOLS
RCSA	Risk and control self-assessment (RCSA) is the exhaustive evaluation of an organization's risk and controls, in a categorical manner (traffic lights), which results in an overall risk map of the organization.
KRIs	Key risk indicators (KRIs) are measures of risk that are meant to act as an early warning of changes in the risk profile of an institution, department, process, activity and so on. Examples of KRIs include level of rotation of key personnel or number of corrections.
Scenario analysis	The detailed assessment of specific extreme scenarios, including how they develop until the OpRisk loss materializes, their potential effects and possible mitigation measures.
Loss data	The database storing all materialized risks that have led to economic losses or have nearly caused economic losses. There are internal losses that have materialized within the institution, and external losses that have materialized in other institutions and have been acquired or exchanged.

In addition, OpRisk modeling often produces unstable capital estimates due to the lack of internal data and shape of the tail distribution (generally "fat" tail). The results then become highly dependent on the modeler's choice of distribution and "non-validated" expert judgment.

Finally, these issues lead to the difficulty of linking the OpRisk modeling and capital calculations with potential mitigation actions. Unlike other risks, such as market, credit or insurance risks where exposures are linked to specific assets/liabilities, in OpRisk, exposures generally are linked to higher units of measurement and processes, such as business lines or even across business lines, making the link between specific action plans and risk measurement more difficult to establish.

In the following sections, we present a method and a framework to address these issues, namely structured scenario analysis (SSA) used in conjunction with a framework/tool seamlessly integrating internal and external data. This would lead to effective management of OpRisk and the calculation of reliable (stable) capital requirements.

STRUCTURED SCENARIO ANALYSIS FOR EFFECTIVE OPRISK MANAGEMENT

Scenario analysis evaluates very specific and potentially severe OpRisk events and links them with the calculation of capital when limited internal loss data is available. However, scenario analysis is subject to significant cognitive biases that need to be mitigated to ensure the reliability of the results. Such biases include herding (the tendency to believe things because many other people believe them), anchoring (tendency to rely too heavily on the first piece of information available when making decisions), denial bias (situation in which experts might not feel comfortable answering questions about their potential losses or errors), confirmation bias (tendency to interpret, favor and recall information in a way that confirms one's pre-existing beliefs or hypotheses), fear of looking unwise in front of peers/superiors, formal/natural leaders influencing the group, dissimilar risk skills across subject-matter experts (SMEs) and others.

SSA is a statistically-driven method derived from the technology and engineering sectors that can significantly improve the quality of expert judgment-based risk assessments. It permits robust validation of risk assessments when little data is available and leverages the collective knowledge of SMEs to enhance the final evaluation. It is structured in phases to ensure an effective management of the biases (see **FIGURE 2**).

Phase 0: In the initial phase, the main risk concerns among SMEs are identified, prioritized and selected for their detailed analysis and final modeling using specifically designed open and closed questions. RCSAs can be used as an initial source for identification of critical scenarios.

Phase 1: The risk scenario is documented with all relevant supporting data including internal (where available) and external data, related RCSAs, KRIs, internal audit reports, case studies and others. This helps to create the correct references and mitigate anchoring bias among SMEs, and it facilitates the use of analytical deduction rather than automatic answering by intuition.

Phase 2: This phase consists of a workshop where the scenario and all supporting data is explained to the SMEs to ensure consistent understanding of the risk scenario to be evaluated, which helps to mitigate confirmation bias.

Phase 3: SMEs provide their loss estimates individually (in the format of, for example, worst loss in five years, worst loss in 15 years, in 50 years and so on), rather than in a group workshop. Responding individually mitigates multiple biases including herding, fear of not looking knowledgeable, and the influence of natural or formal leaders.

FIGURE 2 STRUCTURED SCENARIO ANALYSIS FRAMEWORK

Phase 0. Scenario planning

Survey selected users to identify most relevant risk scenarios by business unit:

➡ Collection of the list of perceived most important risks and the team/resources available to assess them.
➡ Voting process to determine final list of most relevant risk scenarios to be developed by SMEs.
➡ RCSAs are provided to SME as a source for risk scenario identification.

RCSA as scenario identification source

Phase 1. Scenario documentation

Scenario description, includes, excludes, classification and more.

Support data are selected for the scenario to help experts on their analysis: internal loss data, external loss data, relevant key risk indicators.

Available internal and external loss data

KRIs, internal audit and other

Phase 2. Workshop for scenario presentation

Risk scenario presentation and initial discussion to ensure a consistent understanding across SMEs.

Phase 3. Individual estimation of losses

SMEs answer individually to both loss estimates (i.e., worst loss in 25 years) and seed questions, avoiding biases such as herding or the influence of formal or charismatic leaders.

Answers are aggregated and weighted based on SME performance on seed questions.

Source: Automated by OpCapital Analytics from The Analytics Boutique

The scenario questionnaire uses performance-based expert judgment methodologies, meaning that it includes seed questions (questions whose answers are known) to measure the skills and knowledge of responding SMEs. Seed questions are used to identify the SMEs who make better risk predictions.

Then, individual answers of SMEs are aggregated based on an SME's performance on seed questions, with higher weighting on answers from those who demonstrate better predictions. In other words, this results in a single answer from multiple SME answers where the SMEs that performed better in the seed questions are given more weight in the aggregated answer.

In summary, SSA leverages collective knowledge by identifying the most qualified individual assessments and enriching these with other expert views, following a more scientific approach. It also provides traceable and transparent means for a robust justification and quality assurance of the evaluations of risk scenarios.

RISK AND REWARD ANALYSIS: RISK MITIGATION INVESTMENT EVALUATION

Risk management is too frequently evaluated from the single-sided view of potential losses. However, a view of both risk and reward and the resulting trade-offs would increase the value add of the risk evaluation process. The risk and reward analysis is implemented (Phase 4) by analyzing both the current risk levels and their potential reduction given the introduction of new mitigation actions.

The consideration of mitigating actions in risk assessment also increases the value add for the financial institution as well as for the first line of defense, as it represents an opportunity to improve the processes

Phase 4. Risk and reward analysis for mitigation

Evaluation of pre- and post-mitigation plan risk profile and capital and expected loss savings.

Calculation of mitigation plans and insurance NPV based on expected loss and capital reductions.

Phase 5. Cause-driven correlations

Correlations determined based on risk drivers and causes elicited by SMEs.

Phase 6. Modeling for stable capital estimates

Tail shape and loss scale methods are used to create OpRisk models.

Monte Carlos simulation is used to determine capital estimates.

Analysis of capital estimates and loss distribution metrics.

SCENARIO ANALYSIS IS SUBJECT TO SIGNIFICANT COGNITIVE BIASES THAT NEED TO BE MITIGATED TO ENSURE THE RELIABILITY OF THE RESULTS.

they manage. It also mitigates denial bias, permitting a better disclosure of risk exposures.

The risk and reward approach can be implemented by analyzing the risk profile before and after the implementation of mitigation actions, leading to different capital and expected loss estimates. Capital and expected loss savings, together with the required investments for the mitigation action implementation (i.e., controls, automation and others), can be used to estimate the net present value (NVP) of the action.

| FIGURE 3 | PRE- AND POST-MITIGATION RISK PROFILE |

Risk Factor	Description of the Dependency
Increasing business complexity	The increasing complexity and riskiness of the business, products and processes used to deliver them
Employees and work environment	Quality, ability, motivation and employees' willingness to stay at the institution (retention)
External fraud environment and trends	The increasing intensity and sophistication of fraud environment and trends
Internal control environment and trends	The quality, intensity and effectiveness of the internal control and operational risk management environment
Regulatory trends	The increasing number of regulations, laws and corresponding penalties/fines
Technology environment, evolution and trends	The increasing sophistication and dependence on technology and the quality of the processes and infrastructure that supports it
Vendors and other external resources	The evolution in the quality and ability of the institution's vendors and other resources
Volumes and market	The changing business volumes, macroeconomy and market evolution that put stress on the processes that support the business
Financial results of the institution	Sensitivity to the impact of financial results of the institution through the satisfaction of employees, availability of resources (investment and HR) and changes in the organization

Source: Created using OpCapital Analytics software from The Analytics Boutique

The NVP of the investment required to support mitigating actions can be used to build the business case to justify the required investments to facilitate risk management decisions.

CAUSE-DRIVEN CORRELATIONS FOR DETERMINING RISK DEPENDENCIES

Scenario analysis correlations are difficult to calculate based on actual loss observations. Risk scenarios most frequently refer to very specific, low frequency extreme events, generally with few or no internal loss observations, making it impossible to determine correlations using internal loss data.

The use of external loss data can deliver a correlation matrix, thanks to potentially larger data sets. However, external data is a conglomerate of losses from diverse institutions, each with its own idiosyncrasies, making the calibration for a given financial institution challenging.

We propose the cause-driven correlation (CDC) method to improve the calculation of correlations. In this case, correlations are determined based on scenario sensitivity to major common risk factors (Phase 5), such as those in **FIGURE 3**.

The sensitivity of the risk factor to each scenario is determined by expert elicitation, where SMEs provide a percentage of influence to each risk factor per scenario. Then, using a correlation factor model, like those used in credit and market risk, the scenario cross correlations can be derived from the scenario sensitivity to these risk dependency factors.

CDC presents multiple advantages: intuitive correlations (fully explained by the common factor sensitivity across scenarios, when limited data is available); linking correlation analysis with the institution's potential weaknesses and additional insights into effective mitigation; and SMEs are more aware of the risks, causes and dependencies across risks.

MODELING FOR STABLE CAPITAL ESTIMATES

Stability of capital estimates is a critical issue in OpRisk capital modeling. It results in steady resource allocation and provides credibility to the capital modeling process.

However, the capital calculation for OpRisk is often volatile and unstable as we try to model, with a limited amount of data, the shape of the tail distribution, which is often assumed to be fat tailed. It is therefore crucial to be able to incorporate efficiently all the information available.

In this context, we have developed a framework/tool to integrate seamlessly these multiple sources of information (internal loss data, external loss data and scenario analysis)

to provide a more robust and stable estimation of the loss distribution.

We propose the scale and tail shape (STS) method,[4] which directly addresses the volatility of tail shapes due to lack of data (Phase 6). Using STS, the volatility of capital estimates can be significantly reduced, in many cases by up to 80 percent.

Under the STS, external loss data, in conjunction with SSA, is used to determine the tail shape. This can be done by analyzing kurtosis and skewness from external loss data. Alternatively, external loss data can be used to estimate the actual tail parameter of fat tail distributions. In addition, loss estimates provided by SMEs are used for determining the scale of the institution's losses. External loss data is more abundant on extreme tail losses and can provide a more accurate picture of the tail behavior of extreme losses.

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The use of performance-based expert judgment techniques and integration with other sources of information makes the loss estimates from SMEs more robust and trusted."

Both the loss estimates from experts—representing the scale of the institution losses—and the kurtosis and skewness obtained from external loss data analysis—representing the distribution's tail shape—are set as fitting targets for finding a distribution that matches such scale and tail shape.

The use of STS to model OpRisk scenarios results in a stable capital estimate facilitating the use of capital models in the institution's operational and business planning, providing credibility to the modeling process.

CONCLUSION

It is possible to obtain a stable and robust calculation of OpRisk capital estimates and use these estimates to identify the needed, specific and effective risk management actions. The use of performance-based expert judgment techniques and integration with other sources of information (e.g., internal loss data, external loss data, etc.) makes the loss estimates from SMEs more robust and trusted. This results in evaluation of very specific risk events that can be linked to specific mitigation actions. SSA incorporates these benefits using a scientific and practical approach. ■

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MAKING SENSE OF THE
unexpected

BY KARIM J. CHICHAKLY AND CARLOS FUENTES

USING SYSTEM DYNAMICS MODELING TO UNDERSTAND COMPLEX SYSTEMS

"

Essentially, all models are wrong, but some are useful."
—George Box

Typically, business forecasts are heavily dependent on statistics. While statistics are reliable in many circumstances, such as short-term forecasting, life insurance and pension analysis, statistical forecasting doesn't capture the dynamics of complex environments because one of its key assumptions—that historical conditions are a valid proxy of future behavior—may not be satisfied. In a dynamic world, medical technology advances, jobs transition from the manufacturing sector to the service sector, safety standards improve, diseases that were considered eradicated (or, like bacteria, permanently fouled) reemerge, robotics influences workloads, lifestyles change and so on.

System dynamics (SD) is a modeling technique designed to describe the behavior of systems over time. Interconnections among components, especially those that lead to feedback (whereby an action eventually leads to more changes in the same lever), are a key feature of the method. Time delays also are properly represented in the models. SD is a powerful supplement to statistical forecasting, as each technique is well-suited to tackle problems with different characteristics.
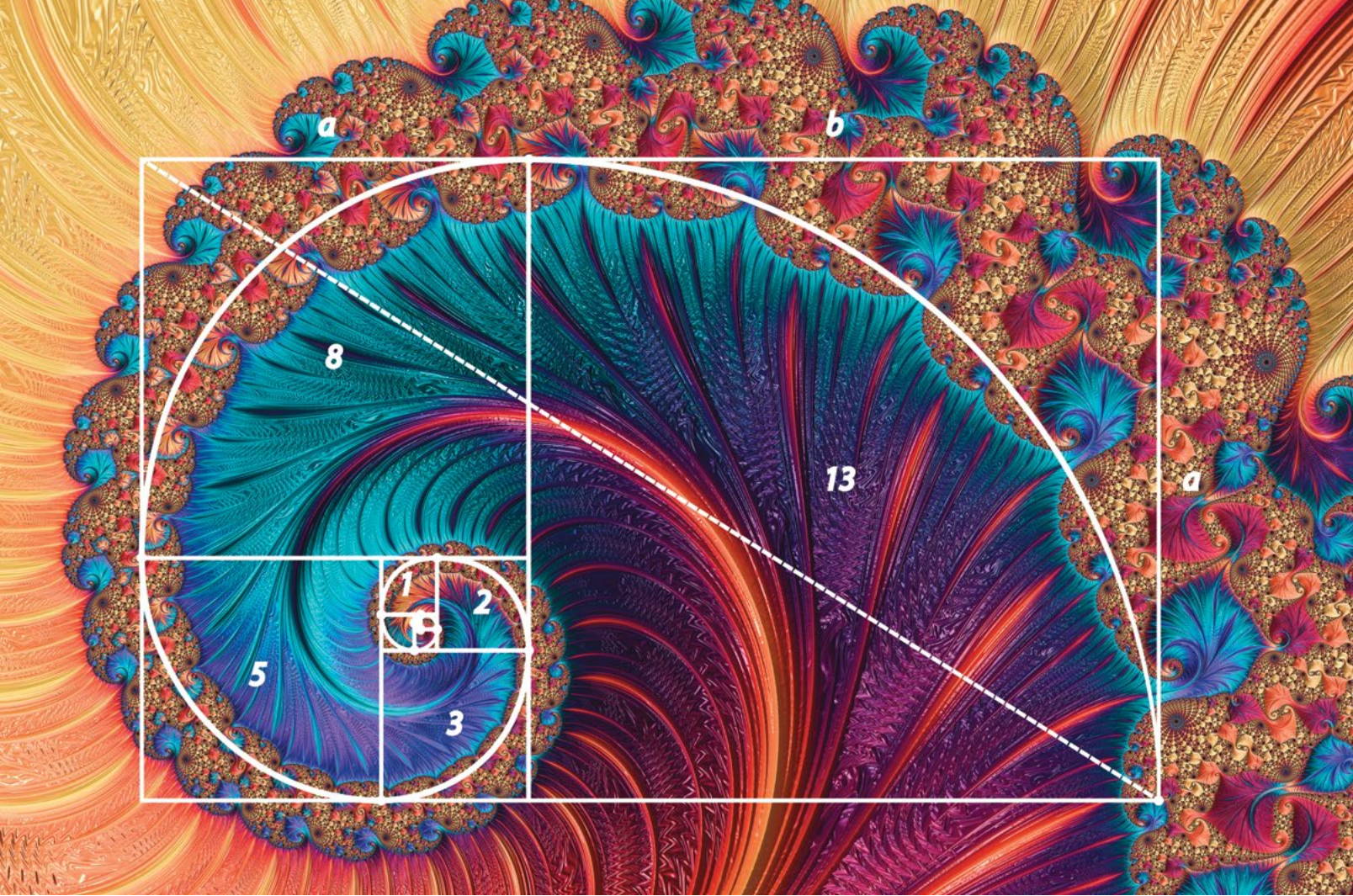
To illustrate: As medical technology improves, people live longer, so population increases. As population grows, the demand for medical technology is fueled, which creates more revenue to further improve medical technology. This is called reinforcing feedback, because the original action (improvement in medical technology) is eventually increased, that is to say, reinforced.[1]

In another example, as reinsurers compete for new and renewal business, they reduce premium rates. Eventually, premium collected won't be enough to cover losses and make a profit. The natural reaction is to raise prices until business becomes profitable again, a process that can take years. But once this goal is achieved, reinsurers start competing to gain market share. The process repeats itself as reinsurers try to capture market share and be profitable. In the lexicon of SD, reinsurers try to keep the system near its goal through a balancing feedback mechanism.

An SD model mirrors the workings of reality as much as is reasonable, but purposefully leaves out irrelevant details that complicate the model without improving it and, frequently, make it less robust. For instance, if we are modeling the population of a country or region, there will be accumulations of people (called stocks and represented with a box in **FIGURE 3** on page 60) in different cohorts. Each cohort has its own death and migration rates, which cause these stocks to change (through flows, represented with pipes with valves on them in **FIGURE 3**). What is happening in the world—war, disease, medical technology, economic condition and so on—can affect these rates. Furthermore, these influences are not stationary and can themselves be influenced by the population.

OBSERVATIONS ABOUT CORRELATION AND PROBABILITIES

"

Models can easily become so complex that they are impenetrable, unexaminable and virtually unalterable."

—Donella Meadows

The tools employed to model many (certainly not all) the phenomena that take place in business trend the past to predict the future, perhaps with some indication of the range of uncertainty. Because these techniques (almost always a form of regression) are not designed for long-term predictions, nor necessarily to understand how variables interact, they can misrepresent causation and correlation. To appreciate the problem, consider sample populations of college students in their senior year from 1976 to 2015. Average medical costs and the average concentration of certain amino acids are recorded and plotted in **FIGURE 1** where, after suitable scaling adjustments, the left y-axis represents average medical cost and the right y-axis represents average amino acid concentration.

The following conclusions are plausible:

▸ The amino acid concentration has increased over time.
▸ Lower medical costs are associated with moderate amino acid concentration.
▸ Patients should take a drug that brings the amino acid concentration to optimal levels to reduce both morbidity and medical expenses.

In this hypothetical illustration, we have attributed causation where it doesn't exist. It turns out that body mass index (BMI) determines amino acid concentration and medical cost. Accordingly, risk-adjusting medical costs based on amino acid concentration is clearly a mistake, and the use of drugs to bring the concentration of the amino acid to "optimal" levels is not only ineffective but perhaps harmful. Yet, the correlation coefficient suggests otherwise.

In many instances where regression and its variants are used, it is entirely feasible to determine causation. But with big data and increased computing power, the odds of making erroneous attributions are magnified. Moreover, since it is possible to be selective in the collection of data, different conclusions can be reached, sometimes unintentionally due

FIGURE 1   **AMINO ACID CONCENTRATION AND MEDICAL EXPENSES**
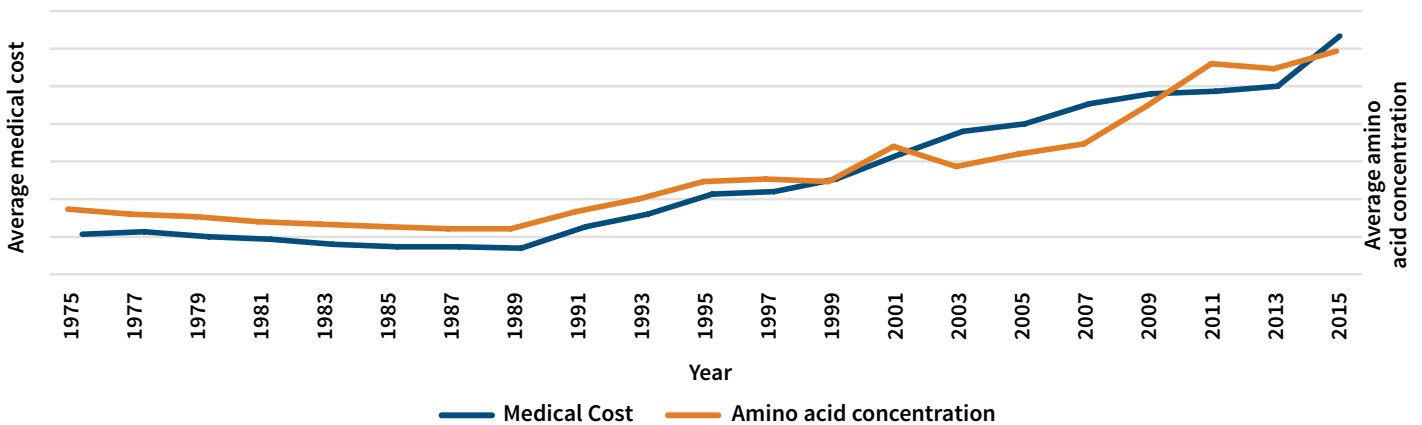
to the overwhelming amount of information, sometimes in response to a modeler's bias. With too much information (not all of which is useful), it can be impractical to review the logic of models that capture a great amount of detail. Finally, it is always possible to over-calibrate and "predict" the past with an accuracy that won't be carried forward in the future.

What about using probabilistic models to estimate outcomes such as expected medical costs without a good grasp of the causal relationships? Here the problem is often associated with the difficulty in understanding, from time series or similar data, how variables interact, and with simplifying assumptions that, however necessary, could be erroneous, such as probabilistic independence. To illustrate: Whereas it is true that the behavior of water molecules is statistically identical, the behavior of people is not. There is no uniformity of thought and feeling; human behavior has elements of randomness and irrationality; genetic makeup plays a role; recovery rates can be individual-based; the environment changes; and so on.

How do we know whether or not a model is reliable? The following criteria come to mind:

> **Model structure.** Is the model consistent with the facts? Does the model reflect our knowledge of how the real world operates? Does the model capture the key elements of reality and ignore those that are superfluous for our purposes?

> **Model behavior.** Are simulations consistent with observations?

> **Learning.** It is possible to conduct "experiments" with a simulator to understand how the system works and to test hypotheses. Have users gained insights about the system structure or learned something new about the behavior of the system?

Two case studies can illustrate the use of SD with real-world problems.[2]

CASE STUDY 1: FIRM GROWTH

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Tackle the root cause, not the effect."
—Haresh Sippy

You have invested for years in your company, Galaxy Consulting, which has finally taken off. You believe that the best way to motivate high performers and to ensure they remain committed to Galaxy is to make them corporate owners. For partners, performance determines the number of client engagements, which in turn influences compensation and work load. Since the number of partners is directly related to growth, you are interested in

FIGURE 2 CAUSAL DIAGRAM—GALAXY'S GROWTH
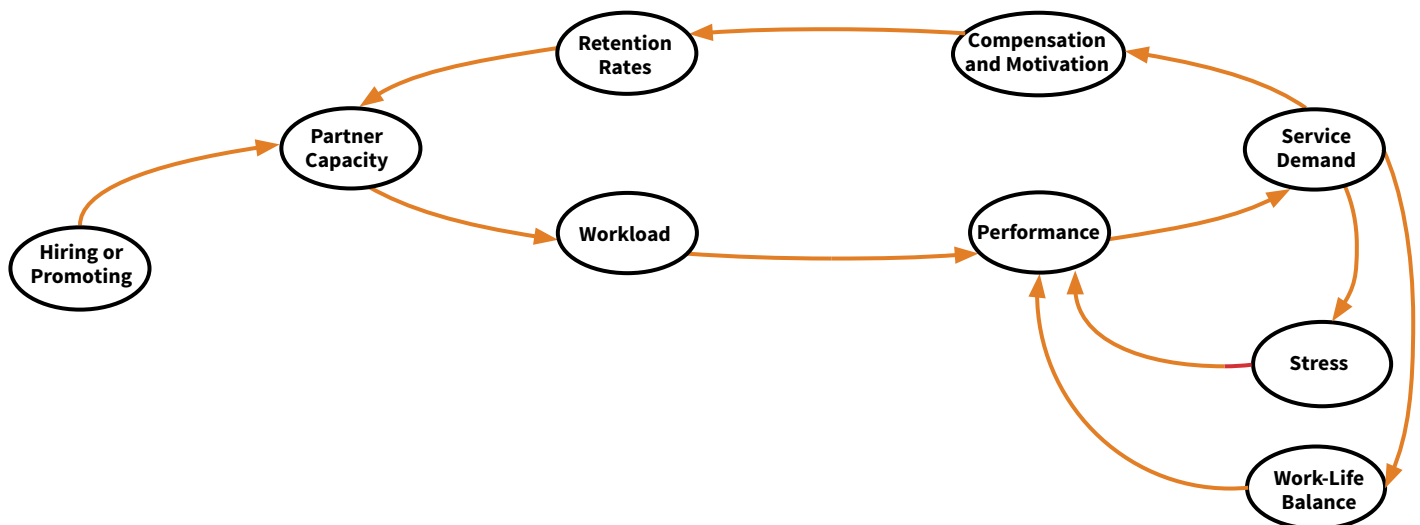
determining the most appropriate promoting and hiring policies. Keep in mind that, on the one hand, you want Galaxy to attain economies of scale and, on the other, maintain the reputation of reliability that is Galaxy's most important asset—losing it would not only compromise growth but also survival. To determine the optimal growth strategy, you and your team develop the causal diagram in **FIGURE 2** on page 59.

As you promote or hire, the pool of partners grows, easing workload per partner and improving performance. Client satisfaction generates demand, which in turn motivates and rewards partners financially. The result is the intended high retention rates. However, as demand for services grows, work-life balance suffers and the corrosive effects of stress become discernible. This takes a toll on performance, demand diminishes, motivation is reduced and compensation is curtailed. Some of the people in whom you have invested heavily leave Galaxy, putting more pressure on those who stay. You want to avoid this situation at any cost. What can you do? The pipeline of potential partners is limited (your company is still small) and you know that new executives need time to adapt to Galaxy's culture, learn about your services and earn your trust. Clearly, there is a point beyond which growth can be dangerous, but where is it?

To answer this question, you must quantify the relationships between variables. For example, research may indicate that a 10 percent increase in compensation improves retention rates by 5 percent; a weekly reduction of 10 hours of family time increases errors by 2 percent; when reported stress jumps 10 percent, peer-review time grows 20 percent; and so on. You will try to

quantify relationships using functions that are as detailed as possible, but only if they have explanatory power.

Modelers spend most of their time developing causal maps and quantifying relationships between variables. The next case study illustrates the latter, with an example that is well-known to actuaries.

CASE STUDY 2:
SOCIAL SECURITY

The most reliable way to forecast the future is to try to understand the present."
—John Naisbitt

Imagine you are analyzing different policies to ensure the solvency of the Social Security program in the face of a greater ratio of retired people to working people combined with increasingly lower average salaries. To do this effectively, you will need to age the population and include proper

FIGURE 3 POPULATION COHORT MODEL WITH MIGRATION AND DEATH RATES
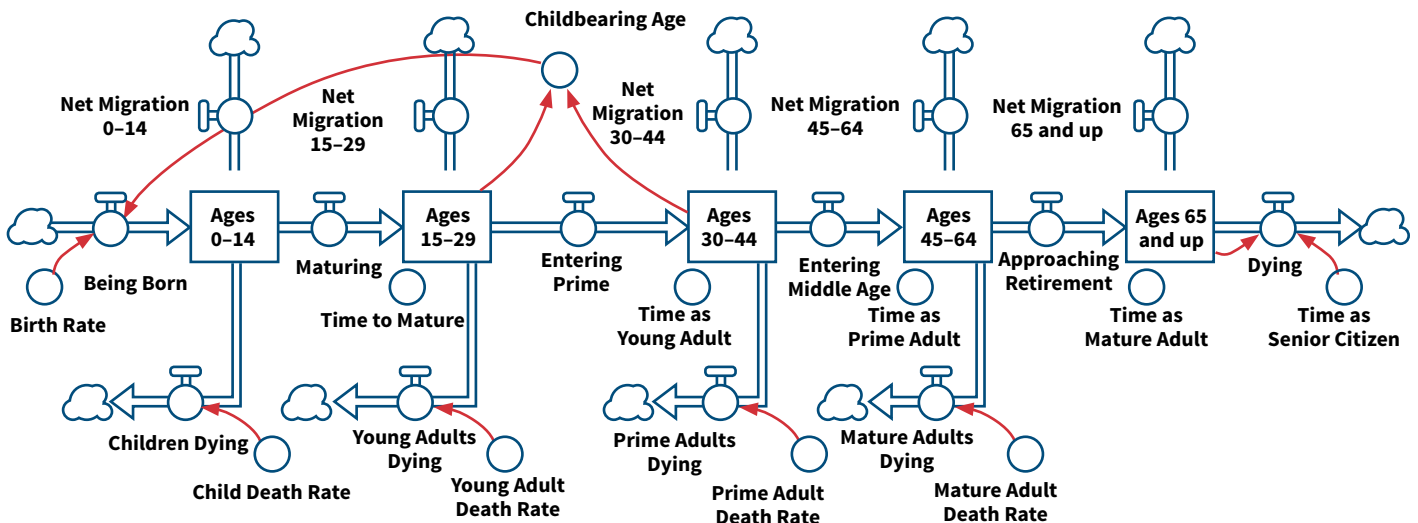
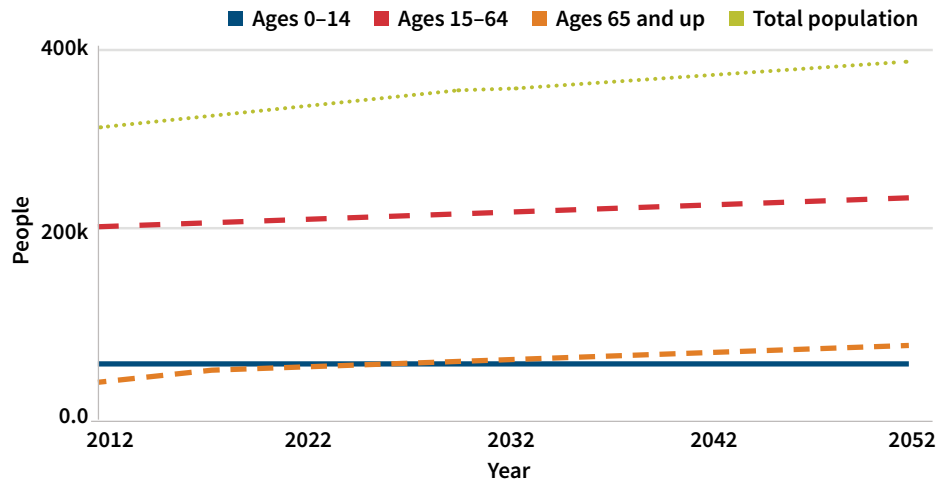accounting for both monies collected and monies due.

FIGURE 3 shows a population model with separate cohorts for ages 0–14, 15–29, 30–44, 45–64, and 65 and up (these are the boxes). People from ages 15–44 reproduce to create children who are born (far left). On the far right, people die of old age. The variable "time as senior citizen" specifies the number of years someone survives—on average—after reaching age 65. In between, people age through their lives to however long they live.

Note that the last category is labeled "Ages 65 and up." While the model is initially parameterized this way, this stock can easily be changed to contain retired people by adjusting the parameter "time as mature adult." In this way, different policies related to retirement age can be tested. In addition, as medical technology improves, the parameter "time as senior citizen" can be extended. The birth rate, migration rates and mortality rates in each age group also can be varied to see the effects under different scenarios.

Running the model with census bureau parameters shows the population growing over 50 years (see **FIGURE 4**). Note the retired population (Ages 65 and up, dashed orange line) is growing at a healthy rate. While it is not evident from this graph, the working population (Ages 15–64, dashed red line) is growing at a slower rate. This is clearer in **FIGURE 5** (solid blue line), which shows the ratio of retired people to working people. From 2012 to 2052, this ratio grows 70 percent.

The implications of these findings are startling and by now well-documented. Since Social Security benefits are cash transfers from the working population to retirees, the burden on the working population almost doubles in 50 years. If you consider that the average salary is falling over the same period, the burden easily doubles. Finally, if you consider extended life expectancies, five years in this case,

FIGURE 4 ▷ **POPULATION OF THE UNITED STATES THROUGH 2052**

Source: U.S. Census

FIGURE 5 ▷ **RATIO OF RETIRED TO WORKING PEOPLE BETWEEN 2012 AND 2052**
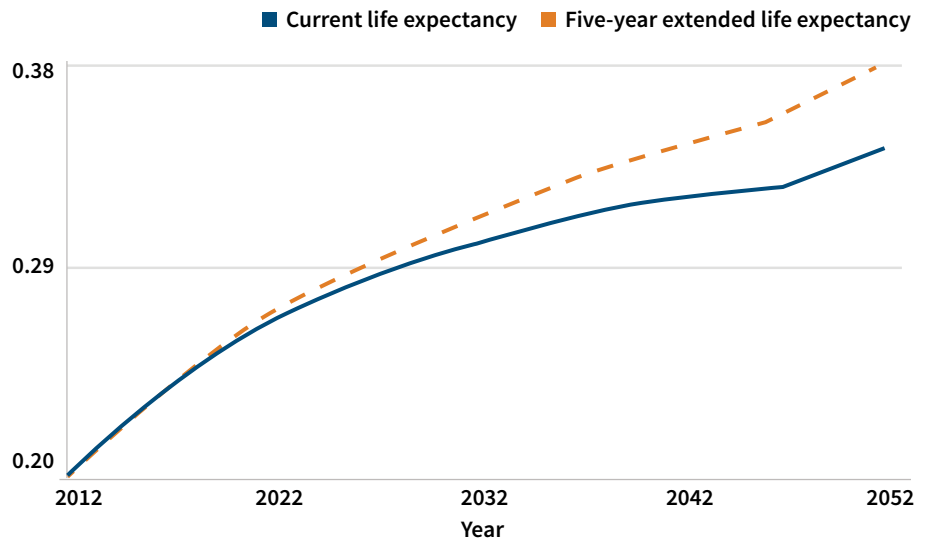
Source: U.S. Census

the situation becomes even worse (**FIGURE 5**, dashed orange line).

This model, as it stands, does not include the accounting for monies collected and due. Nor does it simulate the improvements in medical technology that can extend life expectancy. While these and other variables can be added, the model provides useful insights even without them. For example, if the retirement age is increased from 65 to 70
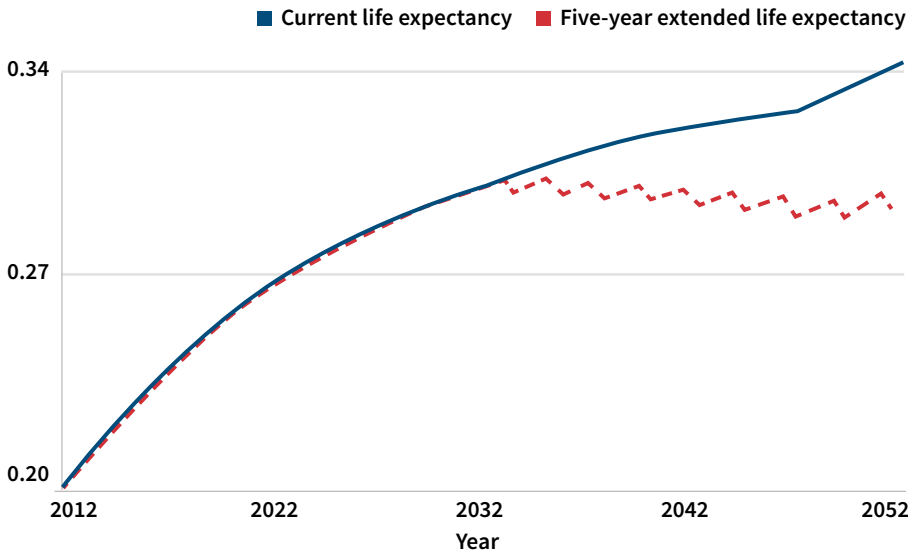
Source: U.S. Census

over 50 years, it is possible to stabilize and reverse the ratio of retired to working people (**FIGURE 6**, dashed red curve).

CONCLUSION

> ## Some things are so unexpected that no one is prepared for them.”

—Leo Rosten

Perhaps the greatest strength of SD is its emphasis on understanding how complex systems work, what matters, what does not and how levers interact. If you understand the problem, you can model it. If you model it, but simulations or predictions are incorrect, then your understanding is deficient. When this happens, as you improve the model, your knowledge of the system is enhanced and you gain strategic insights. ■

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[2] For additional examples, see: Gottfried, Dennis, and Carlos Sanchez-Fuentes. "Modeling Obesity." *Contingencies*. Nov/Dec 2012, 38–45, and Srijariya, Witsanuchai, Arthorn Riewpaiboon and Usa Chaikledkaew. "System Dynamic Modeling: An Alternative Method for Budgeting." *Value in Health* 11 (2008).

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TAKING A SWING AT PREDICTIVE ANALYTICS

Q&A WITH HEALTH CARE ACTUARY CHUCK BLOSS

Q: **Tell us a little about your background. How did you make the decision to become an actuary?**

A: I started out as a physics major in college with the intention of becoming an engineer—I knew very little of the actuarial profession then. It just so happened my college was the only school offering a bachelor's degree in actuarial science at the time. My calculus professor recommended that I sit for exam 100 (the calculus exam). I passed it on my first try, and once I learned that I didn't need to pay to go to graduate school and could find a job that paid me to continue my education, I switched to be an actuarial science major and haven't looked back. Little did I know, however, that studying for actuarial exams would have a severe negative impact on my golf handicap.

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Chuck Bloss, FSA, MAAA, FCA, is senior vice president and chief actuary at Certilytics in Louisville, Kentucky.

charles.bloss@certilytics.com

Q: Why did the actuarial profession attract you? What sparked your interest in the health care industry?

A: I liked the versatility of the work. You could get into a number of areas within insurance and finance, and the work would always be diverse and allow for creative thinking. I was originally a pension actuary, but a big chunk of my work was Financial Accounting Standards Board (FASB) Statement 106 (the calculation of post-retirement health care benefit obligations), which was enacted a few years before I began working. Companies were interested in how they could change their retiree benefits to help reduce their liabilities. This generally led to discussions about active benefits, and next thing I knew I was spending 100 percent of my time doing health care benefits consulting.

Soon after, I was hired at a managed care consulting company where I specialized in provider contract analytics—especially converting bad capitation deals back into fee-for-service reimbursements. Additionally, I helped provider-owned health maintenance organizations (HMOs) develop products and price them, and I also worked in underwriting and sales. It was a tough environment for these entities, and I loved the challenge of trying to help them succeed.

Q: How did your current company get started?

A: My current company is a spin-off from a more traditional actuarial employer benefits consulting company. The benefits consulting company was constantly being asked to do more deep-dive analytics. This would have been a distraction from the core competency of benefits consulting, so the company created a new entity that specialized in analytics, specifically working to bring new ideas into the health care analytics space. We started with four people in 2013 and partnered with a company that had a machine learning platform to help with building the predictive models. Given our rapid success and growth, we quickly needed to add a more robust IT function to handle the massive amounts of data we were getting from clients, so we purchased another company. At the same time, we brought the data science work in-house and built our own machine learning platform. Now we have more than 50 employees, and we're still growing.

The biggest challenge has been trying to meet client deliverables while exploring new product ideas with research and development (R&D) work. At a smaller company, striking a balance between the two with limited resources can pose all sorts of issues. Luckily, we have been able to keep our product development pipeline flowing while continuing to deliver high-value and interesting predictive models to our customers.

Q: What are the main functions of your job?

A: Contrary to what my colleagues would claim, it is not playing golf every day of the week. In all seriousness, I design our models, products and solutions. I work with customers to understand the problems they are trying to solve, and then provide input to our data science team as to which features make sense to include or exclude in the solution and which data should or should not be used. Then, I confirm that the results of a trained model make sense for the problem we are trying to solve. I gather input from our clinical team to design the product, and from our IT team to make sure the necessary data infrastructure is in place. I also work to ensure the completeness and accuracy of the incoming data to support operationalizing the solution. On the customer-facing side, I meet with prospective clients and describe and demonstrate our products and solutions.

Q: You've worked for a number of health care companies during your career. What information have you taken with you that has been the most helpful?

A: There is no substitute for hands-on experience. Like many other health care actuaries, I've sat across the table from a group of unhappy providers when they needed an explanation about risk adjustment when they didn't hit their shared saving target. I've sat in my CEO's office with the head of sales and underwriting to try to work through balancing profitability and growth through rating actions on large groups. I've had to hunt down an answer from operations when my analytics were showing an increase in unit costs when I was expecting a decrease. I worked on many mergers and acquisitions (M&A) deals that had a variety of issues and problems to solve across the managed care spectrum. Through this work and exposure to many other topics, I learned what worked and what didn't work, and what could have been done better with superior information, tools and models.

Q: How are you using predictive analytics in your job, especially as it applies to the health care industry?

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A: There are a lot of opportunities in the population health management (PHM) space. Many of the existing tools and solutions used by managed care entities were developed years ago, and they only consider a handful of data elements and contain static algorithms and rules. To compound the issue of being ineffective, the processes that were built around these tools are broken. These entities have low patient engagement and clinical compliance rates, and they cannot demonstrate the value of their clinical programs. Finally, many prospective clients have a broad array of different kinds of data and want to put the data to good use. Given the nature of their current operational state, the incorporation of new data elements into their existing tools is difficult.

We combine our predictive modeling expertise with efficient process management to help improve these important metrics of a PHM program. This enables us to achieve great success in operationalizing predictive models, turning the theoretical into actionable. Predictive models allow for a more dynamic approach to PHM by continually updating rules as more data rolls in. In addition, the predictive models I design contain elements of traditional health care data, while incorporating a customer's nontraditional data elements as well as any other data I can get my hands on from various domains. Because there is so much information out there, it can be challenging to weed through it all to find those data points that can improve the predictive power of the model.

Q: How do you see the role of predictive analytics in health care changing in the next five to 10 years? Where will actuaries fit into the equation?

A: Many individuals in predictive analytics are not actuaries. They get their undergraduate or graduate degrees in data science or business intelligence and can be considered for predictive analytics positions. Actuaries need to continue to differentiate themselves with superior predictive modeling skills and strong business acumen. With a robust curriculum from the Society of Actuaries (SOA), I think actuaries will continue to show the value we can add.

In terms of predictive analytics in health care in general, I think the integration of data across different disciplines will continue and help health plans and providers improve their outreach to patients. In addition to answering the question of which patients to contact, predictive analytics will improve choices in method of communication—what to say specifically, and how to say it. I think you will see entities putting more provider and payer fees at risk, based on the improvement in metrics that are first calculated using predictive analytics.

The iPhone was released 10 years ago, and the amount of additional data the smartphone has generated has been profound. It will be interesting to see how much additional data will be available in the next 10 years.

Q: What is the most challenging aspect of your work?

A: In my role as a product and model designer, there is innovation and an opportunity to think about solutions to problems differently. Innovation is extremely rewarding, but it can also be challenging. It is exciting to watch a customer adopt one of your ideas; implement a solution; and have a positive impact on financial results, operational efficiency and member satisfaction. But it takes a lot of trial and error, persistence and confidence to get to that point. In my mind, the hardest part of my job is letting go of an idea and going in a new direction, especially if I have spent a lot of time trying to make the original idea work. It is having the ability to pull out of the details, take a step back and reevaluate. Many times, the final product will contain elements of the original design, but being able to switch gears along the way is the key to success.

Q: What is most gratifying about a career as an actuary?

A: The day-to-day challenge of being presented a problem, wrestling with it, devising a solution and presenting results is the most gratifying part about being an actuary. Combine that with the diversity in application of domain knowledge and the use of problem-solving skills, and you have a universe of opportunities to be continually challenged. Specifically, in the predictive modeling space there are so many untapped areas to apply concepts. The universe will continue to expand and only make the actuary's job more interesting and solving problems even more satisfying. ■

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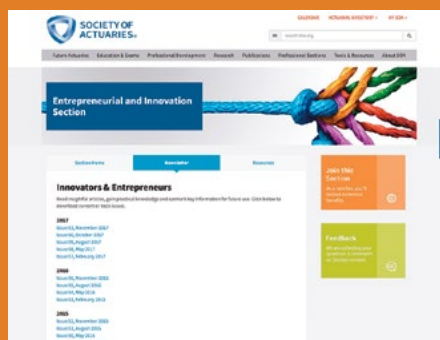
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March 8, 2018 • New York, NY

ERM Symposium
April 19–20, 2018 • Miami, FL

Life and Annuity Symposium
May 7–8, 2018 • Baltimore, MD

Asia-Pacific Annual Symposium
May 24–25, 2018 • Seoul, South Korea

China Annual Symposium
May 28–29, 2018 • Beijing, China

Health Meeting
June 25–27, 2018 • Austin, TX

Valuation Actuary Symposium
Aug. 27–28, 2018 • Washington, DC

Annual Meeting & Exhibit
Oct. 14–17, 2018 • Nashville, TN

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Change
Is in the Air

BY KORY J. OLSEN

EXAMINING THE LATEST UPDATES TO THE SOA EDUCATION SYSTEM

Periodic system updates—as consumers, we are accustomed to these. Updates to our computer and phone operating systems are needed to keep them running smoothly and to incorporate the latest efficiencies and new features. Occasionally, a new device is needed in order to take advantage of the latest features and efficiencies. The Society of Actuaries (SOA) education system similarly needs periodic reviews and updates.

The SOA education system will see a change in the summer of 2018 reflected in the ASA curriculum. The changes are addressing evolving industry challenges and needs, as well as incorporating subject matter on topics, such as predictive analytics, that require significantly increased coverage. The changes also provide the opportunity to better align topics within the SOA education system.

The ASA curriculum and components are the focus of the changes in 2018. However, the ASA revisions will have a ripple effect in regard to the FSA curriculum. The ripple effects will show up in the FSA curriculum in two key ways:

- ➔ Realignment of the topics in the SOA educational system
- ➔ Incorporating predictive analytics

REALIGNMENT OF THE TOPICS

The last time the FSA curriculum was changed significantly was in 2013. At that time, the two six-hour exams were replaced by two five-hour exams and one two-hour exam. This change gave all candidates the option of taking the four-hour Enterprise Risk Management Exam in place of the two-hour track-specific exam. It was an opportunity for all candidates to achieve their CERA designation on their way to fellowship in their chosen track. Along with this change was an opportunity to review and update the FSA curriculum.

The changes in the ASA curriculum affect the background that can be assumed for fellowship exams. The next logical step is to make the appropriate changes to the FSA curriculum. An example is that the topics currently on the Financial Economics Module (currently part of the FSA curriculum) are now mostly covered in the ASA curriculum. This frees up a FSA module slot and has provided an opportunity to better align material in the FSA curriculum. Note that the number, size and type of components that make up the FSA curriculum will not change—it is just where and how the material is covered that will change.

The Financial Economics Module is being used by four of the six FSA tracks. The other two tracks currently share the Financial Reporting Module. The FSA changes will eliminate these shared FSA modules, giving each track the opportunity to create a module that best works for that track, which may include components of the old modules.

PREDICTIVE ANALYTICS

The FSA modules are an appropriate place to locate material that does not need to be rigorously tested or topics that are best taught with more interaction with the candidate. As candidates go through the new ASA predictive analytics components, the FSA tracks will appropriately reflect that change in their curriculums. The new modules are an opportune place to include predictive analytics material, as they are computer-based and allow for multiple interactions with candidates. It is a place to teach candidates using hands-on applications of how predictive analytics is used in their practice area.

The FSA curriculum committees have evaluated the material on their tracks, its placement and how it is assessed. The results of the evaluation vary by track, with different levels of changes needed. Most tracks will be creating a new module and will shift topics around on the exams. The Group and Health track has determined that to more effectively test its material, significant topics need to shift from one exam to another. This significant shift requires specific transition rules and segmenting the administration of parts of the exams during a transition time frame. The other tracks are able to use more straightforward transition rules.

The SOA e-Learning modules have been a key part of SOA education for more than 10 years. When they were launched, they were cutting-edge and not typically found in an educational curriculum. A lot has changed during the past 10 years. Computers have gotten faster with more capabilities, and e-Learning is a standard part of many education structures. During these 10 years, the SOA e-Learning modules have advanced and have been updated. The creation of new modules for each track will allow the SOA to develop and incorporate even more up-to-date techniques and abilities within the FSA tracks.

The roll-out of the new FSA track material will be staged to balance the resources needed to develop and implement a new module for each track. The first of the new modules is expected to be released in summer 2019. It is currently anticipated that all of the module work will be completed by the end of 2020. Specific details will be communicated to candidates and other stakeholders well in advance of the release of each new module. The SOA Education Curriculum Changes webpage will be kept up-to-date with all of the latest information. In addition to the webpage, email and other means of communication will be used to broadcast the information.

The education system structure and curriculum are key to keeping the SOA's actuarial credentials relevant. Every few years, a review is done to ensure the right material is being covered and assessed in the best way. The changes to the ASA curriculum paved the way for enhancements to the FSA tracks. In this way, the SOA is committed to an ongoing cycle of review and revision to ensure a high-quality education for its members and the actuarial profession. ■

RELATED LINK

SOA Curriculum Transition Rules
SOA.org/curriculumchanges

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CALCULATING MORTALITY IMPROVEMENT

BY R. DALE HALL

As a data-driven organization, the Society of Actuaries (SOA) is committed to providing updates to experience studies and related subject matter, including mortality improvement. Last fall, the SOA released the annually updated mortality improvement scale for private pension plans, MP-2017. Developed by the SOA's Retirement Plans Experience Committee (RPEC), MP-2017 incorporates the latest publicly available mortality data from the Social Security Administration (SSA) through 2013. The scale uses the private pension mortality tables RP-2014 as the base table.

Additionally, MP-2017 includes 2014 and preliminary 2015 data, developed by the SOA and obtained from the Centers for Disease Control and Prevention (CDC), Centers for Medicare and Medicaid Services (CMS), and the U.S. Census Bureau. This updated mortality improvement scale on private pension plans provides actuaries and plan sponsors with current information to measure retirement obligations and make forward-looking mortality improvement assumptions. However, every plan is different. It is important for actuaries and plan sponsors to perform their own calculations and decide how to reflect the impact of

emerging mortality changes in their own plan valuations. There's been quite a bit of media coverage on this mortality improvement scale, and you may consider checking out the different articles on the calculations, including one from *Bloomberg*.

This updated scale reflects that age-adjusted U.S. population mortality rates increased 1.2 percent between 2014 and 2015. It is important to note that this is the first year-over-year mortality rate increase since 2005. Based on this scale, pension plan participant life expectancies declined slightly, which may also decrease pension plan obligations slightly.

Our preliminary estimates suggest that implementing the MP-2017 improvement scale could reduce a private pension plan's pension obligations by 0.7 percent to 1.0 percent, when calculated using a 4 percent discount rate.

The updated improvement scale reflects a slight decline in life expectancy, stemming from an increase in mortality from eight of the 10 leading causes of death in the United States, as reported by the CDC. For example, the life expectancy for a 65-year-old male private pension plan participant declined to 85.6 years using the MP-2017 scale, compared to 85.8 years under MP-2016. Additionally, the average life expectancy for a 65-year-old female private pension plan participant declined to 87.6 with MP-2017, from 87.8 years with the MP-2016 scale.

RELATED LINKS

Actuarial Tables, Calculators and Modeling Tools
SOA.org/research/tables-calcs-tools

Living to 100
Livingto100.SOA.org

Find Research by Topic
SOA.org/research/research-topic-list

Mortality Improvement Scale MP-2017
bit.ly/Mortality-Improvement-Scale

Retirement Plans Experience Committee
bit.ly/Retirement-Plans

Bloomberg article
bloom.bg/2gBWf6s

Check out the report as it includes a wealth of information, including a sensitivity analysis to model the impact of different improvement model assumptions on annuity factors for plan funding. We will continue to provide updates to a variety of our experience studies, including on pensions, so check out our research pages for the latest developments. ∎

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action

GOOD RESEARCH READS

UPDATES ON ACTUARIES CLIMATE INDEX
The Actuaries Climate Index reached a new record high in winter 2016–17, following the record value measured in fall 2016. The change reflects increasing deviation of weather extremes and sea levels from historically expected patterns for the United States and Canada.
actuariesclimateindex.org

ANNUITY FACTOR CALCULATOR
The SOA developed the Annuity Factor Calculator to calculate an annuity factor using user-selected annuity forms, mortality tables and projection scales commonly used for defined benefit (DB) pension plans. This tool is designed to calculate relatively simple annuity factors for users who are accustomed to making actuarial calculations for DB pension plans in the United States or Canada.
afc.SOA.org

STATS ON ENTERTAINMENT INDUSTRY PENSIONS
The SOA updated the statistics on multiemployer pension plans and provided a comparison of 2016 pension plan funding within the entertainment industry. These multiemployer pension plans include the Screen Actors Guild–Producers Pension Plan, Directors Guild of America–Producer Pension Plan and the Motion Pictures Industry Pension Plan, among others. Access the comparison paper and the statistics for each of the plans.
bit.ly/Multiemployer-Pension-Plan

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❸ | Expand your network base.
❹ | Make meaningful contributions to your company, your team and the profession.

PODCASTS

Artificial Neural Networks
Artificial neural networks have gone through a recent renaissance as part of deep learning. They can now provide amazing accuracy, but they come with an equally amazing amount of complexity. This podcast provides a high-level overview of everything from their history to modern implementations.
bit.ly/SOAPAPodcasts

Here We Go Again: Potential Impact of Health Care Reform on Dental Insurance
The passage of the Patient Protection and Affordable Care Act (ACA) in 2010 caused sweeping changes in the dental insurance industry, affecting benefits, pricing of those benefits and the availability of dental coverage. Learn about the impact of the ACA on dental benefits and potential ramifications to the dental-related components of the law.
bit.ly/SOAHealthPodcasts

E-COURSES

Applying Professionalism Worldwide
Professionalism is a core competency in whatever you do. This course focuses on situations where actuaries live and/or work outside of the United States. It also covers the Code of Professional Conduct.
bit.ly/ProfessWorld

Social Insurance
This e-course describes social insurance programs, their operation and the current issues they are facing. Most of the content focuses on Social Security and Medicare in the United States and Canada. However, readings on other social insurance programs are included.
bit.ly/Social-In-SOA

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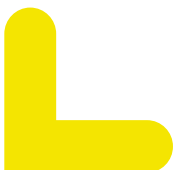
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for Stress and Scenario Testing

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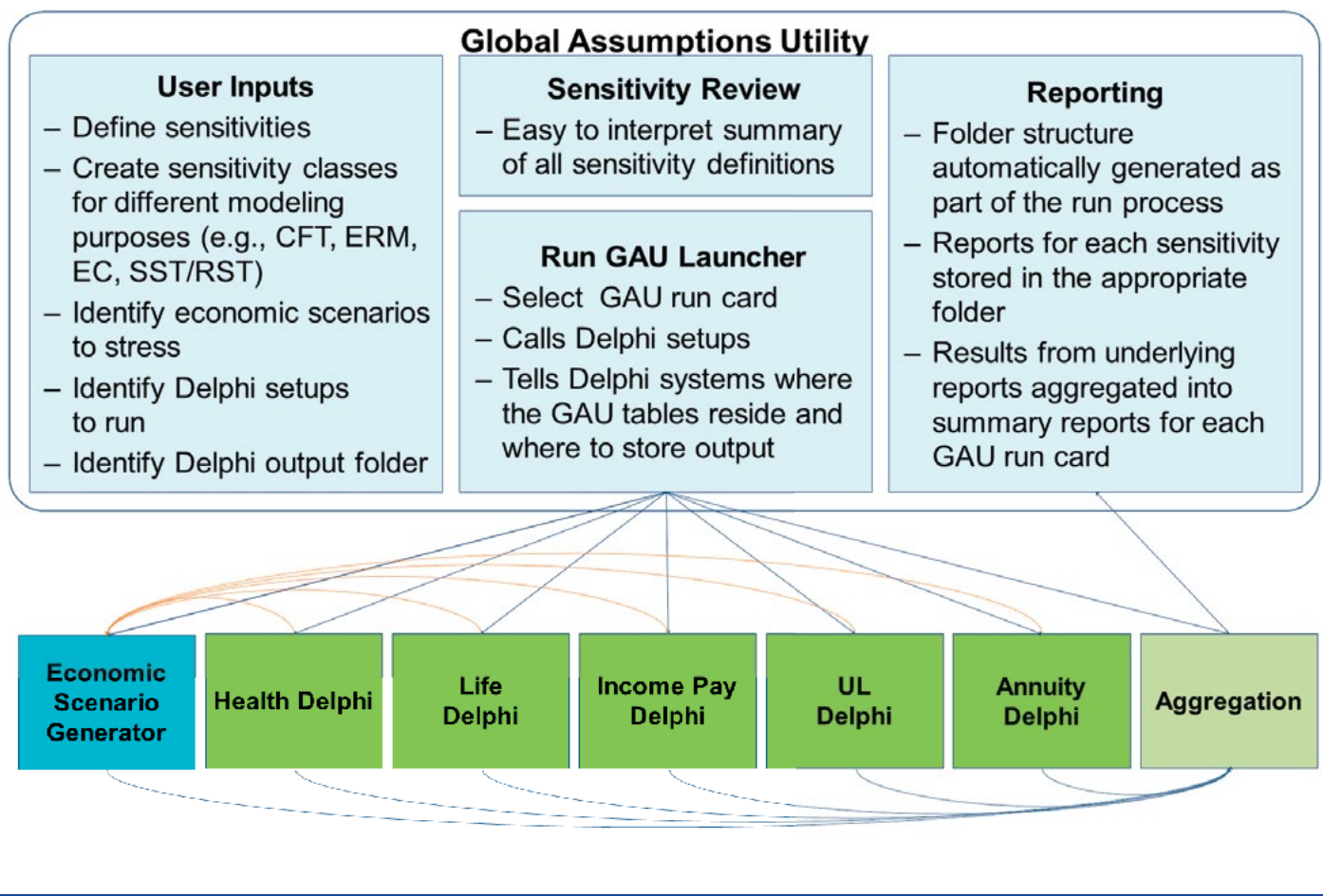- Scenario test and stress multiple assumptions in one pass
- Capture results by line of business or legal entity
- Facilitate stress and scenario testing and reverse stress testing for various projection purposes, including ALM, Cash Flow Testing, Risk Analysis/ERM, MCEV/EV, Economic Capital, Plan, Ad-Hoc Stresses, PBR, IFRS, and Pricing

Global Assumptions Utility

User Inputs
- Define sensitivities
- Create sensitivity classes for different modeling purposes (e.g., CFT, ERM, EC, SST/RST)
- Identify economic scenarios to stress
- Identify Delphi setups to run
- Identify Delphi output folder

Sensitivity Review
- Easy to interpret summary of all sensitivity definitions

Run GAU Launcher
- Select GAU run card
- Calls Delphi setups
- Tells Delphi systems where the GAU tables reside and where to store output

Reporting
- Folder structure automatically generated as part of the run process
- Reports for each sensitivity stored in the appropriate folder
- Results from underlying reports aggregated into summary reports for each GAU run card

Economic Scenario Generator | Health Delphi | Life Delphi | Income Pay Delphi | UL Delphi | Annuity Delphi | Aggregation

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