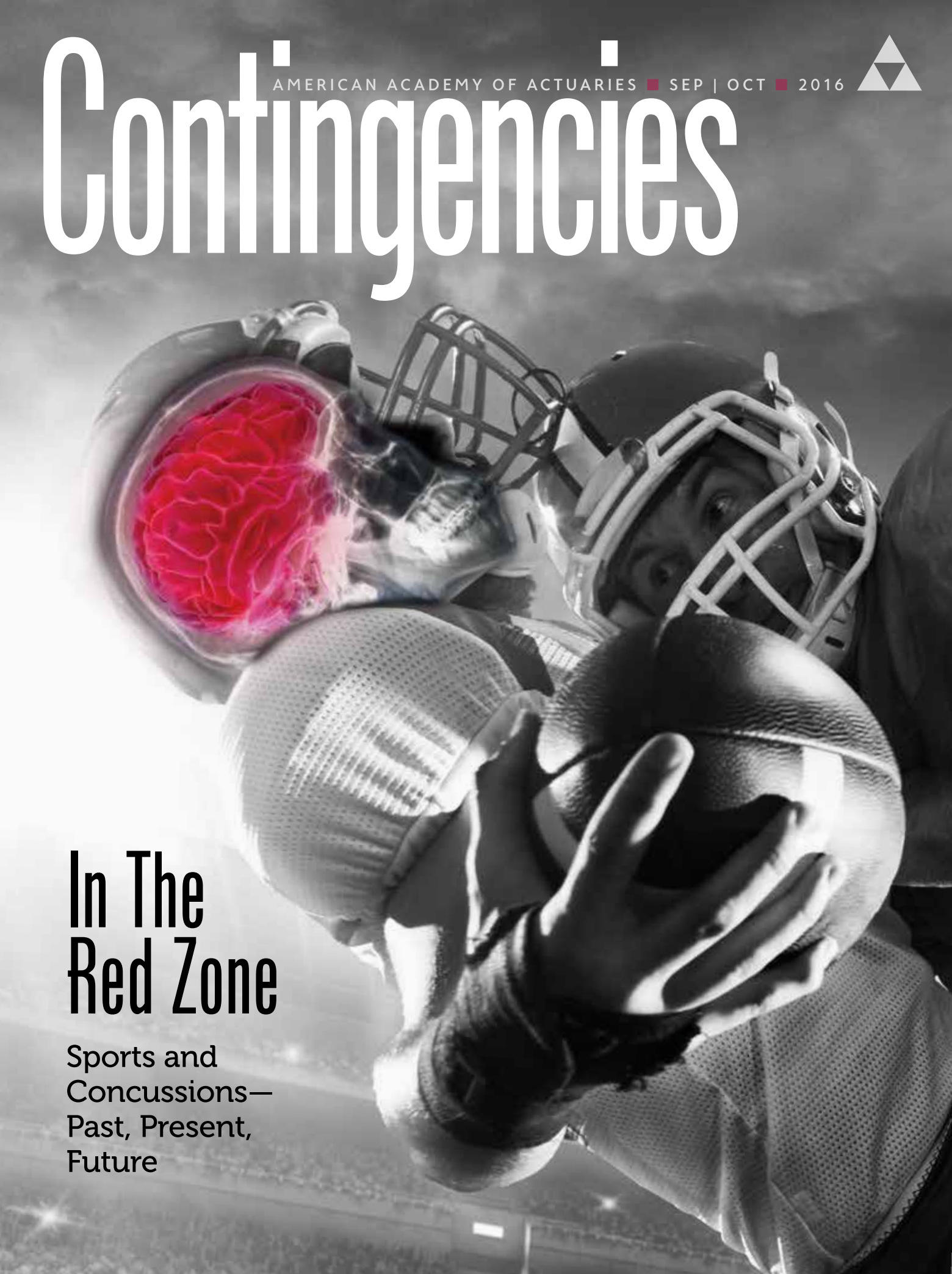




Contingencies

In The Red Zone

Sports and Concussions—
Past, Present,
Future





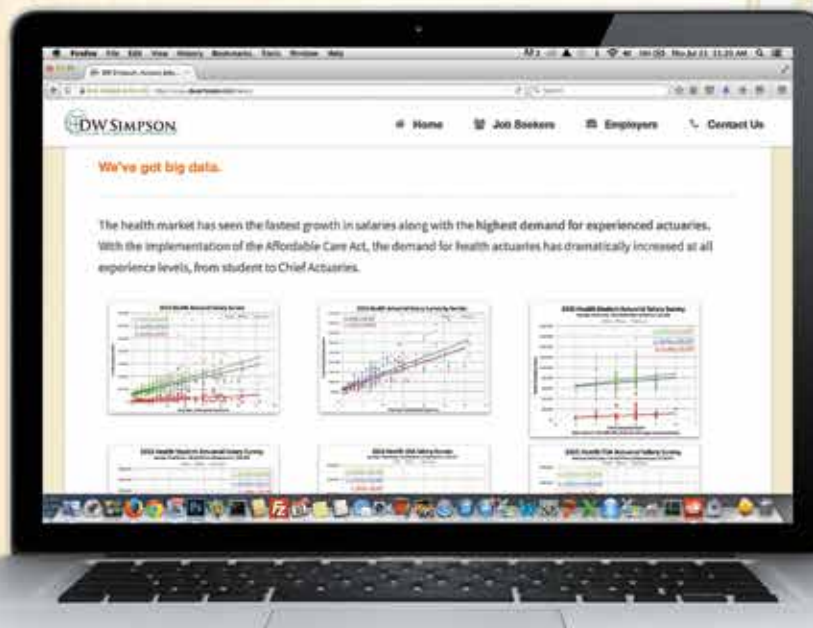
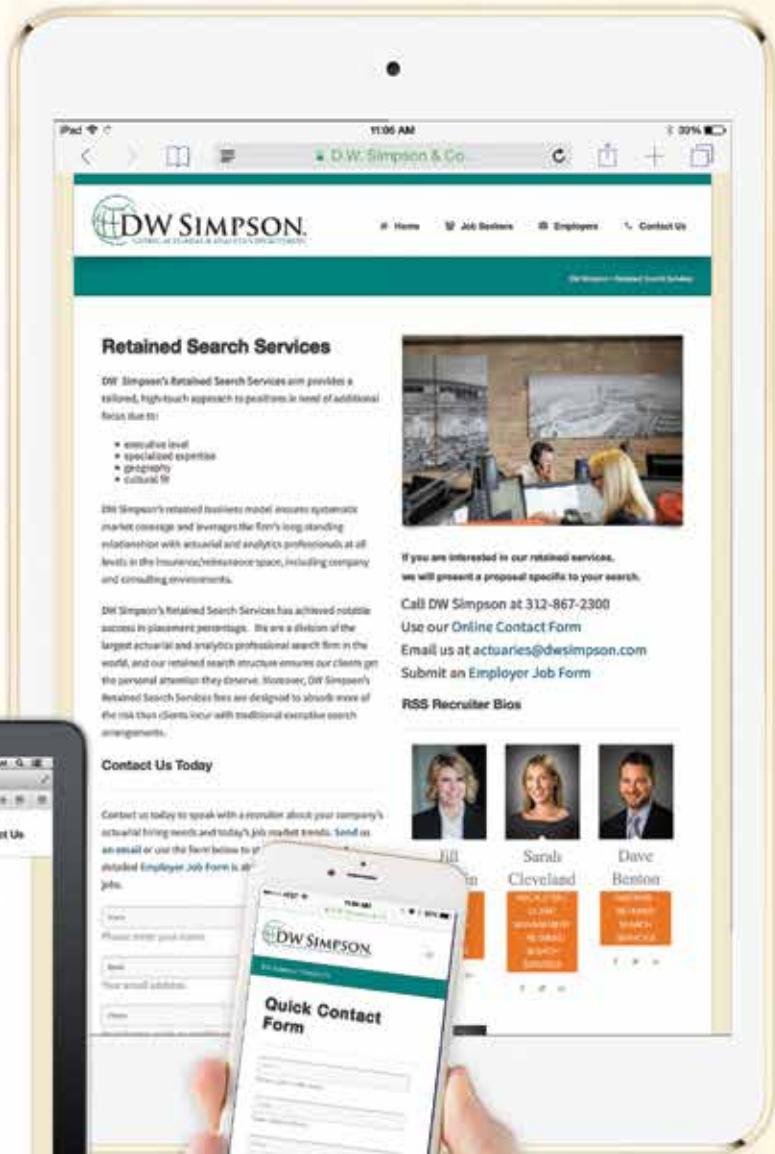
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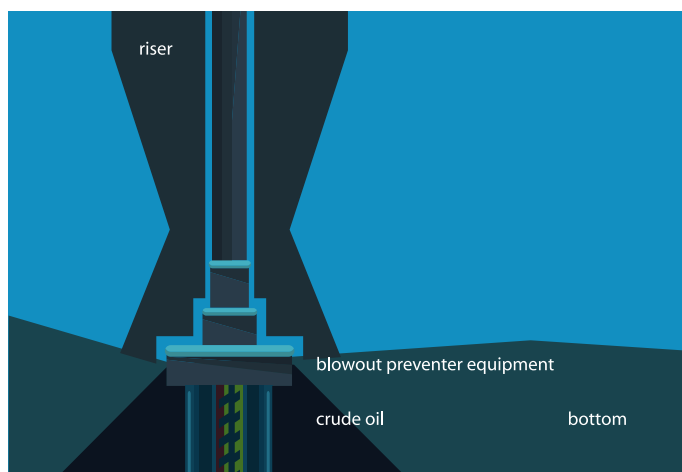


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Contingencies (ISSN 1048-9851) is published bimonthly by the American Academy of Actuaries, 1850 M Street, NW, Suite 300, Washington, DC 20036-5805. For subscription information and customer service, contact the *Contingencies* subscription department at the address above or (202) 223-8196. Advertising offices: Jeff Rhodes of Network Media Partners, 410-316-9857, jrhodes@networkmediapartners.com. Periodicals postage paid at Washington, DC, and at additional mailing offices.

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Postmaster: Please send change-of-address notices for *Contingencies* to *Contingencies*, PO Box 16976, North Hollywood, CA 91615-6976.

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Growing Pains

AS I WRITE THIS NOTE, THE METRO D.C. REGION is mired in a typical August heat wave. Temperatures have hovered near 95 for weeks, and oppressive humidity makes any trip outside unbearable. (Who decided to build the nation's capital on top of a swamp, anyway?)

These unpleasant conditions require creativity when it comes to managing two boisterous boys. There are only so many episodes of *American Ninja Warrior* we can watch before the kids want to try the stunts themselves. In this heat, we forgo the playground and set up indoor obstacle courses—repurposing leftover wooden railings as a balance beam, using toy arrows to measure long jumps—so the boys can work off some energy (and hopefully tire themselves out, leading to an easy bedtime). The kids love it, but my wife and I cringe watching the inevitable trips, twists, and falls.

My younger boy especially likes to test the rules of physics, throwing himself (literally) into any bodily endeavor. Sometimes that intrepid nature gets him into trouble. One time, for example, he saw his older brother leap over a small plastic stool set up as an impromptu hurdle, so he tried it. He fell just short of clearing it, sending him sprawling face-first onto the carpet. A bit of rug burn and tears ensued ... then after about 90 seconds, he was up and at it again.

I've found that holding myself back from intervening in those precarious moments is one of the most challenging aspects of parenting. But any child development expert will tell you that taking risks—and sometimes failing—is an important part of development. Without challenging yourself and testing the limits of your abilities, you'll never realize your true potential.

Our features this month investigate some other intersections of risk and growth:

The National Football League has never been more popular. Its televised games regularly dominate the Nielsen ratings, and the league is building its fan base outside the United States. Amid that global growth, though, sits the issue of player safety—specifically risks to brain health. In our cover story this month, “In the Red Zone” (page 30), Michael Malloy looks at the swirling controversy of sports and concussions. The NFL has garnered the most attention in this area because of its multi-million-dollar settlement with former and current players, but

the issue affects athletes across many sports and at all levels. This feature discusses the history and current standing of the concussion conundrum, and looks at how various sports are changing protocols to protect athletes while preserving the essential nature of the sport.

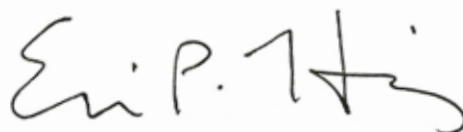
In the pension world, the issue of solvency usually gets the headlines. But “The Sustainability Puzzle” (page 38) suggests that a more important metric may be sustainability—that is, can plan sponsors afford to pay obligations over time based on current assets and anticipated future revenue? This feature looks at the different sustainability implications faced by plans in growth industries vs. those in more mature fields, and suggests some ways that plan sponsors can make appropriately risky investment decisions to grow plan assets based on those differences.

In “Cryonics: The Best Crapshoot in Town” (page 46), the author examines the practice of preserving one's body after death, in the hopes that future scientific discoveries will allow for regeneration and longer life. The field is still in its infancy, but recent breakthroughs suggest the first part of the equation—the cryo-preservation—may be feasible. Putting one's hopes in this nascent technology is risky, but the potential payoff could be enormous.

Our fourth feature this month, “To Block a Blowout” (page 52) suggest that insurance companies can underwrite offshore oil drilling expeditions with greater accuracy if they consider the geophysical properties of the site in question. A partnership between the geophysical and actuarial sciences could yield a more precise risk profile for high-stakes drilling enterprises.

And a final note: The November/December issue will be the final opportunity to enter our fiction contest. Don't miss your chance to share your creative side—and the chance to win a \$500 prize. For details and to enter, visit actuary.org/2016contest. Deadline to enter is Sept. 30.

Thanks, as ever, for reading—and for helping to quantify the risks of our world. □



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Sustaining Our Future

SOCIAL SECURITY AND MEDICARE have changed what it means to be old in America. Poverty is no longer the almost inevitable companion of aging. Millions of Americans depend on these programs for their financial security and health care. Both programs represent long-term promises to the retirees of today and tomorrow—and both face long-term financing challenges.

Actuarial work often focuses on technical measures of solvency. The specific measures used depend on the type of program involved, how it's financed, and how far the promises made extend into the future. But certain underlying questions remain the same: Can the promises be kept? Is the program on track to achieve its goals? Is the program sustainable?

Solvency asks whether the books balance. Sustainability asks whether a program is likely to be prematurely curtailed or discontinued. Sustainability is harder to measure, but it's also perhaps the more important of the two concepts.

Both Social Security and Medicare are financed through trust funds. The trustees for the funds issue annual reports on their financial status, including financial projections developed by the chief actuary of the Social Security Administration (SSA) and the chief actuary of the Centers for Medicare and Medicaid Services (CMS). Recent reports have consistently projected that key trust funds for both programs will run out of money in the relatively near future.

The most recent Social Security Trustees Report projects that the Old Age and Survivors Insurance (OASI) trust fund will be depleted in 2035. When that happens, revenues under the program are estimated to cover only 77 percent of the promised benefits. The most recent Medicare Trustees Report projects that the Hospital Insurance (HI) trust fund will be depleted in 2028, at which time revenues will cover only 87 percent of benefits. It's not clear what would happen at that point. Would Medicare pay benefits at only 87 cents on the dollar, or would benefits be paid on a "first-come, first-served" basis? In either case, the result would be a significant curtailment of benefits. And these programs are growing as the U.S. population ages, taking up a greater percentage of GDP and crowding out other spending priorities in the process.

In my judgment, neither Social Security nor Medicare is fully sustainable under current law. Does that mean the programs are doomed? Of course not. We have time to fix them, and given the number of voters who depend on these programs, Congress will eventually come under tremendous pressure to do so. But the sooner we do it, the easier it will be.



On one level, the issues are simple. Eliminating the financial shortfall will require raising revenues, reducing benefit costs, or more likely some combination of the two. But given the significance of these programs for people's lives, the decisions will not be easy. My Social Security benefits will help determine the lifestyle I can afford to lead in retirement—or perhaps even whether I can afford to retire. The way my Medicare benefits are structured will affect the care I receive on my deathbed.

Determining how the costs and benefits of these programs are spread across income groups, age groups, and generations is an inherently political question. Recognizing this in no way minimizes the vital role that actuaries play in helping the nation understand the financial challenges, quantifying them, and evaluating the adequacy and effectiveness of potential solutions. The annual trustee report projections, prepared by dedicated actuaries at SSA and CMS, are widely recognized as reliable and authoritative measures of the health of these programs. The Academy has a long history of providing the nation with objective, unbiased actuarial analyses of both the financial status of the programs and options for strengthening them. But the tough decisions—such as choosing between higher taxes and lower benefits, or between higher Medicare premiums and fewer choices of health care providers—must be made by the American public through their elected representatives.

You and I are not just professionals—we are citizens as well. We are in the middle of an election year, and the decisions made by the next president and Congress will shape the long-term financial health of Medicare and Social Security. Each of us has a right—and a responsibility—to understand the candidates' positions on these vital programs before entering the voting booth. As you evaluate those positions, the Academy's 2016 election guides on Social Security and Medicare can provide a useful roadmap to the critical issues facing each program—you'll find them at election2016.actuary.org. Once you've studied the candidates' positions on these and other issues, I encourage you to vote—it's a civic duty that we all share. □



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A Matter of Optics

I applaud Tim Geddes and Robert Rietz on their thoughtful article “Step by Step—Reforming Social Security by Aligning Retirement Age With Income” (July/August 2016). I will assume that anyone reading this letter is familiar with the Academy’s support for an increase in Social Security Retirement Age (SSRA) and is also aware of the controversy surrounding an increase in SSRA due to a disparity in mortality improvements between low-income and high-income workers. This disparity supports the position that an increase in SSRA places a greater burden on low-income workers, those most dependent on Social Security in retirement.

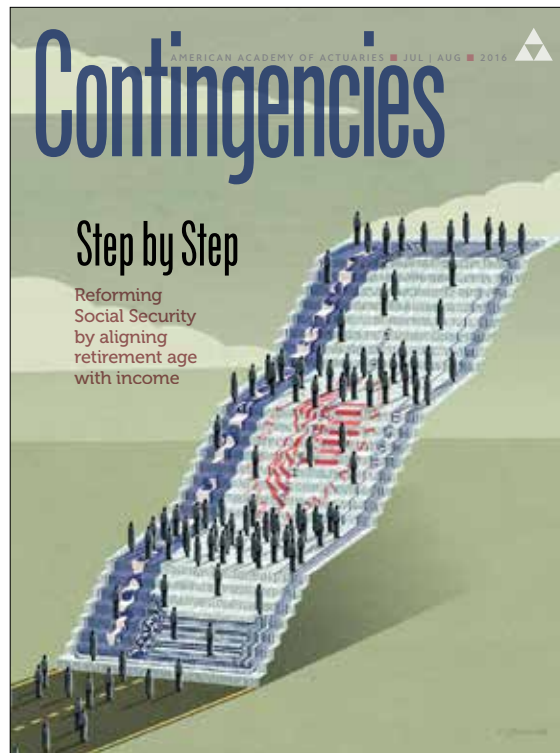
The authors’ proposal is for a transition in the program to have multiple SSRAs (three), dependent on Average Indexed Monthly Earnings (AIMEs). AIMEs are based on wages that Social Security taxes have been paid on and are used to calculate Social Security benefits. The result based on the proposal would be that those at a lower AIME levels would have no reduction in benefits because their SSRA would not change, and those at the higher levels would experience a reduction in benefits because their SSRA would increase. There would also be an in-between cohort with a more modest increase in SSRA.

Conceptually, this proposal makes sense at a macro level. But it poses a serious perception issue. Higher-paid workers already receive a smaller benefit per dollar of payroll tax paid than do lower-paid employees. The authors’ proposed change would exacerbate that disparity further in a manner that may not be well received by some individuals when considering their own circumstances and potential life expectancies.

To assert that one individual should have a greater reduction in benefits than another because he or she is expected to live longer solely based on their benefit levels might hit a wall of resistance. Some people with higher benefits do die early, and some of those with lower benefits do

The authors have done us all a service by articulating a potential solution to a problem that deserves our attention. My position is simply that we need to look beyond the macro analysis.

Mark Shemtob
Florham Park, N.J.



The authors respond:

We thank Mark Shemtob for his support of the Three-Tier SSFRA concept and respond to his concerns. First, just as some females will die sooner than some males the same age, some high-income earners will die sooner than some low-income earners the same age. The former doesn’t invalidate individual annuity pricing, and the latter shouldn’t invalidate the Three-Tier SSFRA design.

Second, as Shemtob pointed out, most high-income earners do realize a smaller benefit per dollar of payroll tax paid than low-income earners—that is, they generally receive a lower “money’s worth” than low-income earners. However, the decreased “money’s worth” is actually not as significant as it seems due to disparate mortality impact.

When the analysis uses appropriate mortality assumptions for the three income groups, the longer longevity of the high-income earners compensates for much of the reduction in benefits. The Three-Tier SSFRA design merely bends the “money’s worth” curve back toward its historical shape, before differences in longevity among income levels became so significant.

We emphasize that this design alone would not resolve Social Security’s 75-year deficit, nor achieve sustainable solvency, but hopefully this proposal will begin a conversation on how to achieve these goals sooner than later.

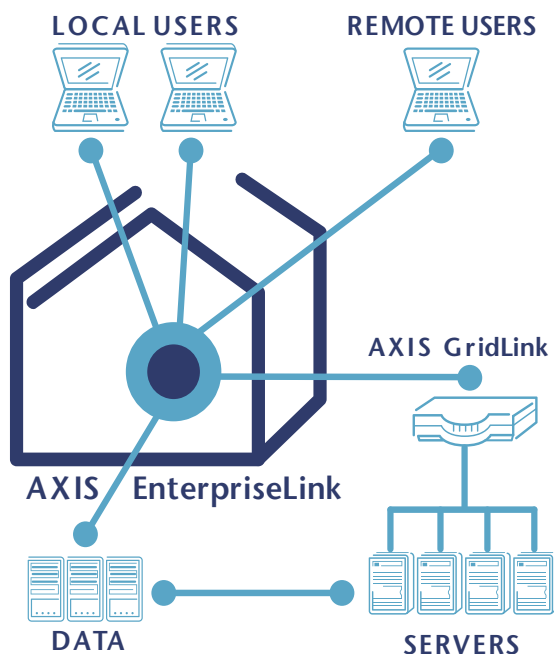
Tim Geddes
Robert J. Rietz

go on to live longer lives.

It is true that on a macro level we are living longer, and that increase in longevity does support an increase in SSRAs, but such bold differentiation in the program SSRAs as proposed by the authors may not be a wise approach. I agree that we need to protect those individuals that are not able to work to an increased SSRA and thus would suffer a reduction in benefits upon early commencement that would be critical to their well-being. A minimum benefit level of some manner could accomplish this goal without having to categorize our population based on anticipated life expectancy purely as a function of benefit levels.



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In Defense of Simplicity

The problem with health insurance complexity—and how to solve it

INSURANCE HAS BEEN PART OF HUMAN SOCIETY since the beginning of civilization. Ancient Mediterranean sailing merchants would secure loans that would be repaid only if an overseas shipment was received. The Greeks and Romans created benevolent societies that would care for the family of a deceased member. Today, insurance policies provide financial protection against a wide range of unforeseen or untimely events, including unexpected death, automobile accidents, and property damage.

Whether in the ancient or more modern forms of insurance, these arrangements have made modest attempts to change individual behavior that could affect the cost of risk for the coverage—including higher premiums for smoking, poor driving, or engaging in risky pastimes. In these cases, the financial impacts of such behaviors are well understood at the inception of the coverage and are reflected in the premium charged.

Unlike the past and current uses of other insurance products, the benefit structures of health insurance have become increasingly ambitious. Health insurance is now designed to change the behavior of consumers and providers with a wide variety of complex benefit features and compensation mechanisms that are designed to encourage more efficient choices in the provision of health services. In response to this trend, this article will discuss some of the many plan design and compensation features that use economic incentives to change consumer and provider behavior and then highlight the most significant shortcomings and costs for these complex approaches.

The article will conclude by suggesting alternative approaches that carefully consider the costs of these complex approaches in developing strategies that are simple and that consider nonmonetary rewards.

Complexity for Consumers

Unlike most other insurance arrangements where the premium is based on past or current behavior—for example, if you smoke, you will pay more for life insurance—a major goal of health insurance plan designs is to drive significant change in how members access and purchase health services. The benefit provisions supporting these purchase

services, maximum out-of-pocket, six-tier prescription drug plans, co-pay per hospital stay, limits on the number of visits, prior authorization requirements, maximum allowable charges, health reimbursement accounts, health saving accounts, medical savings accounts, flexible savings accounts, and rewards for lifestyle choices and other behavior conducive to good health. In other benefit programs described as “value-based insurance design” (VBID), the products are designed to provide economic incentives to use the most appropriate type of care unique to individuals and where they are in their disease state. For example, the cost sharing for a particularly effective service will be lower than for other services.

In addition to plan design complexity, an individual could also have the opportunity to purchase a significant number of products and benefits options across different metallic tiers (bronze, silver, gold, and platinum) on the Affordable Care Act (ACA) exchanges or within an employer group.

The plan design complexity and large number of available plan options has led, in many cases, to overwhelmed and confused consumers who are making poor insurance choices. A recent article in the *Journal of the American Medical Association* cited two research studies that highlighted many of these challenges:¹

- A 2013 survey of 202 insured U.S. adults found that only 14 percent could answer four simple multiple-choice questions regarding the definition of cost-sharing features.²
- Sixty-one percent of employees chose plans for which no level or pattern of their health care spending could justify their choice. These mistakes led to



or care changes are numerous: reduce usage at an emergency room, increase in-network utilization of services, use generic drugs, manage costs within an account, choose a particular site of service, lose weight, adhere to a healthy diet, go to the gym, and so on.

In keeping with these goals, the list of benefit design mechanisms used to encourage these behaviors is also lengthy: deductibles, co-insurance differential between in-network and out-of-network

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- ★ Including experts' views on ways to manage longevity risk for both insurers and retirees; analyze the information used in life underwriting in light of genetic testing and the availability of certain data; and examine lessons learned from the implementation of own risk solvency assessments.

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The natural response to this information overload and fatigue is to simply disengage and hope for the best.

overspending by employees equivalent to 42 percent of the cost of their yearly insurance premiums.³

These complex benefit features that are difficult to communicate are then administered using equally complex explanation of benefits (EOBs) that can comprise lengthy documents describing the reimbursement minutiae of each covered service. In the most extreme cases, members may receive large stacks of documents explaining their benefits at the same time they are suffering through a difficult illness.

While the health insurance plan design and administration attempts to achieve laudable goals—to improve a member’s health or ensure the cost-effectiveness of purchasing a health service—the designs and associated administration could also substantially add to the difficulty in engaging with an insurance product at a time when an individual may be most in need. In addition, the rules and limits of many of these plan designs are not stand-alone features in the lives of members, but rather one of many complex arrangements that are put in place by organizations providing increasingly complicated products and features. The complications are many—the deluge of information from other health insurance products (vision and dental), retirement savings accounts, credit card bonus programs, frequent flyer miles, internet passwords, and the list goes on.

The natural response to this information overload and fatigue is to simply disengage and hope for the best as one listens to the recommendations

of providers rather than actively engaging in activities that are incented in the benefit plan. Taken in total, the added complexity of health insurance plan designs, in many cases, adds precious little to the member’s experience, health, or human flourishing and just further adds to the fatigue many people feel in engaging in the complexity of modern life.

In addition, as suggested in the value-based design literature, many of the traditional cost-sharing features provide disincentives to use more effective services and an incentive to use services that have very little value.

This complexity also needs to be considered in light of other insurance products where an event leads quickly to a simple result—an evaluation by the insurance company of its liability and then a single payment to the recipient. Whether the insurance company uses an adjustor to determine liability or a death certificate to pay a claim, the experience is much more likely to be simple and easy to understand. Even the additional complexity of disclosing a particular risky behavior produces an explicit, simple premium charge.

Complexity for Providers


The challenge of dealing with the growing complexity of health insurance does not end with consumers. Like the benefits package, payments for health services are moving increasingly toward complex payment structures that are designed to reward providers for providing better and more cost-effective care than that of the fee-for-service (FFS) system. The list of these programs is long—accountable care organizations (ACOs), episodes of

care, pay for performance, values-based reimbursement, and global capitation.

The need for this change makes sense, of course. The existing FFS structure does not provide a clear incentive to provide services in a cost-effective manner, and these new payment mechanisms attempt to correct for this problem. Like the

goals of the benefit plan designs, the goals of these programs are laudable and very much consistent with the goals of those organizations paying for health services. Health insurance companies, employers, and government payers are simply demanding transparency and greater value for their health care dollar, and these new programs strive to achieve these goals. However, the increased complexity of these programs may reduce effectiveness and may not be worth the added cost. The discussion below highlights the specific challenges that inadequately prepared providers could face with complex provider payment programs:

- Provider payment programs that make providers **financially liable for the total cost of care**—including global capitation and many ACO payment programs. While these programs offer the promise that medical costs can be moderated through the provision of more cost-efficient care, they also transfer a significant amount of risk to providers that may be unable to differentiate the financial effects of cost-efficiency programs from the statistical variation that naturally occurs in any insured population. As a result, without sufficient statistical credibility in the underlying insured population they are treating or a core competency in analyzing the results, many providers are left trying to determine whether the financial results were connected to their own performance, random chance, or a program that provides inadequate funding for the medical risk accepted.



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■ **Bundled payments** for providing care within entire episode of care for a fixed amount. In the most refined programs, the episode budget will be risk adjusted for the individual patient and make allowances in the budget for potentially avoidable complications. The potential benefits of these programs have been well documented in the academic literature—providers have an incentive to manage costs within a defined continuum of care without the additional burden of managing the cost of an entire population.

The downside of these programs is a substantial increase in complexity. By moving from FFS to a bundled payment model, providers must consider the entire cost of a treatment, develop mechanisms to track and then reimburse physicians and facilities, and ensure that the overall payment is adequate. While this coordination represents a significant step forward, it also requires a degree of management and financial skill that many providers may find challenging.

■ **Quality- and efficiency-focused programs** that provide additional payment for meeting specific objective criteria (immunizations, screening, H1Ac control, well-care visits.) While intuitively appealing, the connection between the provider activities in meeting the criteria of the program and a specific financial outcome is tenuous. As a result, if a health plan is not able to tie the program results to a financial outcome, the amount of the additional payment will invariably be more limited.

In addition, a health plan has to consider the marginal change of the health care services provided resulting from such a payment program. If, for example, 60 percent of patients are already receiving a service before the introduction of a program and the program improves from 60 percent to 70 percent, then marginal advantage of the payment program is only a 10-percentage-point increase. Because

the true value of the program is the marginal change, the compensation approach must be considered in light of the marginal improvement.

In all the above payment approaches, the hoped-for change also requires providers to change their practice patterns in a market where a particular health plan could represent a small fraction of the overall revenue for a particular provider. This dilution occurs because providers have to balance the competing rules and financial programs among several difference insurance companies, as well as the Centers for Medicare and Medicaid Services, in order to identify the changes in their practice patterns with the highest potential impact. In many cases, the net effect has been little improvement across the entire universe of providers.

An Alternative Approach: Going Beyond Complex Financial Incentives

In keeping with other insurance products, I believe we need to appreciate the historical purpose of insurance products—financial protection following an unexpected or untimely event—and have some humility in our ability to influence consumers and providers. Consumers and providers have developed well-entrenched personal habits and practice patterns over time, and modest economic incentives are simply not likely to produce significant change—particularly when many other consumer-oriented organizations are already attempting to influence behavior with other financial incentives.

Beyond the limitations in changing behavior, the additional costs associated with complex solutions should be carefully considered when plan designs are developed and when payment mechanisms are created. This human empathy for basic design principles will help limit the frustration for consumers and providers trying to make reasonable decisions within an increasingly complex framework. In many cases, a simple approach with simple rules could be the most effective.

■ **Plan design simplicity.** Product development leaders should carefully consider the additional cost of complexity associated with new products that influence behavior. We should develop plan designs that have fewer cost-sharing features and a simple and easy-to-understand EOB that clearly explains a member's benefits, and we need to explicitly consider the additional cost of complexity associated with a new feature that attempts to influence member behavior. The work by the VBID advocates also provides a guide for moving forward. While we need to explicitly consider the complexity of specific plan designs, we also need to be open to highly effective economic incentives that can significantly improve the adherence to an important treatment plan.

■ **Targeting provider payment programs.** Provider payment programs should maintain the option for a fee-for-service structure for providers not equipped to handle a more sophisticated payment structure.

As we do with many programs, we often instinctively look for complex monetary incentives rather than considering nonmonetary alternatives that could produce equally positive results. The nonmonetary alternatives include everything from public recognition for a job well done or even public embarrassment for poor behavior.

These nonmonetary alternatives are not new. They are used throughout our society to produce better collective outcomes and help guide behavior toward neighbors, family, and communities. Some specific examples include awards for volunteering, recognition for contributing to a website, or a nod for simply following the rules. Ultimately, these nonmonetary actions help contribute to a community's culture and can be much more effective in producing lasting change than a small economic incentive.

As health care in the United States has become increasingly driven by financial imperatives, we have unfortunately

moved away from other solutions that could be used to improve results. For example, a payer could provide additional services or nonmonetary rewards for those members who adhere to a care management program, or publically call out a provider for abusing the FFS payment system. The Medicare FFS program, for example, routinely publishes the names of those providers who have received the highest aggregate reimbursement from the program. In many cases, this has led to disciplinary action against these providers.

Moving Forward

With more complex computing technology available, we can develop more sophisticated benefit plans and more complex payment structures for providers. With this availability, product development leaders have naturally looked to influence behavior through

incentives that have the potential to produce better results if people respond to them. Unfortunately, the designers of these approaches have not fully appreciated the negative effect that additional complexity has on people's response to the incentive. Invariably, these incentives come at an enormous cost in terms of complexity to many important stakeholders of health plans.

An alternative approach would simply acknowledge the cost of the complexity and instead look for alternatives that are simpler and could produce similar results with nonmonetary approaches

that encourage and discourage other behaviors. Lastly, instead of focusing resources on increasing complexity, health plans could focus their efforts on the core fundamentals of insurance—providing high-quality customer service, paying claims quickly and accurately, reducing the cost of health care, and organizing the delivery of health care to ensure the provision of the highest quality of care for its members. □

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Endnotes

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2. Loewenstein G, Friedman JY, McGill B, et al. "Consumers' misunderstanding of health insurance." *Journal of Health Economics*; 2013.
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Test Your Professionalism IQ

If it has been awhile since you earned your actuarial credentials—and if you enjoyed taking exams as much as I did—this article should be entertaining as well as educational. In a nod to nostalgia, I have created an older-style exam; rather than short-answer format, it consists of six multiple-choice questions and four true/false questions. You can find the answers on page 20, along with explanation as appropriate.

Note that “Code” refers to the Code of Professional Conduct, “ASOP” to actuarial standard of practice, and “USQS” to *Qualification Standards for Actuaries Issuing Statements of Actuarial Opinion in the United States, Including Continuing Education Requirements*. And Actuary (with a capital A) refers to an actuary who is a member of at least one of the five recognized U.S.-based actuarial organizations.

Multiple Choice (select one answer)

Question 1

Which of the following are considered binding guidance for actuaries who are members of at least one of the five recognized North American actuarial organizations?

1. The Code
 2. ASOPs
 3. USQS
 4. Practice notes of the American Academy of Actuaries
- A. 1 only
 B. 1 and 2
 C. 1 and 3
 D. 1, 2, and 3
 E. All

Question 2

In order to be qualified to perform a particular actuarial service, an actuary must:

1. Meet applicable qualification standards
 2. Be able to look at oneself and say “I am qualified to do this work”
 3. Be familiar with every ASOP
- Which of the above phrases completes a true statement?

- A. 1 only
 B. 2 only
 C. 1 and 2
 D. 1 and 3
 E. All

Question 3

Which of the following could be a potential material violation of the Code:

1. Refusal to disclose confidential information
 2. Understating reserves due to management pressure
 3. Intentionally failing to file personal tax returns
 4. Refusal to cooperate with a successor actuary
- A. None
 B. 1 and 2
 C. 2 and 3
 D. 2, 3, and 4
 E. All



Have you always had trouble with multiple choice?

Question 4

Which of the following are true with respect to the USQS:

1. The General Qualification Standard applies to actuaries issuing any Statement of Actuarial Opinion
2. The Specific Qualification Standard applies to actuaries issuing three specific opinions only
3. In order to meet the Specific Qualification Standard, an actuary must first meet the General Qualification Standard
4. The USQS do not apply to non-actuarial services

- A. 1 only
 B. 1 and 2
 C. 1, 2, and 3
 D. 1, 2, and 4
 E. All

Question 5

Under Precept 13 of the Code, an Actuary with “knowledge of an apparent, unresolved, material violation of the Code by another Actuary” is obligated to:

1. Discuss the situation with the other Actuary in an attempt to resolve it
2. Report the apparent violation to the ABCD whether resolved or not
3. Report the apparent violation even if such action would be contrary to Law

- A. None
 B. 1 only
 C. 1 and 2
 D. 2 and 3
 E. All

Question 6

ASOP No. 41, *Actuarial Communications*, along with Precept 4 of the Code, is one standard that will apply to virtually all actuarial services. “Section 4. Communications and Disclosures” in ASOP No. 41 contains four subsections: 4.1 discusses the disclosures that should be in any actuarial communication; section

4.2 discusses “Certain Assumptions or Methods Prescribed by Law”; section 4.3 is “Responsibility for Assumptions and Methods”; and section 4.4 covers “Deviation from the Guidance of an ASOP.” The Actuarial Standards Board has brought consistency to the format of ASOPs, including a “Communications and Disclosures” section in each ASOP. The “Communications and Disclosures” sections in other ASOPs, in addition to providing guidance specific to that ASOP, refer the Actuary to ASOP No. 41 Section 4, including specific reference to sections 4.2, 4.3, and 4.4 described above. Concerning these three sections, which of the following statements are true?

1. Section 4.2 requires, where assumptions are set by law, that the

actuary estimate the impact of using assumptions he or she believes are reasonable, if practicable

2. Section 4.3 describes what must be disclosed, where in situations other than described in section 4.2, the actuary states reliance on other sources for assumptions and/or methods
3. Section 4.4 describes how an actuary can comply with a particular ASOP, even where, in the actuary’s professional judgment, the actuary has deviated materially from the guidance in that ASOP

- A. 2 only
 B. 2 and 3
 C. 1 and 2
 D. 1 and 3
 E. All

True or False

(Select one answer—note there is one trick question!)

Question 7

Actuaries who designate themselves as “retired” in the actuarial directory may perform actuarial services, including issuing statements of actuarial opinion, on occasion without meeting the continuing education requirements of the USQS, as long as they meet all other requirements, met the continuing education requirements when they were working full time, and currently qualify for dues waivers based on age.

- True
 False

Question 8

Enrolled Actuaries are bound by the Code.

- True
 False

Question 9

Discussion papers issued by the Academy’s Council on Professionalism provide useful guidance but are not binding upon actuaries.

- True
 False

Question 10

An actuary in a senior management position who is no longer providing “actuarial services” (as defined in the Code) is not bound by the Code.

- True
 False

Answers and notes appear on page 20 →

Answers

- 1. D
- 2. C
- 3. D
- 4. E
- 5. A
- 6. B
- 7. F
- 8. “It depends” (trick question)
- 9. T
- 10. F

Notes

- **Question 1:** All are binding guidance except practice notes. Practice notes provide useful information, but an Actuary is not obligated to follow any practices that may be described in them.
- **Question 2:** Refer to Precept 2 of the Code. Note that II is what we refer to sometimes as the “Look in the Mirror Test.” Familiarity with every ASOP might be admirable, but I would be hard-pressed to come up with a situation in which it would be required.
- **Question 3:** All but I have the potential to be a violation. Note that with respect to I, Precept 3 of the Code states: “The Actuary

shall disclose such violation ... except where the disclosure would be contrary to Law or would divulge Confidential Information.” III, while perhaps not actuarial services per se, could violate Precept 1, Professional Integrity, which has broader applicability than Precepts applying only to “actuarial services.”

- **Question 4:** All statements are true, which should be clear from a careful reading of the USQS.
- **Question 5:** All statements are false. Note that an Actuary is encouraged to discuss apparent violations with the other Actuary, but not required to do so. If the issue is resolved, there is no need to report, and finally Precept 13 states disclosure should not be made where such action would be contrary to Law (just as with confidential information, as discussed above).
- **Question 6:** This question presents a lot of information on an important topic. Note that II and III are correct, as they state correctly what must be disclosed when an actuary relies on methods or assumptions he or she is not taking responsibility for and what an actuary must do in case of deviation from the guidance of an ASOP. Statement I is false, as there is

no such requirement where an assumption is determined by law.

- **Question 7:** This is false because retirement status and age have no bearing on being qualified to perform actuarial services and issue statements of actuarial opinion.
- **Question 8:** This is the trick question! If the enrolled actuary is also a member of any of the five U.S.-based actuarial organizations that have adopted the Code of Professional Conduct, then the answer is true. Otherwise, false—the enrolled actuary would be bound only by the federal regulations of the Joint Board for the Enrollment of Actuaries, which do include standards of performance and eligibility requirements to perform actuarial services under ERISA.
- **Question 9:** True; discussion papers, while very useful, are not considered binding guidance.
- **Question 10:** False, as Precept 1 always applies.

ALLAN RYAN is a member of the Actuarial Board for Counseling and Discipline.

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Building a better
working world

Editor's note: This is the second in a four-part series on the key elements of the professionalism infrastructure of the U.S. actuarial profession. The first in the series covered the Code of Professional Conduct.

The Academy and the Web of Professionalism Part 2: Qualification Standards

WHEN I WAS A CHILD IN MIDDLE TENNESSEE, boys' hairstyles were simple, with just three choices: short, shorter, or a "flattop" (which was pretty short). Haircuts weren't very expensive, but you needed one every few weeks. The cost could add up.

Dad decided we could save some money if he cut my hair, so one day he bought an electric hair clipper. He read the manual, checked all of the accessories and adjustments, and set me in a kitchen chair for my first home haircut. Dad turned on the clipper, and took his first swipe with it—cutting an almost bald streak all of the way from the front of my head to the back, just slightly off-center.

Had the furrow been centered, it might have been the world's first reverse mohawk—but it wasn't. It was just wrong. And Mom noticed. It was decided that Dad would take me to a barber to see if it could be fixed.

That wasn't a comfortable thing for him to do. It was obvious that my dad had been trying to avoid paying for a haircut. But, the local barber seemed amused. He

fixed the problem as best he could, which involved removing quite a bit of my remaining hair.

Why did Mom insist that I be taken to a real barber, duly credentialed by the great state of Tennessee? Because having seen the alternative, she wanted to be sure my hair was cut right.

Like most homeowners, my wife Sally and I sometimes need home repairs and improvements. Before hiring anyone, we talk to neighbors, look at online reviews, and check references. For jobs that don't require any special skill, such as cleaning gutters, we'll hire anyone with a good reputation. But we hire only licensed plumbers and electricians. Why? Because water that isn't where it's supposed to be can cause thousands of dollars of damage; electricity that isn't where it's supposed to be can kill you.

When getting something done right is important—whether it be cutting a boy's hair or wiring a house—competence matters. Credentialing, certification, licensure—these are all ways of protecting the public by ensuring a minimum level of competence. The goal is to make sure that important jobs are done correctly. This isn't just a technical requirement. Professionals have an ethical responsibility to agree to take on work only when they are competent to do it correctly.

How do I know whether I'm competent to do a particular type of actuarial work? By looking at the *U.S. Qualification Standards* (USQS). The USQS provide us with the guidance we need to meet our ethical obligation to practice competently and responsibly. The purpose of the qualification standards is not to make folks jump through arbitrary hoops, but to ensure that actuaries practicing in the United States are competent at what they do. Protecting the public in this way is



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one of the central reasons the Academy was founded.

This is the second in a series of articles exploring the key elements of our professionalism infrastructure and the deep connections among them. This article will discuss our professional obligation to practice in a competent manner, how that obligation is expressed in Precept 2 of the *Code of Professional Conduct*, and the role the *U.S. Qualification Standards* play in helping us meet that obligation.

Accreditation and the Search for Recognition of the Profession

Prior to the Academy's founding in 1965, there were *no* standards that an actuary had to meet in order to practice in the United States. As one regulator put it at the time, "Our laws today demand no more proof of the actuary's competence than did the laws of ancient Rome."¹ Instead of waiting for a crisis that would result in heavy-handed standards and requirements being imposed on actuaries by the government, visionary leaders recognized the need to create a self-regulating profession that could earn recognition by legislators and regulators. These visionaries knew we had to build a profession that would ensure that practicing actuaries were both competent and committed to serving the public. They had the insight to recognize that such a profession could be built on a flexible, self-regulating system, rather than on a rigid system of prescriptive government regulations. And they had the initiative to make it happen. Rather than waiting for government to impose the types of standards and institutions that other professions use to protect the public, they decided we should do it ourselves—and created an independent body, the Academy, for that purpose.

The creation of the Academy was the first step in a long journey toward our current qualification standards in the United States. The Academy established "competence" as a bedrock membership requirement in its first set of bylaws. In 1965, the year of the Academy's founding, the Academy's Board of Directors issued *Guides to Professional Conduct*, which stated: "The member will bear in mind that the actuary acts as an expert when he gives actuarial advice, and he will give such advice only when he is qualified to do so." The next year, in 1966, the National Association of Insurance Commissioners (NAIC) adopted a resolution supporting recognized standards of actuarial competence and conduct and urged the commissioners to support the Academy's efforts to gain official recognition. Indiana was the first to do so in 1968. By 1975, 17 states had recognized Academy membership as qualification for signing life and health insurance annual statements; 15 had done so for public employee retirement systems.

In 1981, the Academy Board adopted *Qualification Standards to Sign Statements of Actuarial Opinion on NAIC Annual Statement Blanks* (for "Life, Accident, and Health" and "Fire and Casualty"), addressing education and experience requirements. In 1982, the Academy created the Committee on Qualifications (COQ), consolidating the previous committees in order to consider qualifications across practice areas. The current committee is composed of highly regarded practitioners in each of the profession's traditional practice areas—casualty, health, life, and pension.

The Current Qualification Standards Take Shape

In June 1989, modern U.S. actuarial qualification standards began to take shape

when the Academy Board adopted the recommendations from the COQ that suggested restructuring the qualification standards to create a "General Qualification Standard." This General Standard would apply to Public Statements of Actuarial Opinion (PSAOs) for which a Specific Qualification Standard had not yet been developed. At that time, three Specific Qualification Standards existed for the NAIC Life, Health, and Casualty annual statements.

Two years later, in 1991, the Academy Board adopted the newly structured *Qualification Standards for Public Statements of Actuarial Opinion*, incorporating continuing education requirements for the first time. While the scope of the 1991 qualification standard was broad, it remained limited in this sense: The qualification standard did not apply to all statements of actuarial opinion (SAOs) but only to those issued for purposes of compliance with (i) law or regulation; (ii) an actuarial standard of practice (the Actuarial Standards Board was established in 1988); or (iii) standards promulgated by certain accounting standard-setting bodies.

Strengthening the Web: The 2008 Qualification Standards

When the current *Code of Professional Conduct* took effect on Jan. 1, 2001, it included a qualifications mandate that echoes the requirement of the 1965 *Guides to Professional Conduct*. Precept 2 of the Code states: "An Actuary shall perform Actuarial Services only when the Actuary is qualified to do so on the basis of basic and continuing education and experience, and only when the Actuary satisfies applicable qualification standards."

Within a few years after the adoption of the 2001 Code of Conduct, the COQ

moved to better align the 2001 qualification standards, which applied only to PSAOs, and the iron-clad requirement of professional qualification set out in Precept 2 of the Code, which applies to all actuarial services. These developments culminated in a watershed event in the evolution of actuarial qualification standards when, in 2008, after a five-year effort by the COQ that included several opportunities for the profession to comment, the Academy Board adopted a revision to the *Qualification Standards for Actuaries Issuing Statements of Actuarial Opinion in the United States*.

The 2008 USQS revisions represented a true milestone in U.S. actuarial professionalism because they expanded the profession's commitment to robust professional qualifications that the public can rely upon: The USQS broadened the definition of a Statement of Actuarial Opinion (SAO) to an opinion expressed by an actuary in the course of performing actuarial services and intended by that actuary to be relied upon by the person or organization to which the opinion is addressed. This was a significant expansion of the USQS from applicability to PSAOs to all SAOs.

Qualifications and the Real World

The 2008 USQS recognize that “qualification” is not an abstract concept—I am qualified (or not qualified) with respect to a specific set of actuarial services or area of practice. In the U.S. actuarial profession, qualification and competence have long required a minimum level of technical skill; practical real-world experience; familiarity with all the laws, regulations, and standards of practice that apply; and up-to-date knowledge of new techniques, rules, and market developments. These elements are not arbitrary, but simply reflect what is needed for any actuary to be able to serve the



public in a competent manner.

Because the goal of the standards is to ensure that the public can rely on the work done by actuaries, the standards are written to focus on the final results that we present. The technical term “Statement of Actuarial Opinion” is used for this; some might misunderstand this term to be limited to a formal statement filed with a regulator—nothing could be further from the truth. A simple rule of thumb is that if I perform work that someone else relies on *because I am an actuary*, then the USQS likely apply.

It is also important to note that once we get beyond basic education, each of these elements is dependent on the specific jurisdiction in which we provide actuarial services. Laws, regulations, and markets vary from country to country. I cannot assume that I am qualified to practice in China, for instance, simply because I am qualified to do health work here in the United States.²

It is worth noting that the profession is mature and highly specialized in the United States. Our qualification standards reflect this and focus on the specific type of work done by each actuary. This approach is more sophisticated than is common in the rest of the world.

Meeting Our Responsibilities to the Public

Why are qualifications important? Because the work we do is important—it

affects people's lives. *Qualifications* matter because *competence* matters. The distinguishing mark of actuaries as professionals is that we recognize an ethical responsibility not just to our employers and clients, but to everyone who relies on the work we do. Competence is part of that responsibility.

The USQS are a vital tool in meeting our professional obligations. They help us understand what services we are competent to provide, and when we can responsibly offer actuarial advice. Being qualified is a key requirement of the *Code of Professional Conduct*; it is also an ethical imperative. By defining what competence, or qualification, means, the USQS help us meet our responsibilities to the public—individually and as a profession. Just as the Code creates the foundation we need to build a culture of professionalism, the USQS provide the framework we need to build a culture of competence.

Over its 50-year history, the Academy has developed our actuarial qualification standards from inchoate concepts to robust, objective, and officially recognized standards of professional competence. By doing so, the Academy has ensured continued respect for, and the well-earned favorable reputation of, actuaries—and it has played an important role in strengthening the web of professionalism. □

TOM WILDSMITH is president of the American Academy of Actuaries.

Endnotes

1. “Address by Henry Root Stern, Jr.,” *Transactions of the Society of Actuaries*, 1965, Vol. 17, Pt. 1, No. 47AB, p. 74.
2. For more on this subject, see *Considerations of Professional Standards in International Practice*, a discussion paper release earlier this year by the Academy's Committee on Professional Responsibility.



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Election 2016—Breaking Down the Positions

EVERY FOUR YEARS, millions of Americans head to the polls to cast a vote for president of the United States. Before that auspicious day, though, voters and nonvoters alike are subjected to months of debate, horse-race polling, character attacks, and rare moments of true inspiration that allow each of us to decide on the best candidate to represent us.

Every cycle is unique, but 2016 has been particularly interesting—we’ve seen everything from email leaks and hacks and promises to build a wall at the Mexican border, to divisions within both the Republican and Democratic parties and threats against the first and second amendments. Often missing from the headlines, though, are actual policy debates and proposals.

With the end of the Republican and Democratic national conventions, the American populace now has its primary candidates: Donald J. Trump, a businessman whose anger and willingness to say whatever he thinks has resonated with many voters, and Hillary Clinton, a politician and policy wonk who stands as the first female nominee of a major political party. Having accepted their respective parties’ nominations, Trump and Clinton now head into the final months of campaigning—using all available resources to differentiate their policy positions from those of their opponent in the hopes of gaining a few more votes.

This article will focus on outlining each candidate’s stance on several key policy issues of interest to the actuarial profession. To the extent that one of the candidates may not have specific policy proposals on any of these key issues, this article will supplement with information based on public statements made by the candidate and/or information



presented in the two party platforms, which may not fully comport with an individual candidate’s positions.

Wall Street Reform

Both candidates have been fairly vocal about their opposing viewpoints on Wall Street reform, specifically in reference to the Wall Street Reform and Consumer Protection Act (often referred to as Dodd-Frank). Trump has announced his plans to significantly scale back or repeal Dodd-Frank, some of the most significant financial regulatory changes since the Great Depression, arguing that if banks aren’t lending money to individuals and/or small businesses, then the economy suffers in terms of growth. He has consistently blamed federal regulation for the country’s slow recovery from the 2008 financial crisis.

In addition, Trump has expressed support for imposing tighter congressional

oversight of the Federal Reserve Bank (the Fed), supporting legislation introduced by Sen. Paul Rand that would essentially provide an audit of the Fed, and potentially taxing hedge-fund managers’ “carried interest” as income rather than capital gains, recognizing that they should not be able to have their income taxed at rates capped at around 23.8 percent.

While Trump wants to eliminate Dodd-Frank, Clinton wants to extend it to encompass larger insurance companies and hedge funds. She has explicitly stated that she would veto any legislation that would weaken the law. Her proposal includes levying a graduated risk fee on banks with more than \$50 billion in assets, encouraging regulators to impose higher capital requirements as necessary, and closing the Volcker Rule’s hedge fund loophole that allows firms to invest up to 3 percent of their capital in hedge funds that can make risky investments.

The GOP has generally not favored breaking up big banks, and Trump has demurred when asked, but Clinton has noted that she will use the authority in Dodd-Frank to do so if they pose a systemic risk to the financial system. In addition, Clinton has indicated plans to strengthen the Financial Stability Oversight Council (FSOC), impose strong global capital requirements, increase transparency in the financial system, tax carried interest as ordinary income (similar to Trump’s proposal), and ban private bankers from the boards of the 12 Fed banks.

Tax Reform

Comprehensive tax reform is a cornerstone of Republican policy. In one of the



most detailed of his policy positions, Trump has outlined his proposal for tax reform, including a reduction from the current seven tax brackets to four (at 0, 10, 20, and 25 percent), with no income tax for individuals who earn less than \$25,000 and joint filers who earn less than \$50,000. Through further changes in the tax code, he would eliminate the marriage penalty and the alternative minimum tax, no business would have to pay more than 15 percent of their income in taxes, and there would be no more estate tax.

On his website, Trump also provides some detail on how he would plan to pay for these tax cuts, including reducing or eliminating certain tax deductions/loopholes (e.g., phasing out the tax exemption on life insurance interest for high-income earners), a one-time 10 percent repatriation fee for corporations holding cash overseas, and ending the deferral of taxes on corporate income earned overseas.

Clinton has outlined several general proposals for reforming the tax code. She has indicated plans to implement a 4 percent “fair-share surcharge” on individuals making more than \$5 million per year and supports a 30 percent minimum rate for individuals making more than \$1 million per year (also referred to as the Buffett rule, a proposal made during the Obama administration). In addition, she has proposed tax relief for a variety of individuals (i.e., caregivers) and small businesses (i.e., employers with one to five employees), and she has proposed an exit tax on businesses leaving the United States, as well as incentives to reward businesses that remain in the United States.

Health Care

Health care reform remains one of the most debated domestic policy issues in the campaign. Trump and Clinton have

taken opposing views of the Affordable Care Act (ACA), with Trump supporting repeal and Clinton supporting potential expansions. But health care reform isn't only about coverage, meaning both candidates will have to eventually offer more detail around their individual plans to address the growth in health care costs, as well as mental health and long-term care reform.

As noted, Trump has consistently indicated that repealing the Affordable Care Act will be a day-one priority for his administration. He favors implementing some reforms to replace the current law, including allowing the sale of insurance across state lines, allowing individuals tax deductions for their health insurance premiums, encouraging the use of health savings accounts and health reimbursement accounts, requiring price transparency, and removing barriers to allow importation of safe prescription drugs. According to analysis from the Center for Health and Economy, repealing the ACA would likely result in an increase in the uninsured population of approximately 18 million people, although the study also notes that his plan could also lower premiums for some individuals.

Clinton is probably best known for her commitment to health care issues, specifically for expanding affordable health care options for low-income and vulnerable populations. She has reiterated her plan to retain the ACA and would, in fact, expand the program by considering the implementation of a public option. Furthermore, she has proposed incentivizing states to expand Medicaid—to date there are still 19 states that have not expanded Medicaid under the ACA.

Clinton has some specific thoughts about addressing long-term care, specifically the caregiving aspect. Clinton is a strong proponent of supporting

individuals who serve as caregivers for elderly family members and has proposed a 20 percent tax credit to offset \$6,000 in caregiving costs (up to \$1,200 in tax relief per year).

Medicare and Medicaid are also key components of any discussion of health care policy. Trump has not provided specific plans for Medicare; however, the GOP platform calls for no changes to the program for anyone over age 55. For those under age 55, the GOP's platform would provide individuals an option of the traditional Medicare program or the ability to transition into a premium support program that would provide individuals with an income-adjusted government contribution they could put toward a plan of their choice. Furthermore, the GOP platform indicates an interest in reevaluating the eligibility age for Medicare to bring it in line with increasing lifespans.

In terms of Medicaid, Trump has indicated his support for a block grant approach, essentially providing states with a specified amount of money that they can decide how to use. States could use their annual federal allotment to provide benefits for their low-income populations with the understanding that any benefits provided above the allotment would be paid for by the state.

Clinton, who has been a vocal advocate for strengthening Medicare as well as expanding health care reform, offers a different approach for Medicare. She has advocated a “Medicare for More” program that would allow individuals over the age of 55 to buy into Medicare, the details of which have yet to be fleshed out. Furthermore, she has endorsed payment reform by encouraging bundled payments initiatives and delivery system reforms. She also advocates looking for opportunities to drive down prescription drug costs for seniors.

Social Security

According to Trump's campaign website, "The key to preserving Social Security is to have an economy that is robust and growing." He then lists his proposals for accomplishing a robust economy, including comprehensive tax reform, renegotiation of trade deals, repealing Dodd-Frank and the ACA, and immigration reform. The GOP platform also has few specifics beyond opposing any tax increases to shore up Social Security. Historically, Republicans have supported privatizing Social Security and raising the retirement age.

For Clinton, her plans for Social Security fit into three key proposals: 1) expand Social Security for women who are widows and/or caregivers; 2) oppose an increase in the retirement age, any attempts to privatize the program, and/or

any reduction in the annual cost-of-living adjustment; and 3) increase taxes on high-income earners (over \$250,000) to pay for any expansion.

It will be interesting to see whether either candidate provides any more detail about potential proposals in the coming months to provide incentives to encourage individuals to save for retirement—a key issue for the actuarial profession (see sidebar for Academy publications that address the need for lifetime income).

Climate Change

Despite polling that indicates 73 percent of Americans believe that climate change is real—up from 66 percent two years ago—with the steepest increase among Republicans, Trump has referred to global warming as a "hoax." He has

indicated that he would renegotiate the Paris Agreement, a climate agreement adopted by 195 nations, and roll back the Obama administration's regulations to limit greenhouse emissions. Beyond that, his plans regarding climate change have been vague. The GOP platform has been somewhat more explicit, calling for a rejection of the Kyoto Protocol and the Paris Agreement and the cessation of funding for the United Nations Framework Convention on Climate Change. The party favors solving environmental concerns through incentives for the development of new technologies rather than the imposition of extensive regulatory requirements.

Clinton, on the other hand, has generally favored maintaining the current course of action on climate change. She has indicated plans to deliver on the

2016 Election Guides: 'Making Issues Count'

The Academy's 2016 election guides focus on several major issues to help voters become better informed in the run-up to the 2016 election. The guides, available at election2016.actuary.org, provide high-level descriptions of major public policy programs such as Social Security and Medicare, as well as various options for reform. The Academy has raised these issues because of their importance to voters and the well-being of the nation.

Health care policy is consistently at the top of the domestic policy agenda and often a major topic of debate during election years, and 2016 is no different. From measured improvements to more significant repeal-and-replace strategies for the Affordable Care Act, as well as

approaches to mitigate health care spending growth and improve quality, candidates are hinting at a variety of proposals to modify the current "Obamacare" system.

The Academy's Health Practice Council has identified three keys to a sustainable health care

system: For insurance markets to be viable, they must attract a broad cross section of risks; market competition requires a level playing field; and for long-term sustainability, health spending growth must be reduced.

The most recent additions to the guides outline what a single-payer system would look like; high-performance networks; and the Medicare buy-in option. Another guide considers the growing issue of long-term care, including financing and insurance.

The Medicare program has played a vital role in providing health care benefits to nearly all Americans age 65 and older. Last year, 55 million Americans had Medicare coverage, but the program faces long-term sustainability challenges as the baby boomer population ages into the program in the next few decades. The guides consider the implications of revising Medicare's traditional benefit design, premium support, buy-in option, and more.

promises made during the Paris climate conference, including reducing greenhouse gas emissions by up to 30 percent by 2025 and 80 percent by 2050. She has proposed a \$60 billion “Clean Energy Challenge” that would allow the administration to partner with states, cities, and communities to reduce carbon pollution and expand clean energy resources. Specifically, the Democratic Party platform has expressed a commitment to getting “50 percent of our electricity from clean energy sources within a decade.”

The Road to Election Day

It’s still a long time to November. Each day brings new opportunities for Trump and Clinton to highlight their policy positions on key issues and/or struggle with the political minefields that litter the

campaign trail. A current (as of this writing) national CNN/ORC poll has Clinton leading Trump 52 percent to 43 percent, in large part because of recent divisions between Trump and some top Republican leaders, but those numbers change daily. Consider this—the race was considered neck and neck coming out of the conventions.

The horse-race polling will continue up until the election, but we can only hope that the candidates will pivot to policy sometime in the coming weeks and do their best to ensure an informed electorate shows up on Nov. 8 as we elect the 45th president of the United States. □

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Social Security is the most significant public program for retirement security in the United States, and more than 90 percent of Americans over age 65 receive benefits from the program. This year, the program is providing benefits to more than 60 million retirees, survivors, disabled workers, and dependents.

The Academy’s Election Guides look at options to provide adequate long-term financing for Social Security, including potential revenue increases, benefit cuts,

or some combination of the two; how raising the retirement age would address the program’s challenges; whether payroll taxes should be raised; and whether any proposed changes to Social Security would disproportionately affect women.

Another Election Guide considers lifetime income issues, including altering federal retirement policies, highlighting the importance of financial literacy and education, and encouraging flexibility

in retirement plans, to facilitate greater use of lifetime income options.

Many Americans have keenly felt the effects of extreme climatic events, including droughts and wildfires in the West, higher rainfall and snowfall in the East, and significant damage from tornadoes, hurricanes, and floods across the country.

While climate scientists continue to

refine their models, most data show record-breaking warm temperatures in many parts of the world in the past several years. While acknowledging the public debate on climate risk has often been contentious, the Academy encourages the public to inform itself with objective information and data to more fully engage in the debate, with an overview of climate-risk issues.

The Academy is committed to highlighting these important issues as Americans prepare to cast their ballots in this pivotal election year.



in the **RED**

*Awareness of concussions
and their aftermath is on
the rise—and nowhere is this
more true than in the NFL*

By Michael G. Malloy

Concussions are nothing new in sports, but widespread attention and concern about them have jumped in the past few years, to the point where concern has become front and center across just about all sports, at every level. While most attention has been focused on the National Football League, concussions and their related concerns are prevalent across all sports, men's and women's alike, from the NFL to hockey, basketball, and soccer—and both boys and girls youth sports.

Concussions in the NFL jumped 31.6 percent to 271 recorded in the 2015 season, from 206 in the 2014 season, according to the league's official figures. Most occurred in games, accounting for 234, or 86.3 percent of the total, with another 37 in practices, including preseason. But just eight happened during in-season practices, as the NFL limits full-contact practice with pads to 14 per year.

The movie *Concussion*, released in late 2015, fictionalizes the discovery of what is now known as chronic traumatic encephalopathy (CTE) by Dr. Bennet Omalu—played by actor Will Smith—who was a neuropathologist based in Pittsburgh. While documenting tension between the powerful pro league and Omalu over his work in the cause and effect of players with brain disease, the film's end credits note a statistic from an actuarial study prepared for the NFL that 28 percent of all pro football players will suffer from some form of serious cognitive impairment, including CTE, over the course of their lives.

ZONE

ISTOCK / PAUL PHILPOTT

| Age Group | Segal Model Results—Prevalence of Alzheimer's and Dementia in Participating Player Population | Epidemiology on General Population |
|--------------|---|------------------------------------|
| less than 50 | 0.8% | <0.1% |
| 50-54 | 1.4% | <0.1% |
| 55-59 | 2.3% | <0.1% |
| 60-64 | 3.5% | <0.1% - 1.3% |
| 65-69 | 5.2% | <0.1% - 2.1% |
| 70-74 | 7.8% | 2.8% - 3.7% |
| 75-79 | 12.1% | 4.9% - 6.8% |
| 80-84 | 22.2% | 12.3% - 13.0% |
| 85-89 | 58.2% | 20.3% - 21.6% |
| 90+ | n/a | 38.5% - 45.2% |

*Source: Report of the Segal Group to Special Master Perry Golkin
In re: National Football League Players' Concussion Injury Litigation, MDL 2323*

This year, just several months after the movie's release, the NFL's executive vice president for health and safety, Jeff Miller, stated to a congressional roundtable that there was a connection between football and CTE, even though the league has in recent years modified its playing rules to sharply reduce contact to players' heads and necks, in addition to its longstanding prohibitions against helmet-to-helmet contact, which routinely draw penalties and often fines and suspensions as well.

Thomas Rhodes, vice president and actuarial director with MIB Group in New York, said he finds the NFL's ongoing concussion controversy "quite disturbing, especially with the scientific evidence of concussion on pro football players," and that the issue involves open-ended questions as well as implications for long-term care for CTE and the ability of life insurance underwriting to detect it.

"When I look at concussions from an actuarial view, it's based on my current experience at MIB. I also look at it in terms of the studies that we do on structured settlements," he said. "The NFL viewed this as more of a threat to their income."

In a typical structured settlement, payments are structured for treatment either immediately or in the future, as opposed to an annuity that makes level payments over a period of time, Rhodes said, adding that with CTE there could be less of an immediate financial effect, with more monetary costs for treatment later.

Structured settlements are based on the facts of a given case, he explained. For example, they are often set from a court case due to the result of an injury, such as a car accident, which could require future surgeries and/or ongoing treatment.

Concussion and CTE's First Diagnosis

Much of *Concussion* focused on the case of Mike Webster, the Pittsburgh Steelers center whose case—and subsequent death at age 50—prompted Omalu's discovery of CTE. While the cause of Webster's death was never officially released publicly, Omalu's work on his brain tissue helped inform his diagnosis of the degenerative brain disease. Webster, who won four Super Bowls with the Steelers during his 16-year Hall of Fame career, "was fine for a number of years, but then he deteriorated," Rhodes said, noting that such cases can involve situations in which a patient runs out of money and could need more in the future.

Because CTE is not diagnosable until a person has died and their brain tissue can be examined, Rhodes said it would be

unlikely for an underwriter to find medical evidence that would reflect it. "But my suspicion is that it depends on the severity and frequency and number of concussions that people have had throughout their life and it seems to be cumulative over time," he said. "The more extreme effects of concussion, such as CTE ... more or less fits within the central nervous system, and although the effects aren't immediately as severe, they grew over time, so it fits within that medical impairment."

Rhodes, who himself played football in high school, recalled that he was once knocked out during a practice after being hit in the head, though just one time. But in the NFL, "These are big men doing constant collisions which are much more violent, and much more frequent," he said. "So I can see how the effects on the central nervous system would tend to get worse over time for professional football players. Repetition [of injuries] is obviously an important factor."

MIB's impairment codes, which are widely used in individual life underwriting, provide medical impairment information along the dimensions of the bodily system affected, "such as the brain and central nervous system, or the heart and circulatory system," Rhodes said.

The severity of any injury or impairment is important, as is the duration of its effect, he said, using the example of a car accident in which someone is severely injured immediately, but over time the effects could be less pronounced. Conversely, a condition like diabetes has less of an immediate effect but generally has a more severe effect as it worsens in the long term.

Rhodes noted that the NFL's actuarial study—undertaken by the Segal Group and since publicly released—used information on existing players, constructing a model of the prevalence of Alzheimer's and dementia. Its figures showed that players under age 50 had a 0.8 percent prevalence of those conditions, while ages 50 to 54 were 1.4 percent, and 55 to 59 were 2.3 percent. The general population epidemiology prevalence, by contrast, was less than 0.1 percent for those age groups, while above age 60 the NFL's numbers rose dramatically compared with the general population (see chart, above).

CTE is "not something that would appear in your typical life insurance underwriting, and it seems related that the number of concussions that you've had would tend to increase the probability of it occurring," Rhodes said.

Another actuary noted some of the potential health and liability concerns of concussions. "Everybody's been put on a heightened alert to treating this," said John Governale, president of Actuarial Health Solutions in Maple Glen, Pa. "Certainly, when [players] get symptoms, there are costs. ... The question is, who should be responsible for that, and how far into the future?"

"Certainly, eliminating thousands of hits to the head would help ... with players competing at such a high level for such high stakes," Governale said. "We're talking about the best of the best—well beyond Pop Warner."

NFL and Players' Union Views

For its part, Segal Group said that in connection with the *original* proposed settlement, which contemplated a *capped* fund for monetary awards and claims and expenses, it believed that

based on reasonable assumptions over the 65-year life of the proposed settlement that it had a “very low probability” of exceeding \$760 million [emphasis in original].

Because the purpose of the exercise was to test whether the eventual \$765 million capped-settlement fund would be sufficient to pay all conceivably possible claims, its methodology was purposely designed to err on the side of overestimating possible injuries to ensure that adequate funds would be available to pay all awards, Segal Group said in a written response to *Contingencies* questions.

“There is no simple way to explain what we did, which was inherently complex, since it involves a 65-year projection of a group of maladies for which there is limited incidence data for both the general population and the former player population,” the company said. “The rates of incidence, the timing of

presentation, the severity of onset, and the progression of the neurological conditions all influence the results,” under which it used actuarial tools and techniques in “careful coordination with leading medical experts and epidemiologists to produce our results.”

The NFL Players Association (NFLPA) declined to comment for this article, but NFLPA Executive Director DeMaurice Smith said on the “Sports Junkies,” a Washington, D.C., radio show, in late May that several changes in protocol regarding head injuries in recent years have included measuring injuries beyond a player simply missing practice or game time, and measuring increases in injuries on artificial turf, which are more prevalent than on natural grass fields.

As for the players, “What we’ve tried to do is to make sure that no player becomes bankrupt because of uncovered medical

Concussion Concerns Not Limited to Professional Leagues

Concussions are not limited to football—or men’s sports. Lauren Chase, who wrapped up a standout career with George Washington University’s women’s basketball team in March, was forced to sit out her junior year due to a concussion, one of several she suffered during her playing career at GWU and, previously, at the University of Maryland Baltimore County.

Chase did an internship this summer at the U.S. Department of Veterans Affairs in the VA’s vocational rehabilitation and employment section, where she sat in on counseling sessions for veterans with traumatic brain injuries. Her own injuries—collisions with teammates and opponents in both practice and games, and falling to the floor—inspired her to study the issue as part of a master’s degree, which she is currently pursuing at GWU. The internship was part of Chase’s work toward the degree—in rehabilitation counseling with a concentration in traumatic brain injury (TBI)—which she is scheduled to complete in December. Chase said she has a goal of working with athletes who, like her, have had TBI.

“It was a rough time in terms of sitting out with concussions throughout my junior year,” she said. “Once I was able to get over the injury psychologically, I made an attempt to try to turn my situation into a positive and take my own experiences and use them with other athletes” at the collegiate as well as high school and younger levels. Her main interest is in sports injuries, and her master’s coursework has included papers, study, and research on TBI, most involving athletes.

“I’ve noticed a more serious approach about concussions in the past two years. The movie *Concussion* came out [in



late 2015] ... and athletes have died from concussions later in life,” she said. “It’s being taken more seriously because it is an invisible injury and you really have to hone in and focus on athletes who might not even realize they have concussions.”

Chase—who ended her Division I collegiate career on a winning note, as the Colonials won the Atlantic 10 conference championship last year—said she is feeling healthy now and is “appreciative of the fact that I was able to overcome the concussions. There was a time where I had headaches for a long period of time, and I was able to go out in my last year in a very successful way.”

Youth sports are also taking steps to reduce concussions in their ranks. Late last year, the U.S. Soccer Federation banned heading the ball by players—boys and girls—under 10, and limited heading in practice sessions for players 11 to 13 years old. Those changes followed a class-action suit filed by a group of parents, who cited a prevalence of concussions in the sport among younger players.

“We filed this litigation in [an] effort to focus the attention of U.S. Soccer and its youth member organizations on the issue of concussions in youth soccer,” Steve Berman, lead counsel for the plaintiffs, said in a statement. “With the development of the youth concussion initiative by U.S. Soccer and its youth members, we feel we have accomplished our primary goal and ... are pleased that we were able to play a role in improving the safety of the sport for soccer-playing children in this country.”

In March, the Pop Warner youth football league announced it would ban kickoffs beginning this year as a means toward reducing high-impact tackles and hits. The change—along with a reduction of in-practice contact to 25 percent of practice time, down from 33 percent previously—are for players 8-10 years old, the league said in a statement.

“We are constantly working to make the game safer and better for our young athletes, and we think this move is an important step in that direction,” said Jon Butler, Pop Warner’s executive director. “Eliminating kickoffs at this level adds another layer of safety without changing the nature of this great game. We are excited to look at the results at the end of the year as we explore additional measures.”



This past spring, Ivy League football coaches voted unanimously to ban in-practice hitting during the season, as a means to keep their players injury-free, particularly from concussions.

care—that’s the thing that costs our players dearly after they leave,” said Smith, fielding questions from the radio show’s callers. “If you have an injury that occurs while you’re playing and it’s not covered by either workers’ comp or some other benefit, and you have to pay out of your own pocket, that’s the quickest way to become bankrupt.”

Smith said that under the 2011 collective bargaining agreement between the NFL and the union, players get five years of post-career health care, under which they can use health reimbursement accounts (HRAs), which are deducted pretax and that players can begin building in their rookie year.

“You’re allowed to stay in the NFL [health] plan throughout that [time], and pay premiums out of your HRA,” Smith said. “We created new benefits where if you get injured there’s a neuro-cognitive benefit that you can apply for that will cover your medical costs if you have long-term health care costs, and we continue to fight for our players for workers’ comp.”

Retirees’ Suit Nearing Final Resolution

Following lawsuits by a group of retired NFL players several years ago, the league reached a settlement to cover long-term costs associated with concussions and related neurological disorders.

A group of 5,000 retired players—out of about 20,000 total—filed suit against the NFL beginning in 2011 regarding the league’s treatment and disclosure of concussion-related risks. The case was consolidated in the U.S. District Court for the Eastern District of Pennsylvania before Judge Anita Brody.

The parties reached a class-wide agreement in principle covering all 20,000 retired players and family members in August 2013 for a \$765 million settlement—\$675 million of which was for compensation to players who suffered from qualifying conditions including dementia, Alzheimer’s disease, amyotrophic lateral sclerosis (ALS, also known as Lou Gehrig’s Disease), Parkinson’s disease, or a diagnosis of post-mortem CTE. The remaining money was for a baseline assessment program and other miscellaneous costs.

A motion for preliminary approval was filed in January 2014, but soon thereafter Judge Brody denied that, questioning whether \$675 million would be enough to compensate retired players who suffered from those conditions—or would suffer

from them over the life of the 65-year agreement. A revised, uncapped settlement agreement was filed in June 2014 and ultimately approved in April 2015.

Compensation is determined by an actuarial formula based on the player’s age and length of time in the NFL. For a player with five or more seasons under the age of 45, for example, there was no reduction in compensation. Maximum compensation per player is set at \$5 million, which would be for a player who had played at least five seasons who developed ALS before reaching age 45. Other qualifying diagnoses are eligible for lesser amounts, with reductions based on length of playing career. The rationale for the tiered compensation structure was that the older a player became, the less likely any of the conditions may have been football-related.

Also under the settlement, players do not have to prove that playing in the NFL caused a subsequent condition. That was in part because many players had prior playing experience—at the youth, high school, and college levels—that lasted longer than their ultimate NFL careers did. The rationale for not requiring proof was in part that it will be very difficult to prove direct causation of future injuries or medical conditions.

A settlement amount of “nearly \$1 billion” was widely reported in news stories because the original \$675 million would have been enough to pay out about \$1 billion in claims, with interest growing over the 65-year lifespan of the agreement. The \$675 million in compensation costs from the original \$765 million settlement was in addition to \$75 million for a baseline assessment program, with the remainder for educational programs about head injuries and for notifying and educating players about the settlement, which covered players who retired before July 7, 2014.

Players had three options—do nothing, in which case they would become part of the settlement; opt out of the settlement, in which case they would not receive benefits but would retain the right to sue the NFL; or remain part of the settlement but object to it, asking for the court to revise it.

Ultimately, about 99 percent of retired players opted to remain in the settlement. Those who objected were heard in November 2014, and Judge Brody overruled their objections, approving the settlement in April 2015, after which the objectors appealed to a federal appeals court.

The U.S. Court of Appeals for the Third Circuit in Philadelphia heard the objectors’ arguments last November, and in a unanimous opinion in April rejected the appeal. The objectors then appealed to the entire Third Circuit Appeals Court; that appeal was also rejected, with the court noting that less than 1 percent of the objectors opted out of the settlement. Objectors were facing a deadline late this summer of whether to carry the appeal all the way to the U.S. Supreme Court.

Ivy League Takes a Stand

Growing awareness of the concussion issue has spread beyond the NFL, with colleges and lower leagues also making changes to their football practice protocols. This past spring, Ivy League football coaches voted unanimously to ban in-practice hitting during the season, as a means to keep their players injury-free, particularly from concussions. In doing so, they followed the lead of Dartmouth College, whose coach, Buddy Teevens, has banned such hitting since 2010.

“People were kind of shocked,” Teevens said. “They were asking, ‘What did you do, how did you do it, and why did you do it?’ It was concern I had with concussive head injury and where it was going—it seemed back then like it was going to be something significant—and certainly it’s turned out to be.”

Teevens said that at this year’s spring coaches meeting, he brought up the proposal for an in-season practice tackling ban for the entire Ivy League. “There was a five-minute discussion, and everybody was all in,” he said. “They all played against us and saw that we were a very solid football team, a solid tackling team. It really was a good step to take to eliminate in-season tackling for the benefit of our players, and my hope is that others will follow.”

Dartmouth has developed a mobile tackling device for players to practice with “so we wouldn’t have to tackle each other,” said Teevens, who played quarterback at Dartmouth in the late 1970s, recalling that he “never got tackled in practice, while my teammates were getting banged around. On game day, I took my share of hits, but I was always better off the following Saturday than guys who were taking hits Monday through Thursday.”

He said he could not quantify how many hits were saved per player by the new protocol—“Hundreds? Thousands? Tens of thousands?”—but that both injury and concussion rates have “fallen appreciably. Our injury rate is down, but our success rate is up. The kids I’m coaching will be doctors, engineers, government officials, investment bankers—they won’t play football for a long time, but they will use their minds. Is this going to help them down the road? My gut says yes.

“The way most of us were raised playing the game, no one even thought about concussions,” Teevens added. “I hope people will take a look at all levels and consider reducing the amount of contact without compromising the game to the benefit of their players and their programs.”

Dartmouth’s missed tackles dropped by half in the first year it moved away from tackling in practice, to about 10 percent from about 22 percent, Teevens estimated. Concussive head injuries, which previously tallied about 15 to 20 per year, declined to two last season, on offensive linemen, and none on the Big Green’s defense, which was ranked No. 4 in the NCAA’s Football Championship Subdivision last season.

Teevens was previously an assistant coach at the University of Florida under Steve Spurrier—who coached at the University of South Carolina for 10 years and was briefly an NFL head coach—and he said Spurrier “made a point, as only he could, of getting [players] to game day. His push was protect your players, make sure you do things safely and soundly; there’s only so many hits a body might be able to take, don’t use them all up in practice.”

Teevens also worked as assistant at Stanford University in the early 2000s, where he met regularly with former Stanford coach Bill Walsh, who won three Super Bowls as head coach of the San Francisco 49ers in the 1980s, and who “said the same thing—take care of your players, protect your players,” Teevens recalled. He talked with then-Tennessee Titans head coach Jeff Fisher (now coach of the Los Angeles Rams), who told Teevens that he, too, had banned tackling in practice. That was around the time that the Mike Webster concussion case was gaining publicity.

Following those discussions, Teevens said he watched an extensive amount of game tapes and pitched the idea to his Dartmouth staff of banning tackling during practice. “It was not entirely well received” at first, he recalled with a chuckle. “But I just said we’re not going to do it anymore. NFL players knew how to tackle and didn’t need to teach tackling the way I felt we need to do at the college level,” which led to Dartmouth’s development of the mobile tackling device.

Statistics for Lower Levels Still Evolving

College statistics are harder to gauge overall because the NCAA does not have a mandatory reporting structure, said Terry O’Neill, founder and CEO of Practice Like Pros, a group that promotes reduced hitting and tackling for football players across all levels of competition. (The NCAA did not respond to an interview request for this story.)

“The same is true for high school, but that’s even more difficult,” because player-safety rules are regulated by states, although some have passed legislation requiring some degree of concussion reporting, he said. Wisconsin adopted regulations promoted by Practice Like Pros, and a review of that state’s concussions after implementing the rules in the 2014 season showed they fell by more than half. Florida—one of the country’s biggest high school football states, along with Texas, California, and Ohio—passed regulations in June limiting in-season full contact at practices to 30 minutes a day, and a total of 80 minutes per week in season.

“The trend shows great momentum for our movement,” O’Neill said, noting that Practice Like Pros has the backing of former NFL star players and coaches including Mike Ditka, Ronnie Lott, and Warren Moon. “We’ve been in business for three-and-a-half years, and 46 of 50 states have taken some action to reduce contact on the practice field.”

Overall high school concussion statistics are difficult to ascertain, with more than 1 million boys estimated to be playing high school football. Dawn Comstock, a professor of epidemiology at the University of Colorado-Denver, has been a leader in gathering such statistics in the past decade.

Comstock—who spoke at a White House summit on youth sports and concussions two years ago—has been the primary investigator for a national surveillance system tracking high school sports injuries known as the High School RIO, for reporting information online.

While High School RIO is a general sports-injury surveillance system, rather than strictly a concussion data hub, it became “a right place, right time, where I was capturing concussion data along with all the other injuries,” she said. Comstock

has maintained the RIO system since 2005, and it has become the largest data-gathering system for high school sports concussions. While the figures were relatively stable for the three years following its creation in the 2005-06 school year, about three years later “concussion rates rose dramatically,” she said, although they have leveled off in the past few years.

RIO figures show that the overall concussions—including from football, boys and girls soccer, boys and girls basketball, and girls volleyball—were in the 135,000 to 150,000 range for the first four years (2005-2009), with a rate of concussions per 10,000 athletes of 2.27 to 2.55. In the following six years (2009-2015) they jumped to a range of 192,000 to a high of 348,500 (2012-13), with rates from 3.22 to 5.63 per 10,000.

Comstock said the rates rose for either a true increase in injuries, “or an artifact of reporting” by schools. “It was likely the latter, because high school kids haven’t gotten particularly bigger, faster, or stronger in the past 10 years,” she said. “What has happened is a huge increase in concussion awareness,” since Washington state became the first to pass youth-sports concussion legislation in 2009.

The increase coincided with a host of groups ramping up concussion awareness programs, including initiatives from the U.S. Centers for Disease Control and Prevention (CDC), which developed educational information, and the National Federation of State High School Associations, which produced free concussion clinics for coaches. Those efforts were in addition to the heightened awareness by professional and other leagues like the NFL, the National Hockey League, USA Football, USA Lacrosse, and others, Comstock said.

“I think a decade ago it was not uncommon at all to hear terms like ‘He got his bell rung,’ or ‘He had a dinger.’ You don’t see that anymore,” she said. “We’ve had this amazing and dramatic cultural shift. Now people call concussions ‘concussions,’ and we refer to them as brain injuries.”

The higher rates did not necessarily mean that more athletes are being hurt, but that more concussions are being diagnosed, she added. “From an actuarial perspective, seeing those increasing numbers could be a double-edged sword,” Comstock said. “On one hand, you’re thinking about more people who could have long-term complications associated with these injuries. On the flip side, if there aren’t that many more people being injured, but fewer are undiagnosed, then from a long-term perspective that’s good news—they’re being cared for appropriately at the time of initial injury, which improves their long-term outcome.”

Better Equipment Not a Cure-All, Group Says

The Concussion Legacy Foundation, a nonprofit organization started in 2007, believes that only about 1 in 6 concussions are reported, based on a 2014 study that asked college football players how many concussions they had the previous season, said Cliff Robbins, the foundation’s education and research programs manager.

“That’s a really important piece, especially from an actuarial science perspective—even more unsettling was how they responded to concussive symptoms,” Robbins said. “The underreporting issue is huge.”

The foundation’s website says that as many as 3.8 million

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Concussions’ Effects Can Be Serious

Concussions becoming a spotlight issue in sports have led to large numbers of high-profile athletes coming forward with plans to address the issue, even as tragic stories continue to emerge from the effects of brain trauma.

Rarely a week goes by without more revelations. One of the most recent was in mid-July, when several dozen professional wrestlers filed a class-action suit against World Wrestling Entertainment, claiming WWE concealed the long-term effects of chronic traumatic encephalopathy (CTE). WWE denied any wrongdoing.

Some other recent individual examples of how concussion concerns have affected the lives and careers of high-visibility athletes include:

- **Brandi Chastain**, 48, former professional and U.S. women’s national team soccer player and star of the 1999 Women’s World Cup, said in March she will donate her brain to science posthumously for CTE research. “It’s scary to think



about all the heading and potential concussions that were never diagnosed in my life, but it’s better to know,” Chastain told the Concussion Legacy Foundation in making her announcement.

- **Sidney Crosby**, 29, of the Stanley Cup champion Pittsburgh Penguins and the most valuable player of last season’s

National Hockey League (NHL) playoffs, sat out for almost a full year in 2010-11 due to multiple hits to his head.

- **Dale Earnhardt Jr.**, 41, one of NASCAR’s most popular drivers, announced via Twitter in March that he would donate his brain posthumously to scientific research. Earnhardt, who missed several weeks of racing after suffering multiple concussions four years ago, sat out a race in July due to concussion-like symptoms.

- **Calvin Johnson**, 30, five-time Pro Bowl wide receiver for the Detroit Lions, retired at the end of last season despite being among the best players in the NFL at his position. He told ESPN that he had his “fair share” of concussions during his nine-year professional career.

- **Chris Borland**, former linebacker for the San Francisco 49ers who was one of the most promising young players in the league, retired last year at 24 after just one season in the NFL, citing concerns about

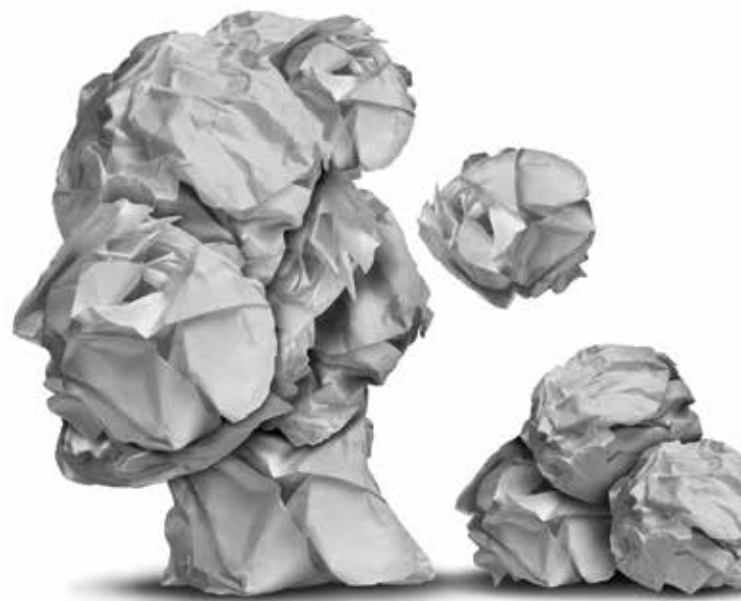
The Concussion Legacy Foundation, a nonprofit organization started in 2007, believes that only about 1 in 6 concussions are reported, based on a 2014 study that asked college football players how many concussions they had the previous season.

recreation-related concussions occur annually in the United States, which Robbins said is based on CDC figures. Going forward, he said that while better equipment can help, it is not a cure-all for eliminating sports concussions.

“Helmets are a solution to a different problem,” Robbins said. “Hard plastic helmets in collision sports were designed to prevent skull fractures, and they do a great job of that. We haven’t had an athlete pass away from a skull fracture on the field in decades.”

But he added, “They don’t really address concussions at all, because what causes concussions is a difference in the response rate between the hard bone of the skull and the soft, fatty tissue that’s suspended in the fluid of the brain. So when the head comes to a quick stop, the skull [is protected] but the brain continues to move forward—nothing you can put on the outside of the head can reduce that decoupling.”

Equipment, while helpful, is not the most effective way to reduce concussions, Robbins said, with focus instead shifting to ways of limiting exposure. The foundation is backing more use of helmet accelerometers to gauge exposure estimates on



how many hits are taken, including low-level hits, and to work toward getting an objective measure of that exposure.

“My guess is that using that data to inform our decisions and estimates down the road will be a much more reliable indicator of concussions rates” because of the ability to measure exposure more directly, Robbins said.

The sports world has taken the issue of concussions seriously, and awareness of the issue is growing rapidly as players, coaches, and administrators at all sports and levels continue taking action to curb their incidences and effects. □

MICHAEL G. MALLOY, a rabid New England Patriots fan, is managing editor for member content at the Academy.

for Athletes in Many Sports

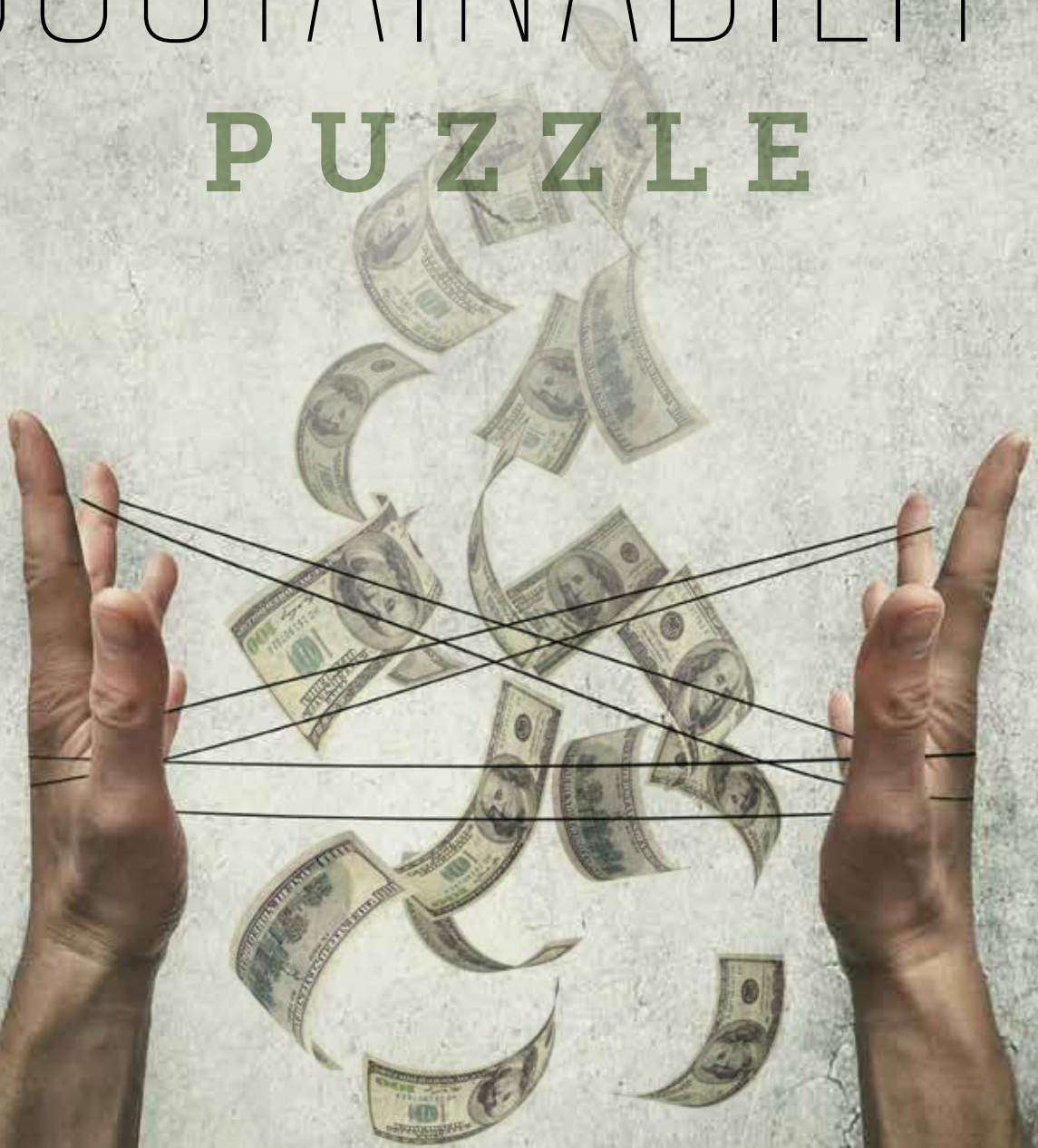
head trauma. Borland estimated he had suffered about 30 concussions throughout his amateur and brief professional football career, *ESPN The Magazine* reported.

- **Bubba Smith**, NFL Hall of Fame defensive lineman with the Baltimore Colts and Oakland Raiders in the 1960s and '70s, died at age 66 in 2011. The Concussion Legacy Foundation announced in May of this year that Smith had CTE.
- **Doug Whaley**, general manager of the Buffalo Bills, said in a radio interview earlier this year that football is “a violent game that I personally don’t think humans are supposed to play.” He subsequently told *Pro Football Talk* that he had used a “poor choice of words.”
- **Dave Duerson**, Super Bowl-winning safety who played for the Chicago Bears in the 1980s, committed suicide at age 50 in 2011, shooting himself in the chest and requesting that his brain be donated for CTE study. This incident was dramatized in the 2015 movie *Concussion*.

- **Junior Seau**, a Hall of Fame NFL linebacker for the San Diego Chargers and New England Patriots, also committed suicide by shooting himself in the chest and preserving his brain for study, in 2012. He was 43.
- **Chyna**, the female professional wrestler whose real name was Joan Marie Laurer, died of a drug overdose in April at age 46. Her manager told the Associated Press following her death that her brain would be donated to Dr. Bennet Omalu, the neuropathologist portrayed in the movie *Concussion* who first diagnosed CTE.
- **Josh Satin**, 31, a former New York Mets infielder, announced in June he was retiring from Major League Baseball due to concussive hits, including running into a teammate last year during a minor league game.
- **Stephen Peat**, 36, a former NHL player with the Washington Capitals who retired 10 years ago, suffers from CTE-like symptoms, has trouble focusing and

- with headaches, and was charged with arson in Canada last year after apparently inadvertently leaving a blowtorch lit in his garage, burning down his home, the *New York Times* reported in June. No one was hurt.
- **Dave Mirra**, a bicycle motocross (BMX) rider, killed himself with a gunshot at age 41 in February and was posthumously diagnosed with CTE. *ESPN The Magazine* reported that Mirra, one of the forerunners of the action sport, suffered a fractured skull at 19 when a car hit him and endured “countless concussions” during his BMX career.
- **Len Oliver**, 82, a U.S. soccer Hall of Famer who played college soccer in the 1950s and on semipro and U.S. armed forces teams in Germany, said he would donate his brain posthumously for CTE research. Oliver suffered six head-to-head injuries during his playing career, including one at the 1963 Pan American Games in Brazil, the *Washington Post* reported in March.

THE SUSTAINABILITY PUZZLE



When is solvency important, and how can plan sponsors adjust over time to maintain sustainability?

BY BILL HALLMARK

Are Illinois' pension plans solvent? Are they sustainable? What about other pension plans?

The Central States multiemployer plan is projected to run out of assets within 10 years, and the Puerto Rico government plan is out of assets. Should we focus on the sustainability or the solvency of a pension plan, or both?

Whether it is a public pension plan, a multiemployer pension plan, or a single-employer corporate pension plan, we want the pension plan to be sustainable. We may also want it to be solvent. Unfortunately, these concepts are often confused with each other, and this confusion can lead to the misuse of actuarial measurements and flawed decisions.

Consider a hypothetical plan in which there is a single obligation to pay \$100,000 in 10 years. *Solvency*, as used here, is not just the avoidance of *insolvency*, or running out of plan assets. *Solvency* means that there are sufficient assets set aside to pay the obligation with near certainty. For example, if a zero-coupon Treasury bond had been set aside that matures in 10 years in an amount of \$100,000, the plan would be considered solvent. The asset may only have a market value today of \$80,000, but unless the U.S. government defaults, there will be sufficient assets to meet the obligation when it is due. In this case, the *solvency* value of the obligation is said to be \$80,000.

In contrast, *sustainability* depends on the revenue source that supports the obligation as well as the current assets of the plan. If it is an obligation of an entity with significant income or significant wealth compared to the obligation, the obligation may be sustainable even if no assets have been set aside. Using the same example of a \$100,000 obligation in 10 years, it would likely be considered sustainable if the entity with the obligation had annual income sufficient to set aside the \$100,000 over the next 10 years. But if the entity responsible for the obligation has minimal income and no assets set aside, full payment of the obligation is not likely to be made. And it is not sustainable. It is the size of the obligation for which no plan assets are available compared to the wealth, income, and willingness of the entity responsible for the obligation that determines whether or not an obligation is sustainable.

Defined benefit pension plans create promises of payments in the future. These promises are only secure if they are

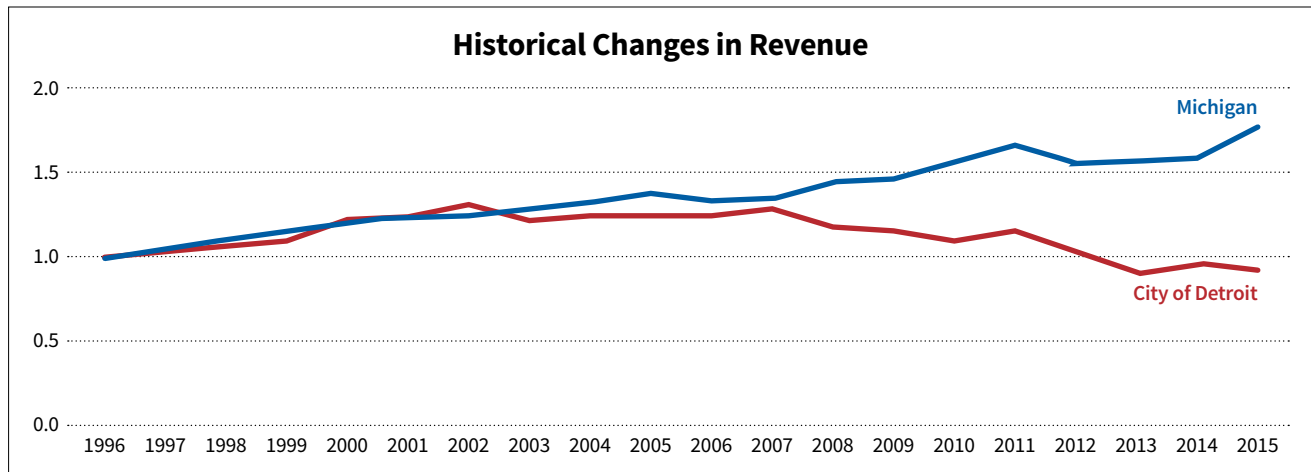
sustainable. Sometimes these plans need to be solvent in order to be sustainable, but often they do not. Social Security, for example, does not need to be solvent. To be sustainable, it just needs a sufficient revenue stream to pay the benefits when they are due. Under current law, the projected revenue is not sufficient to sustain Social Security, but the U.S. economy is large enough to provide that revenue stream if we so choose. A terminated pension plan, on the other hand, may need to be solvent in order to be sustainable if there is no longer a sponsor with resources to contribute in the event the plan's assets are insufficient to pay the promised benefits at some point in the future.

There are three key considerations in assessing the degree to which a pension plan needs to be solvent in order to be sustainable: the reliability of plan sponsor revenues, the size of the plan compared to sponsor revenues or the plan's contribution base, and the net cash flow of the plan.

The Importance of Plan Sponsor Revenue

Suppose a pension plan is sponsored by a small company in a growth industry. As the company grows, the pension plan appears to be very small compared to the assets and income of the company. Based on the probability of future growth, one may conclude that the plan is sustainable even if no assets are set aside. More commonly, some level of assets are set aside and invested in a diversified trust.

But what happens if the company's growth stops? What happens if the industry is disrupted by a technological innovation or a change in laws or regulations that protected the industry? Or what happens if competitors in the industry drive the sponsor out of business? The income and assets of the company sponsoring the pension plan may decline or disappear, making the plan unsustainable unless sufficient assets had been set aside and invested such that the plan is solvent. Note that it is not just the amount of assets set aside; they also have to be invested, not



Source: City of Detroit, State of Michigan annual financial reports

in a diversified trust, but in a default-free portfolio that matches the anticipated cash flow of the pension obligation, because the sponsor no longer has any resources to make up for any losses.

Even plans with no assets set aside can be sustainable if the ongoing revenues are sufficient. When the ongoing revenues cease, however, the plan needs to be solvent or it cannot be sustainable. This situation has played out repeatedly in the private sector, most notably in the steel, auto, and airline industries, where the revenues of plan sponsors did not keep pace with the size of the pension plans due to changes in the industry as well as the growth of the plans.

On the other hand, if the revenues of the sponsor continue to grow, the pension plan does not need to be solvent. It can continue to be sustainable while a lesser amount of assets are invested in a diversified portfolio. Consider our initial example of an obligation to pay \$100,000 in 10 years. At a sufficient income level, this obligation would be sustainable with no assets set aside in advance.

If the sponsor's income is lower, the sponsor may need to budget for the obligation by, for example, setting aside \$10,000 per year for 10 years in order to make the obligation sustainable. If the sponsor wanted to reduce costs further, the assets that are set aside could be invested in zero-coupon Treasury bonds that mature when the \$100,000 obligation is due. The plan would be sustainable if the sponsor can afford to make the budgeted contributions each year.

Alternatively, the sponsor may choose to invest the assets in a diversified portfolio, hoping to achieve a higher return and reduce the total contributions needed to pay for the obligation. If so, the plan is still sustainable if the sponsor can afford the planned contributions plus any investment losses that may ensue. However, the plan is not solvent—and if the plan sponsor's revenue declines or disappears, the plan that appeared to be sustainable may not be so any longer.

A Multiemployer Example

The Teamsters' Central States plan is an excellent example of this dynamic. Before trucking deregulation, the plan covered

approximately 400,000 active employees who worked for more than 11,000 employers. It was thought that individual company bankruptcies would not affect the sustainability of the plan because any bankrupt employers would be replaced in the plan by new employers or mitigated by the growth of current employers.

However, with trucking deregulation and other changes to the industry, many of the employers went bankrupt or withdrew from the plan, and they were not replaced by new employers in the plan. In 2005, there were fewer than 3,000 employers contributing to the plan. At the same time, the active membership and the contribution base for the plan had also declined dramatically to about 150,000 active employees. The withdrawal of the largest participating employer further reduced the contribution base, and today there are only about 60,000 active employees participating in the plan. While sponsor revenue didn't completely disappear (as it may in a bankruptcy), the plan's resources to make up for any unanticipated loss were significantly curtailed.

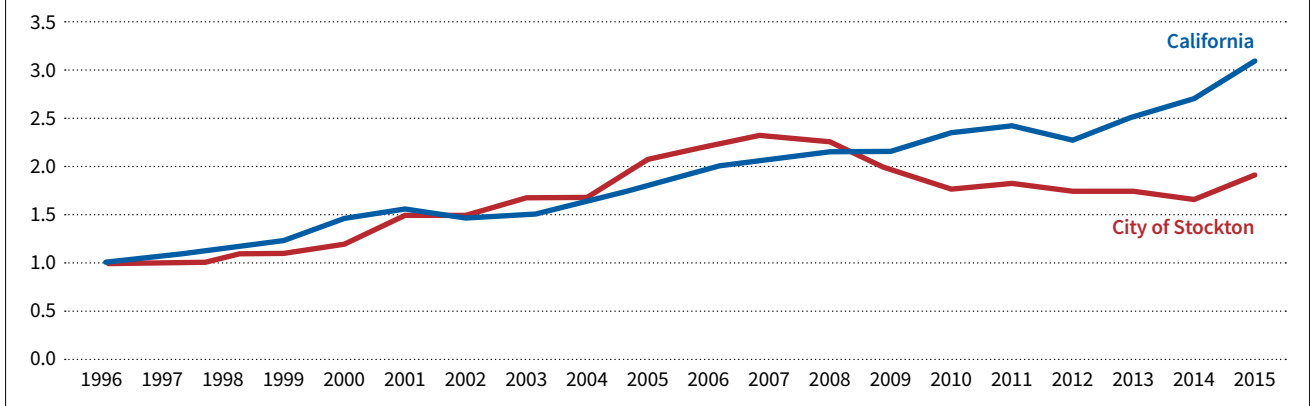
Public Plan Examples

Changes in sponsor revenue have also affected public pension plans from Detroit to Stockton, but the revenue for these plan sponsors does not disappear as it does for bankrupt private employers, and it doesn't decline as precipitously as the revenue in a single industry might if that industry is disrupted. Revenue for public plan sponsors, particularly states and large cities or counties, usually comes from a diverse tax base that can recover from changes to specific companies or industries. However, smaller public entities or areas that are highly dependent on a specific company or industry may be more vulnerable to changes.

In Detroit, revenue declines were driven by the decline of the auto industry within the city, eventually resulting in a bankruptcy filing in 2013. The chart above compares the changes in nominal revenue for the city of Detroit and the state of Michigan starting in 1996. Both governments are broadly subject to the same economic factors, but the larger, more diverse state continued to grow revenues after 2002, while the city of Detroit's revenues stagnated and then declined to less than it was receiving in 1996.



Historical Changes in Revenue



Source: City of Stockton, State of California annual financial reports

In Stockton, the housing bubble created a flood of revenue and an expansion of pension obligations followed by a drop in revenue when the bubble burst. The chart above compares the changes in nominal revenue for the city of Stockton and the state of California starting in 1996. From 2002 to 2007, Stockton's revenue increased by more than 50 percent. After some long-term decisions were made based on this expanded revenue base, the housing bubble burst and revenue declined by 23 percent from 2007 to 2012, when it declared bankruptcy. Again, the broader, more diverse tax base for the state of California continued to grow, while the city of Stockton suffered its revenue declines.

In each of these cases, sponsor revenues are ongoing and can continue to support some level of contributions to the pension plan. The issue is whether that level of contributions is sufficient to provide for active employees' benefits, the payment of the unfunded benefits for past services, and any unanticipated investment losses. If so, these plans can be sustainable.

When a pension plan starts, it typically has no liability, and the initial benefits that are earned are not paid until many years in the future. By far, the most important cash flow to the plan is contributions. Investment returns—good or bad—pale in comparison.



Importance of Plan Size Compared to Plan Sponsor Revenues

While we have focused on the risk of unanticipated changes in plan sponsor revenue, one of the most critical factors in assessing the sustainability of a pension plan is the comparison of the size of the pension plan to the revenue that supports it. If the pension plan is very large compared to its supporting revenue base, any changes to the pension plan may have a dramatic impact on the plan sponsors. During the 1990s, for example, it was often said that General Motors had become a pension plan that operated a car business on the side. The gains and losses of its pension plan were just as important to the bottom line as the profitability of the car business.

When a pension plan starts, it typically has no liability, and the initial benefits that are earned are not paid until many years in the future. By far, the most important cash flow to the plan is contributions. Investment returns—good or bad—pale in comparison.

As the plan matures, these relationships change. Investment returns become much more important, and the relative size of contributions to benefit payments becomes more important. The speed and extent to which these relationships change is affected significantly by the level of growth of the plan sponsor. If the plan sponsor grows rapidly, the pension plan may retain many of the characteristics of a new pension plan, including that investment losses are easily made up with additional contributions. If the plan sponsor becomes smaller, however, the natural growth and maturation of the pension plan is compounded, and investment losses and other changes to the pension plan are much more difficult to make up through additional contributions. Investment losses can be recovered either by increasing contributions, usually over a period of time, or by future investment gains. To the extent the sponsor cannot afford the needed contributions to make up for an investment loss, the plan would need to rely on future investment gains—and the plan may not be sustainable.

Consider two hypothetical pension plan sponsors with the same level of revenue, but different levels of pension assets

invested in a diversified portfolio (not matched to liabilities) as shown in Table 1.

TABLE 1. The Effect of Investment Loss Varies With Assets

| | Sponsor A | Sponsor B |
|-------------------------------------|------------|------------|
| Revenue | \$1,000 | \$1,000 |
| Pension Assets | 3,000 | 6,000 |
| 10% Investment Loss | 300 | 600 |
| Loss as a Percent of Revenue | 30% | 60% |

The same 10 percent investment loss for both pension plans represents 30 percent of revenue for Sponsor A and 60 percent of revenue for Sponsor B. As a result, Sponsor B is twice as sensitive to investment experience as Sponsor A and, all other things being equal, Sponsor B can only sustain half as much of an investment loss as Sponsor A. Note that to the extent the pension investments are matched to the pension obligations, interim investment gains and losses don't matter. If Sponsor B were to match \$3,000 of its pension assets to a portion of its pension obligations, then Sponsor B would have the same sensitivity to pension investment returns as Sponsor A.

To address this issue, corporate pension plans have worked to downsize their pension plans through payment of lump sums, purchases of annuities, and reductions in the accrual of additional benefits. They have also worked to limit the risks remaining by more closely matching investments to the obligations and transferring other risks to employees by switching to defined contribution plans. These actions have been strongly incited by federal rules on minimum required contributions and Pension Benefit Guaranty Corp. premiums.

Multiemployer and public pension plans have also reduced the accrual of additional benefits, but for the most part have not offered additional lump-sum payments or purchased annuities to transfer the risks to another party. They also have not matched investments to obligations. Public plans have shifted some risks to employees and retirees through variable cost-of-living adjustments and higher employee contributions, and there has been some movement toward defined contribution plans among employers that have traditionally participated in multiemployer pension plans.

Importance of Negative Cash Flow

Investment returns from a diversified portfolio are by their nature volatile. Expected returns represent an estimated average, taking into account the ups and downs that are likely to emerge. However, expected returns do not take into account the impact of cash flow (contributions less benefit payments and administrative expenses).

For pension plans that are large compared to the contribution base, the cash flow may increase the difficulty of sustaining the plan through the ups and downs of investment returns even if the average return appears to be sufficient to sustain the plan. As noted above, pension plans can make up for investment

losses through either additional contributions or future investment gains, or both. For a plan that is large compared to its contribution base, investment losses may be too large for additional contributions to cover. If the plan's cash flow is significantly negative, even good future investment returns may not be able to make up for an investment loss because the asset base on which the future investment returns are earned diminishes from the negative cash flow as well as from the investment loss.

Table 2 shows the effect of negative cash flow compared to no net cash flow in a simple case where the expected return is 0 percent. With no net cash flow on assets of \$100, a \$10 investment loss requires an 11.1 percent return to recover to the expected level of assets of \$100. With negative cash flow of \$10, the same \$10 investment loss requires a 12.5 percent return to recover to the expected level of assets. Plans with large negative cash flows are most sensitive to investment returns in the short term when their asset base is the largest.

TABLE 2. Impact of Negative Cash Flow

| | Sponsor A | Sponsor B |
|--|-----------|-----------|
| Initial Assets | \$100 | \$100 |
| Net Cash Flow | 0 | -10 |
| Expected Return | 0 | 0 |
| Expected Assets | \$100 | \$90 |
| Actual Return | -10 | -10 |
| Actual Assets | \$90 | \$80 |
| Return Needed to Recover Expected Assets | 11.11% | 12.50% |

Managing Investment Risk for Sustainability

Many financial economists advocate the funding of pension plans by matching contributions and investments to the solvency measure of pension promises. Under this approach, investments are made in a default-free bond portfolio that matches the cash flow of the benefit promises, and contributions are made in the amount necessary to purchase the additions to the portfolio necessary to match the future cash flow for the benefit promises earned that year.

This approach ensures that the plan is always 100 percent funded on a solvency basis, and contributions vary only due to demographic changes and changes in interest rates. This approach is sustainable as long as the sponsor can afford the contribution level required, which may require controlling the level of benefits promised for future accruals.

Ignoring some of the practical limitations, the downside of the matching bond approach is that the total contributions required over time are likely to be significantly higher than if the assets are invested in a diversified portfolio. However, as discussed above, investing in a diversified portfolio can imperil the sustainability of a pension plan, particularly if:





The risk to sustainability is whether or not an unexpected loss or change in assumptions can be made up with future contributions.

Consequently, it may be useful for the plan's trustees to assess what level of future contributions would be affordable either for a short period or for a sustained period.

1. Plan sponsor revenues (or the plan's contribution base) decline or disappear;
2. The size of the plan becomes too large relative to its contribution base (or plan sponsor revenues) to make up for investment losses; or
3. Negative cash flow exacerbates either of those conditions.

When a pension plan starts, none of these three conditions are typically a concern, so the appealing approach is to invest the assets in a diversified portfolio. Any modeling will show that over the first 20 or more years, the plan is sustainable under a wide variety of economic conditions provided that the sponsor does not go bankrupt. Over time, however, the size of the plan and any negative cash flow can become significant factors, and the realization of their significance may come too late. By the time the risks are realized, it may not even be possible to convert the portfolio to default-free matching securities without significant reductions in the promised benefits or increases in contributions. So, how should we think about managing the investment risks of a pension plan?

Investment professionals can help plans implement a variety of strategies, but conceptually it may be useful to think of a spectrum ranging from default-free matching strategies to high-risk versions of diversified portfolios. Plans need to assess their strategy on this spectrum based on the three conditions described above.

First, **how strong is the contribution base?** Is there a risk that it will disappear? Is there capacity to increase contributions, if needed, to make up for investment or other losses? A detailed analysis of the plan sponsors is beyond the expertise of most pension actuaries and many investment professionals, but at a macro level, it is understood that individual small companies represent greater risks than individual large companies; that individual companies represent greater risks than groups of companies; that companies represent greater risks than

governments; and that small governments dependent on a single industry or employer represent greater risks than large governments with a diverse economy. The greater the risks associated with the contribution base, the closer the investment portfolio may need to be to a default-free matching strategy.

Second, **how large is the plan compared to the contribution base?** This can be measured as the assets or obligation divided by the revenue of the sponsors of the plan. The ratio based on assets is useful for assessing the sensitivity to investment risk. The ratio based on the obligation is useful for assessing the sensitivity to demographic experience and assumption changes. For multiple employer plans, information on the revenue of the sponsors may be difficult to gather. For public pension plans, payroll is often used as a rough proxy for sponsor revenues, and for multiemployer plans, it may be more appropriate to use contributions given that contributions to the plan are collectively bargained with active employees. While informative, these measures are not intuitive and can be difficult to translate into actions by the fiduciaries of the plan.

The risk to sustainability is whether or not an unexpected loss or change in assumptions can be made up with future contributions. Consequently, it may be useful for the plan's trustees to assess what level of future contributions would be affordable either for a short period or for a sustained period. Investment losses, for example, that would cause the plan to exceed these affordability parameters should be avoided, if possible, by limiting the investment risks in the plan's portfolio, either by matching a portion of the assets to the obligations or by reducing the risk in the diversified portfolio, or both.

Third, **what is the ratio of net cash flow to plan assets?** If this ratio is positive, there is generally more capacity to take on investment risks. Any investment losses can likely be made up with an affordable level of future contributions, and moderately good future investment returns will diminish the need for such additional contributions. If this ratio is significantly negative, any investment losses will likely need to be made up by additional contributions because the declining asset base diminishes the impact of any future good investment returns. Consequently, there is less capacity to take on investment risks.

Even with this type of analysis, the difficulty is recognizing the need to adjust strategies as a pension plan matures. One simple conceptual way to track how the strategy may need to shift from a fully diversified portfolio to a fully matched bond portfolio is to split the obligation of the plan into the obligation for active employees and the obligation for retirees and other inactive participants. The obligation for active employees is proportional to the current size of the sponsors and has a positive net cash flow, so it might be funded using a diversified portfolio. The obligation for retirees is unrelated to the current size of the sponsors and has a negative cash flow, so it might be funded using a matching bond portfolio.

As a plan grows and matures, this conceptual division would naturally move the plan's investment strategy from

The Sustainability Puzzle

predominantly a diversified portfolio to a blend of a diversified portfolio and a matching bond portfolio. This simple conceptual strategy may need to be modified to reflect the attributes of the plan sponsors. That is, an individual company sponsoring a plan may want to be closer to the matching bond portfolio to ensure sustainability while a large, multiple-employer public plan may be able to be closer to or entirely in a diversified portfolio and still maintain its sustainability even when it is relatively mature.

From Here to There

The discussion above has focused on some key factors affecting the sustainability of pension plans and how to manage them as they mature. Unfortunately, many of the problems today are the result of not making the needed adjustments as plans matured. How do we get those plans from where they are today onto a more sustainable footing? The answer is difficult, and may not be possible to apply in every case.

For plans like Central States and Puerto Rico, the only solutions are some combination of contribution increases and benefit reductions. To the extent there is no capacity for contribution increases from plan sponsors or other sources, benefit reductions will have to be made at some point.

For some public pension plans, the most significant issue is

that they have simply not made the recommended level of contributions, sometimes for years or decades. The accumulated missed contributions have now become so large that it is difficult to catch up. The sustainability of the plan in the future depends largely on developing an affordable plan to catch up on the missed contributions and finding the discipline to stick to the plan. In some of these cases, the downside investment risks may be affordable (at least until the plan is better funded), and good investment returns have significant potential to relieve the long-term burden. In any case, plans in this type of situation will not be fixed overnight. It will take time—perhaps decades.

For many mature pension plans, the situation is not so dire. They have accumulated a reasonable, but not solvency-level, amount of assets and are making contributions to improve their funded status. They may have some capacity for additional contributions, but they may be taking more investment risk than they would like or can afford.

The difficult trade-off is that reducing the investment risk reduces the potential for investment returns to provide relief to already high contribution rates and may require contributions to increase immediately. To manage this trade-off, plans are likely to need to develop strategies to gradually move to the level of risk they prefer over time.

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Sustainability and solvency are different concepts, and the primary objective for a pension plan is to make sure it is sustainable.

The California Public Employees' Retirement System (CalPERS) recently adopted a strategy such that whenever actual investment returns exceed its assumption, instead of just reducing contributions to reflect the good investment returns, it will also reduce the investment risk. As a result, contributions go down, but not as much as they would have. Similar strategies

may also be developed to reduce investment risk toward a target level as plan sponsors grow and higher contribution amounts are more affordable. All of these strategies, however, rely on some good experience to facilitate the transition to lower levels of risk. If the good experience does not materialize, the transition will not take place and the plan could become unsustainable.

Sustainability and solvency are different concepts, and the primary objective for a pension plan is to make sure it is sustainable. Sometimes a pension plan needs to be solvent in order to be sustainable, but not always. The reliability of plan sponsor revenues, the size of the plan compared to its contribution base, and the degree of negative cash flow are all key factors in determining how much risk can be undertaken while still maintaining the sustainability of the plan. To the degree plans are different with respect to these characteristics, they may need to adopt different contribution and investment strategies. Consequently, these characteristics should be monitored closely, the need for changes should be anticipated, and strategies should be adjusted accordingly to ensure the sustainability of the pension plan. □

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BY ALYSSA OURSLER

CRYONICS

'The Best Crapshoot in Town'

The practice of freezing people after death with the hopes of later reviving them is riddled with question marks—even the organizations touting it don't offer those who sign up any guarantees.



CRYONICS is an effort to use low temperatures to freeze humans (or animals) with the hope that medical technology will advance and later be able to restore them. In some instances, just a person's head is preserved, with the hope the brain can later be restored, while other times it's the entire body that is preserved. Cryonics is often confused with cryogenics, which refers simply to the study of low temperatures' effect on materials. (In between is cryobiology, which is the study of low temperatures' effect on organisms specifically.¹)

This field is admittedly nascent and often contested; plenty of research and thought about cryonics and its implications still needs to take place, as we'll cover here. But a recent breakthrough suggests things may at least be moving in that direction. Earlier this year, we learned that scientists were able to preserve a rabbit brain in "near-perfect" condition—the first time a whole mammalian brain wasn't damaged from the freezing process.²

The idea of using extremely cold temperatures for preservation likely sounds familiar, and not just because it's the premise

of quite a few science-fiction plots (*Austin Powers* and *Futurama* are perhaps the most recent examples of this common trope). It's been done on much smaller scales, such as when sperm, egg, embryo, or ovarian tissue is frozen via vitrification and saved for later use. There have also been cases where hypothermia inadvertently saved individuals who seemed to have drowned in cold water. As aging and technology expert Steven J. Hausman, Ph.D., explained to me, in such cases, "The water had the effect of slowing down a person's metabolism such that brain function was preserved and tissues and organs were stabilized. Then, once body temperature was gradually raised, the person could be revived with no loss of function."

The medical community has learned from these instances and related research, now using or testing the use of mild hypothermia as a method to safely perform heart operations and treat patients with cardiac arrest³ and gunshot wounds.⁴

In such applications, the hope is that cold temperatures can buy time and/or minimize blood loss and thus make existing medical procedures more effective. With cryonics, the



difference is that patients are already legally dead. As a result, even colder temperatures are needed to buy even more time.

We're talking enough time for the creation or discovery of new medical procedures altogether.

And those new medical procedures need to not just reverse a far more extreme and often damaging cooling process, but also to potentially cure whatever caused the death to begin with.

Death: Just the Beginning

Before diving into the theoretical future medical procedures that cryonics hinges on—and that represent a big bullet point in the list of reasons cryonics is contested—let's outline the process of being cryonically preserved as it stands today. There are just a handful of cryonics companies (most technically classified as nonprofits), and none has more than 200 “patients” (read: legally deceased and now frozen bodies or heads).

Alcor is one of the better-known names in the field; the Arizona-based cryonics organization stores baseball star Ted Williams' head (and was the subject of a whistleblowing book penned by a former employee a few years ago). Alcor has 146 patients, while a similar organization called Cryonics Institute, based in Michigan, isn't far behind with 137 patients. The California-based American Cryonics Society is much smaller, with just shy of 30 patients, while KrioRus (the first company outside the United States that offers cryonics services) has 51.⁵

Preservation ideally begins almost immediately after a formal declaration of death. Time is of the essence to minimize damage, to the point that Alcor's procedures state: “Cryonics cases in which life support techniques are promptly used to maintain brain viability after the heart stops are considered to be ideal cases.” Similarly, it is encouraged that terminally ill members relocate near their respective cryonics facilities, although medical and transport teams (made up of contractors and cryonicist volunteers) are put on “standby” for patients in critical condition.

But the hard reality is that it's difficult to predict precisely when the end is near. Jim Yount, COO of the American Cryonics Society, was on the standby team for Jerry White, a longtime ACS member and former president. Yount recalls that even while White's health was declining, his actual death was (perhaps unsurprisingly) hard to predict with accuracy. In one instance, the team was called in because White was believed to be near death, yet by the time they arrived, he was sitting up and drinking a beer.⁶

Other times, preservation can be delayed because the body has to be released from a local medical examiner, and autopsy prevented. Cases that involved hours of delay are relayed in *Frozen*, former Alcor COO Larry Johnson's 2009 book recounting his time working there. Prior to joining Alcor, Johnson was a paramedic for 25 years and laments in the book the lack of organization and training that went into the cryopreservation procedures.

Still, any cryonicist would likely add that even a less-than-perfect procedure offers a better shot than none at all, and that procedures will continue to improve.

Deep Freeze

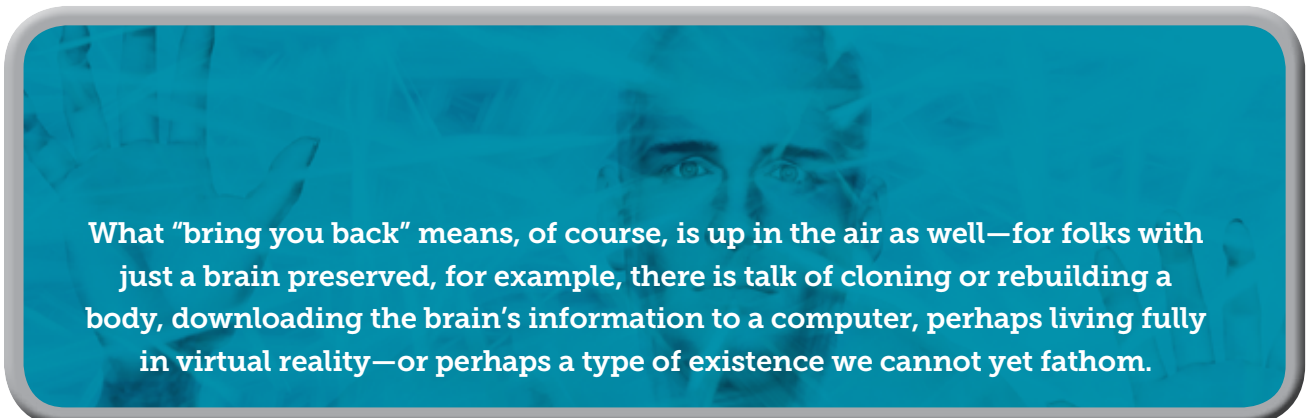
A simplified version of the actual cryopreservation process goes as follows:

1. Patient is placed in an ice-water bath and breathing is artificially restored (using a thumper that performs CPR) to maintain oxygen to the tissues.
2. In cardiac arrest cases, heparin is used to prevent the formation of blood clots.
3. Femoral arteries and veins are “surgically accessed” and used to establish a circulatory system “bypass loop.” This loop takes over the CPR function.
4. As the patient's blood is circulated and oxygenated, it's also cooled to lower the body temperature quickly, and is then replaced with an organ preservation solution.
5. The patient is packed with ice and transported to a suspension facility for further treatment.
6. At the facility, the patient undergoes an operation during which increasing concentrations of cryoprotective solution, similar to antifreeze, are circulated and replace all blood. Technically speaking, the solution does not “freeze” the brain and other tissues, but “vitrifies” them, turning them into a glassy substance and preventing the formation of ice, which can cause damage.
7. Patients are then cooled further and stored under liquid nitrogen at around negative 190 degrees Celsius in dewars (large vacuum-insulated tanks).

Even if started promptly, this procedure isn't perfect. The vitrified substance can fracture, for example, causing damage. And the American Cryonics Society notes: “Cryonic suspension subjects are research subjects where the procedures used are NOT proven techniques, and where ACS must use its own best judgment to determine what treatments are most appropriate for any given subject.”

But while shortcomings remain, the process has come a long way from earlier ones. Bob Nelson, a former TV repairman who became the first president of the Cryonics Society of California, led the first freezing (of a Dr. James Bedford) in 1967, which was recounted (using a pseudonym for Bedford) in a book published the following year.⁷ Bedford's body was then turned over

The hope is that cold temperatures can buy time and/or minimize blood loss and thus make existing medical procedures more effective. With cryonics, the difference is that patients are already legally dead. As a result, even colder temperatures are needed to buy even more time.



What “bring you back” means, of course, is up in the air as well—for folks with just a brain preserved, for example, there is talk of cloning or rebuilding a body, downloading the brain’s information to a computer, perhaps living fully in virtual reality—or perhaps a type of existence we cannot yet fathom.

to relatives, but Nelson continued to freeze and actually care for the bodies of several others in the years that followed.

Unfortunately, not all patients had financial arrangements in place to pay for the storage and dry ice (which was being used instead of liquid nitrogen at the time). As a result, Nelson eventually put multiple bodies into a single storage capsule to save money, but ran out of funds anyway and let the bodies thaw without telling anyone.

This lapse was later discovered and in the 1970s, Nelson was sued for what’s since been dubbed “the Chatsworth Incident,”⁸ named after the town in California where Nelson had purchased an excavated cemetery plot and kept the capsule that stored the bodies. (Note: Bedford’s body, because it was handed back over to relatives, was not thawed and actually has since been transferred to Alcor.) If the whole thing sounds like a movie plot, it might be; a few years ago there was talk of an Errol Morris film based on these events, but progress seems to have stalled.⁹

Following the Chatsworth Incident, two members of the Cryonics Society of California (which no longer exists) went on to form Alcor. But even with new procedures, Alcor hasn’t avoided bad publicity. While the freezing of Ted Williams may have put cryonics on the map for many, reports of his head being damaged and mistreated run rampant. Plus, reports suggest that his son signed him up for the procedure after his death, going against Ted’s wishes for cremation. In his book *Frozen*, Larry Johnson paints a gruesome picture of both the situation and the procedure (although Alcor denies his allegations).

More recently, cryonics was thrust in the spotlight via a *New York Times* feature on Kim Souzzi, a 23-year-old neuroscience student dying of brain cancer who crowdfunded her brain’s cryopreservation.¹⁰ She was able to successfully raise the funds via Reddit (and with the help of the Society for Venturism), and her brain was preserved after she died in early 2013. Alcor itself released mixed results on how the procedure went, though, first saying there was “negligible” or “minimal” cryoprotection, then saying protection was actually “vastly better” than originally reported, due to the fact that the CT scan had been uncalibrated.¹¹

Again, though, Alcor’s assessment of cryoprotection is not widely accepted. In fact, that’s what spurred neuroscientist Kenneth J. Hayward, Ph.D.’s call to action in 2011. In Alcor’s *Cryonics* publication, he wrote:

“I have discussed the idea of cryonics with dozens of my fellow neuroscientists over the years and this is the central question that comes up again and again: ‘Do current cryonic suspension techniques preserve the precise wiring of the brain’s neurons?’ The prevailing assumption among my colleagues is that current techniques do not. It is for this reason my colleagues reject cryonics as a legitimate medical practice.”¹²

Hayward thus offered a prize for the successful preservation of mammalian brain—a prize that was just won a few months ago when, as mentioned, 21st Century Medicine preserved a rabbit brain with all internal neurons and synapses intact. The new technique was hailed as a huge breakthrough for cryonics. But even assuming it will eventually be applied successfully to human brains, gaps remain—the first being the fact that there is currently no way to successfully revive the rabbit brain, nor any other cryonically preserved brains or bodies.

The Second Life Cycle

Cryonics organizations are upfront about the current medical gap between cryonic preservation and reanimation, with the American Cryonics Society writing in its brochure: “No animal with a backbone can now be frozen to liquid nitrogen temperature and revived. What our procedure seeks to do is reduce the damage which would otherwise occur.”¹³ Similarly, Alcor writes: “The nature of the injury caused by cryoprotectant exposure is currently unknown. We are hopeful that it is a relatively minor injury.”¹⁴

Which brings us back to the creation or discovery of new medical procedures; cryonicists are optimistic that technology and medicine will advance to a point that reanimation, damage control, and possibly curing the original cause of death are all possible. Dennis Kowalski, a paramedic and the president of the Cryonics Institute, summed up this thought process by saying: “Cryonics is an ambulance ride to a hospital of the future that may or may not exist. If the hospital is advanced enough, they’ll be able to bring you back. But if you don’t get in the ambulance, you’re guaranteed to be dead.”¹⁵

What “bring you back” means, of course, is up in the air as well—for folks with just a brain preserved, for example, there is talk of cloning or rebuilding a body, downloading the brain’s

information to a computer, perhaps living fully in virtual reality—or perhaps a type of existence we cannot yet fathom.

Thus, the many questions raised by the possibility of re-animation—cost of resuscitation, quality of life, culture shock, care, governance—tend to be answered with something along the lines of “we don’t know yet, but we will.”

Yount of the American Cryonics Society, for one, admits cryonics is a crapshoot, but is fond of saying that “it’s the best crapshoot in town.”

Funding the Cryonics Gamble

As things stand now, there are two main financial requirements for becoming a cryonics patient. First, you need to have funding in place; Yount said the big lesson from the Chatsworth Incident was for cryonics organizations to never take patients on credit. Minimum funding requirements vary by organization and run anywhere from \$28,000 to \$200,000. (Specific prices and breakdowns can be found in Table 1.)

Second, you need to become a member of a cryonics organization, which usually means annual dues of a few hundred dollars. Broadly speaking, these dues are meant to fund research, further fundraising, and eventually the cost of resuscitation (which cryonicists believe will end up being quite low thanks to technological advances). For ACS, annual dues are \$376 per year for the first four years and \$300 per year after that, with discounts for younger members and students.¹⁶ CI charges \$1,250 once for a lifetime membership or \$120 yearly and maps minimum funding to membership type. Alcoa charges \$525 annually with discounts for long-term members (over 20 years) and additional family members.

While annual dues are relatively manageable if you’re serious about the prospect of a second chance at life, the minimum funding requirements are a bit more daunting. As mentioned earlier, though, you don’t necessarily have to be outright wealthy to make cryopreservation happen (although some people do use trusts to cover their expenses). Instead, life insurance is often used as the funding means. A would-be cryonicist must take out a policy in the amount of the minimum funding requirement and name the respective cryonics organization the beneficiary.

Some insurance companies have no problem with such a setup; Daniel Witt, for example, is a retired actuary and current Alcor member who said he had no trouble taking out a life insurance policy with North American Company for Life and Health Insurance to fund his eventual cryopreservation.

But Rudi Hoffman, an insurance salesman who brands himself as the “world’s leading cryonics insurer,” noted that “insurance companies consider cryonics a reputation risk, often cannot see that there is an insurable interest on the part of the cryonics organization, and most of all are reticent to engage in corporate-owned life insurance.”

Hoffman says the most cryonics-friendly carrier is Kansas

MINIMUM FUNDING REQUIREMENTS

AMERICAN CRYONICS SOCIETY:

\$33,000 to \$153,000, whole body only

NOTES: Lower end requires membership of CI and ACS; upper end includes standby and a more “technologically sophisticated procedure”

KRIORUS:

\$36,000 for whole body

CRYONICS INSTITUTE:

\$28,000 to \$35,000 for whole body

NOTES: Includes just preservation; price is between \$88,000 and \$95,000 with standby/transport included. Young refers to this option as the “McDonald’s” of cryonics procedures.

ALCOR:

\$200,000 for whole body or \$80,000 for brain only

NOTES: Whole body breakdown is \$115,000 for storage; \$60,000 for cryopreservation; \$25,000 for standby, stabilization, and transport. Brain breakdown is \$25,000 for storage; \$30,000 for cryopreservation; \$25,000 for standby, stabilization, and transport.

City Life, which is also the carrier he recommended for my own indexed universal life policy—one with a premium of \$64 per month for a \$200,000 policy.

Beyond sometimes underwriting these policies, though, the insurance world doesn’t seem to have given much thought to the implications of a successful cryopreservation and resuscitation—perhaps because of the aforementioned “reputation risk,” or perhaps because insurance is generally meant to provide a guarantee and cryonics is far more speculative.

Most safeguards in place for patients, for example, are put there by the cryonics organizations themselves. The American Cryonics Society, for one, has “fail-safe” plans for a worst-case scenario where the organization would go out of business. In such an event, patients will remain frozen, with custody, trusts, and maintenance transferred to a new organization or company. ACS also contracts with the Cryonics Institute, and the two have an arrangement so that both would have to go out of business before it was necessary to transfer care to a third-party organization.

A would-be cryonicist must take out a policy in the amount of the minimum funding requirement and name the respective cryonics organization the beneficiary.

But those fail-safes are merely for the risk of the organization going out of business. ACS directly tells patients that even if reanimation technology is created, there remains a “host of other problems” that could prevent its application, such as “massive civil unrest or atomic warfare.” Patients of ACS are actually stored at CI in Michigan and, while there is the usual hazard insurance on the building, according to Yount and Kowalski, there is not any additional coverage for potential damage to patients. As Yount put it: “One could envision Lloyd’s of London, for example, issuing a policy that would pay off a lump sum should there be damage to patients—but such a policy (if it was issued at all) would likely be very expensive.”

In terms of insurance against another Chatsworth Incident, things are a bit more informal. With ACS, each frozen member has a live “sponsor” with the power to inspect the facility and monitor investments made on behalf of a patient. Similarly, the facility has logbooks for each patient and storage container, conducts yearly inspections, and uses containers that have long holding periods, “meaning if someone fails to fill [it] with liquid nitrogen in a timely manner that there will be a long time before the cryostat runs out,” according to Yount.

But at the end of the day, cryonics organizations can’t and don’t promise patients that they will never accidentally be thawed, Yount said. “In fact,” he added, “we ask our members (future patients) to sign a very extensive hold-harmless agreement that makes them aware of all the possible things that might go wrong.”

Kowalski seconded this, saying: “There’s no way we can guarantee people can be brought back. And we make people abundantly aware [of that].”

Because patients are made aware of all the possible question marks, they can add their own contingencies, including their preferred circumstances or minimum requirements for preservation, reanimation, and even a potential thawing. For ACS, all members include in their documents what they wish to happen to the body if it is not possible to keep them frozen, for instance. “Some wish burial in family plots; others want chemical preservation; still others have various other wishes such as being buried in permafrost,” Yount said.

In terms of reanimation, the idea is that the organization will, in a patient’s best interest and in the interest of science, determine when the time is right, should the proper technology come to exist. But patients can add their own specific stipulations if they would like.

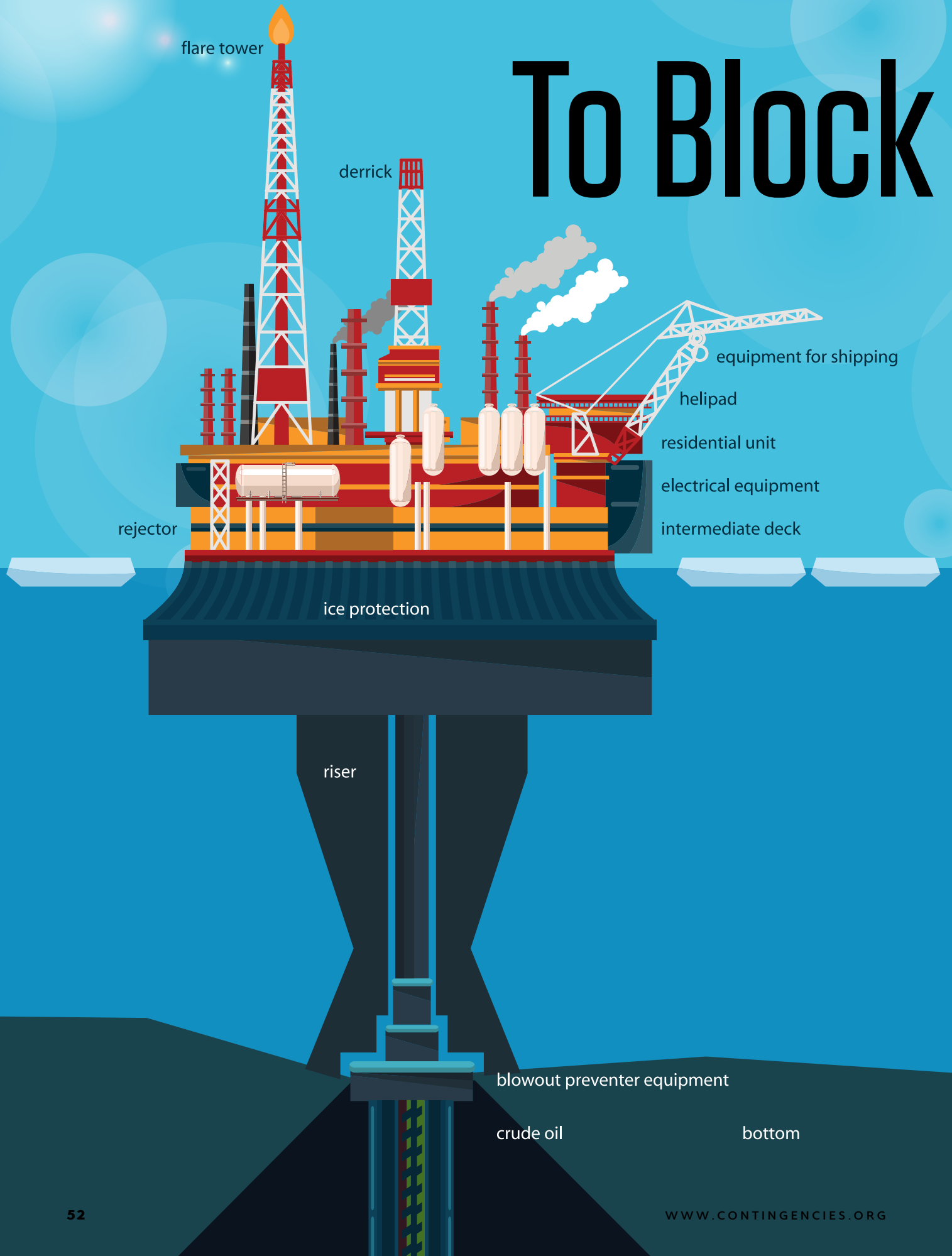
Still, the same bottom line remains: There are no guarantees. As Kowalski put it, “I can’t guarantee it will work, but no one can guarantee it won’t work, either. The only guarantee is that if you don’t try ... you’ll be dead.” □

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To Block



a Blowout

A possible partnership
between the actuarial
and earth sciences

By Roberto Gullco and José Manuel Castillo Covarrubias

IN THE OIL INDUSTRY, well loss while drilling underwater represents a real financial breakdown. Consequently, insurance against these losses has become big business and a financial rescue tool.

Normally, the calculation of premiums is based on applying a factor to the authority for expenditures, or AFE, of the well. In order to calculate this factor, actuaries use information that does not take into account the very nature of the source of this risk—the geological setting where the well will be drilled. The authors contend that earth sciences can complement actuarial science in estimating the probability that a well loss may occur.

To be clear, financial implications of this probability remain firmly in the realm of the actuarial field. But calculation of premiums using geological and geophysical information could lead to a truer understanding of risk, thereby allowing for individualized and competitive insurance products for well loss.

Normally, two wells in the same area and whose projected costs are the same would have to pay the same premiums, because the geological differences between the two drilling locations are not taken into account in the authors' experience. The AFE factor is merely based on statistical data common to both wells.

Well control while drilling is closely linked to the pressure in the pores of the rocks in the subsurface (pore pressure). A driller will experience a loss of the well control—that is, a blowout—when the drill bit cuts through permeable sands whose pore pressure is greater than the pressure exerted by the surrounding drilling mud. Pre-drill knowledge of the pore pressure is a fundamental piece of information that defines the risk involved in the operation.

Pore pressure calculations require certain data normally provided by the oil company. If this information is available, an optimized estimation of the premium can improve a premium calculated only from an AFE factor.

This optimized premium is characteristic for each individual well. Earth scientists can differentiate between wells that are easy to drill (low risk) and those with a high risk of control loss—and those that eventually would not be convenient to insure at all. In other words, the existence of geological and geophysical information allows the calculation of *individualized premiums*.

The probability that a well will experience a blowout can be estimated from the pore pressure profile in the well location prior to drilling. This probability would be the raw material for further calculations by the actuary.

Definitions

The underground materials—which may be unconsolidated, such as sands, or consolidated, such as sandstone or shale—consists of solids (minerals) and pores. The pores may be connected or not, but they are always filled with a fluid, which is (regrettably for the oil companies) generally water. The fluid contained in the pores is subject to a pressure, which we call pore pressure.

Imagine that we have a tank filled with sand and that the pores of the sand are saturated with water. Imagine also that the top of the tank is open to the atmosphere and that the height of the tank is H . At the top of the tank the pressure will be exactly one atmosphere. At the bottom, where the depth is H , the pressure in the water will be $P = P_{atm} + \rho gH$, where ρ is the density of water and g is the acceleration of gravity (when dealing with depths of hundreds of meters below sea level, the atmospheric pressure can be ignored).

Note that in ordinary circumstances, the pore pressure is close to the hydrostatic pressure. In fact, at a certain depth, if the actual observed pore pressure is close to the theoretical hydrostatic pressure at such depth, we say that the pore pressure is “normal.”

We can define the “equivalent density of the pore pressure” by: $\rho_{eqpp} = P/(gZ)$, where P is the actual pressure and Z the depth below sea level of the point. If such a density is close to the actual density of seawater (about 1.03 g/cc) the point is considered to be at “normal pressure.”

Because there are impermeable barriers between different zones in the underground, there is no connection of the fluids that exist in these different zones. The lack of connection generally implies different pressures. For instance, Zone A can have an equivalent density of the pore pressure of 1.03 g/cc, while the adjoining Zone B can have an equivalent density of the pore pressure of 1.7 g/cc (implying a very high pore pressure). These zones of high pressure have to be detected prior to drilling, because most of the hazards when a well is being drilled derive from high pressures.

When a well is drilled, the hole is permanently filled with a fluid—the drilling mud. When the bit cuts through permeable rocks, the pore pressure in these rocks must be less than the pressure exerted by the column of drilling mud. If the pore

pressure is greater than the pressure exerted by the mud column, a blowout may occur. If the drilling engineer knows the pore pressures in the area where the well is going to be drilled, he or she will be able to keep the appropriate weight of the drilling mud to avoid any hazard.

Another fundamental quantity closely related to pore pressure is the overburden pressure. At a certain depth, the overburden pressure is defined as the weight per unit area of all the materials (solids and liquids) located above the point in question. The pore pressure is always less than the overburden pressure. Theoretically, at a particular depth, the pore pressure could be equal to the overburden pressure, but this never occurs in practice. Even in zones of extremely high pore pressure, it is always less than the overburden pressure.

Again, the overburden pressure can be expressed as “the equivalent density of the overburden pressure”: $\rho_{eqop} = P/(gZ)$, where P is now the overburden pressure and Z, as before, is the depth below sea level.

Estimation of Pore Pressure

This well-developed branch of geology and geophysics is routinely applied to the design of wells. The knowledge of the pore, overburden, and fracture pressures (the last is very important but beyond the scope of this article) allows the drilling engineer to set the casing points and determine the mud weight along the well.

Pore pressure and overburden pressure are calculated from seismic velocities. Note that the two most important waves that travel in the underground are the primary or longitudinal waves and the secondary or shear waves. The velocity of the longitudinal waves is the parameter used in the calculation of pore and overburden pressure (fracture pressure is a function of these two). Wherever we have a tridimensional seismic survey, we can calculate a tridimensional distribution of velocity of the primary waves. So, for a certain region in space, we can have a velocity field, where the velocity is known at each point of the region. Hence, we can have pore and overburden pressure fields, meaning we know these two parameters at any point in the region, prior to drilling any well.

Perhaps the most critical point in the pore pressure calculation process is the assessment of the quality of the seismic velocities, which are the raw material for all further calculations. Note that an oil company that wants to insure the future well should possess the required seismic information. Nobody drills an exploration well without a previous seismic survey these days.

Estimation of Blowout Probability

Estimating the probability that a certain event may occur and assigning a financial meaning to such a probability is perhaps the crux of actuarial work. However, statistics in the realm of the earth sciences, where plenty of data are of a qualitative nature and ultimately scarce and incomplete, are more difficult to interpret than in other sciences. The authors, as earth scientists, will make some rough estimations of the probability of a blowout. However, we have not attempted to draw any financial consequences of such probabilities, because that is a field far beyond our expertise.

Example 1: There is only statistical information (the number of wells drilled in a certain sedimentary basin and the number of wells that suffered a blowout in the basin).

An oil company wants to drill a new well in a basin where N wells have already been drilled and k wells were obliterated by blowouts. What is the probability that the new well will suffer a blowout?

Under certain assumptions, it can be shown that this probability is not a single number, but a random variable, given by the beta distribution

$$f(x) = \frac{x^k(1-x)^{N-k}}{\frac{k!(N-k)!}{(N+1)!}}$$

where x is the probability that the well will suffer a blowout.

Eventually, we can use the mean of the beta distribution to reduce this probability to a single number:

$$P = \mu = (k + 1)/(N + 2) \tag{1}$$

For example, if N=30 and k=0 in a certain zone, the probability of having a blowout in a new well would be, according to (1), $(0+1)/(30+2)=0.031$.

Example 2: There is statistical information (total number of wells and number of blowouts) as well as values of the maximum observed equivalent density of the pore pressure, both for wells that were successfully drilled and for those that had a blowout. In addition, there is pressure information about where the new well is going to be drilled. Under these circumstances, what is the probability that the new well will suffer a blowout?

Consider that there are N wells, k of which suffered a blowout. An analysis of the maximum equivalent density of the pore pressure encountered in these k wells has been carried out, getting a probability density function that we'll call $f_1(x)$, x being the equivalent density values. Similarly, we can make a study of the maximum equivalent density for the N-k wells that were drilled successfully. Let us call this new probability density function $f_2(x)$. At the well that is going to be drilled, the maximum equivalent density of the pore pressure is given by x_0 . Then, according to the Bayes theorem,

$$P(\text{blowout}|x_0) = \frac{\alpha f_1(x_0)}{\alpha f_1(x_0) + (1-\alpha)f_2(x_0)} \tag{2}$$

where:

- α : proportion of wells that experienced a blowout (as discussed in the previous paragraph, the value is taken as the mean of the beta distribution, given by $(k + 1)/(N + 2)$).
- x_0 : value of the maximum equivalent density of the pore pressure observed in the future well.
- $f_1(x_0)$: probability density function of the maximum equivalent density for the wells that suffered a blowout, evaluated at x_0 .
- $f_2(x_0)$: probability density function of the maximum equivalent density for the wells which were drilled successfully, evaluated at x_0 .

Equation (2) provides the answer to the problem—that is, the estimation of the probability that a well will suffer a blowout if at the well the maximum equivalent density of the pore pressure is x_0 . Note that to apply this method, a lot of information must be available in order to set the probability density functions $f_1(x)$ and $f_2(x)$.

(It should be pointed out that the example above is a great simplification of a complex reality. The idea here is to show how a complex problem can be quantified.)

Example 3: The only piece of information is the equivalent density of the pore pressure at the well to be drilled—the proposed well is to be the first in a basin. What is the probability the well will suffer a blowout?

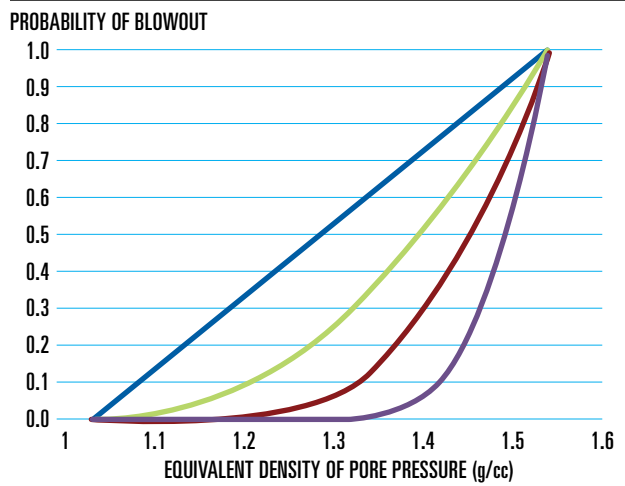
A heuristic approach can be taken to estimate such a probability. First of all, we accept that there is a relationship between pore pressure and the probability of a blowout. The greater the pore pressure (or the equivalent density of the pore pressure), the greater will be the probability that a well suffers a blowout. If a zone is at a normal pressure (when the equivalent density of the pore pressure is about 1.03 g/cc; i.e., the approximate density of seawater), the likelihood of a blowout is almost nil. We can say, then, that when the equivalent density of the pore pressure is 1.03 g/cc, the probability of a blowout is zero. Recall that for a particular depth, the equivalent density of the pore pressure will always be less or equal than the equivalent density of the overburden pressure. The latter density could be regarded as the maximum possible value that the equivalent density of the pore pressure can achieve, although overburden pressure and pore pressure (and their related equivalent densities) cannot be equal in practice. However, in the theoretical case in which both densities were equal, the whole system would not be mechanically stable. If both densities were equal, we would assign, arbitrarily, a probability of blowout equal to 1.

At this stage we have accepted that an increase in the equivalent density of the pore pressure results in an increase of the probability of a blowout. We have also defined two points. The first point implies that for an equivalent density of the pore pressure equal to 1.03 g/cc, the probability of a blowout is zero. The second point means that if the equivalent density of the pore pressure is equal to the equivalent density of the overburden pressure, the probability of a blowout is equal to 1. Note that this latter point is depth-dependent, so ultimately the probability of a blowout will be variable for different depths.

Although we have two points of the curve, we still do not know the shape of the curve. Empirically, we can guess that for low equivalent densities the probability of blowout increases slowly, while it increases rapidly for high equivalent densities of the pore pressure. Expressed in other terms, the derivative of the curve should increase monotonically, and such a curve should be concave upward.

Figure 1 shows the equivalent density of the pore pressure as the X-axis, the probability of a blowout as Y-axis, and several possible curves that relate both quantities, satisfying the two fixed points and the upward concavity. The graph is valid for a

FIGURE 1. Family of Curves Representing Possible Relationships Between Equivalent Density of Pore Pressure and Probability of Blowout



particular depth, where the equivalent density of the net overburden pressure is 1.54 g/cc. Note that the straight line is the upper limit of the family of possible curves. Above the straight line, any curve would be concave downward.

Assume now that we have a point at the depth for which Figure 1 was prepared, with an equivalent density of the pore pressure equal to 1.2 g/cc. According to Figure 1, the probability of a blowout for this point would range between 0 and 0.333. The latter point is taken from the straight line. So, knowing the equivalent density of the pore pressure, we do not get a single value for the probability but rather a range of values.

However, an average value of these two end values can be taken; that number would be the solution to the problem. Note that the solution presented here is completely heuristic, without a solid theoretical background. Most probably, the probabilities calculated with this method are relative rather than absolute.

Conclusions

Financial loss due to catastrophic events while drilling an oil well could be reduced if the probability of these events can be assessed by means of applied earth science tools, such as the geological setting evaluation and the pore pressure estimation. For this purpose, specific geological, geophysical, and statistical data must be collected and should be an input to any actuarial analysis. This article points out the basic steps to be taken into account to complement this work. The proposed approach would allow insurance companies to calculate individualized premiums related to well loss insurance, driven by a more precise knowledge of the risks at hand.

A partnership between the actuarial and earth sciences might bring new insights to the oil insurance business. □

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Open the Doors

How risk exchange can help address the organ shortage

HOW IS A HUMAN KIDNEY LIKE A HOUSE, a job, and a string of massive earthquakes? A new financial technique called risk exchange and more ordinary tools tailored to living donors could open doors to solving one of the greatest calamities of our time: the organ shortage.

Miraculous and Catastrophic

The organ shortage has gone beyond crisis; it has morphed into a large-scale catastrophe with a waitlist of more than 100,000 patients in the United States alone. The list continues to grow each year, in proportions overshadowing any physical disaster ever experienced in U.S. history. Worldwide, *The Lancet* reported 5 million people needed dialysis or kidney transplants in 2010, yet estimated only half—at best—could access treatment crucial for survival. The extreme magnitude of the calamity suggests that the organ shortage may warrant an emergency response, much in the way special teams are called to respond to a major catastrophe.

The miracle medical advancement of organ transplantation has allowed thousands to maintain active lifestyles, to enjoy a high quality of living for decades, even after severe diagnoses of end-stage renal disease (ESRD) that would otherwise result in permanent disability. Improvements in anti-rejection drugs and innovative programs like “paired matching”—allowing kidney recipients to swap for the most compatible donor—are leading to increasingly

better outcomes. But deceased donor organs, such as those procured in fatal accidents, are neither in great enough supply to meet demand, nor do they last as well as kidneys from living donors. Accidents can be remote, or damages too severe, to procure organs. Families and loved ones cannot always meet the need for organs among themselves, es-



pecially smaller families, those without children, or those with certain medical conditions.

Compounding the shortage of living donors is a rigid and unsound system. Living donors arrive with benevolence but are shut out by staggering costs and shaky, inconsistent protection to their own physical well-being. Patients unable to receive a timely transplant wind up in

deteriorating states of disability. Black markets emerge, further endangering the poor. This system begs for flexibility from the financial sector, which can feasibly bend in response. It is time for some mathematical solutions to this ongoing disaster.

Flexible Financial Tools

Missing from the imbroglgio are the financial and risk-based approaches essential to solve the organ shortage, which this article will describe. The tools are largely available; for those that are not, the market has room for innovation.

In the past, protection against large-scale catastrophes was limited by insurance company capital until an innovative product appeared—the “catastrophe bond.” The sale of these bonds opened up financial market capital, enormous resources to protect disaster-prone areas along coasts and fault lines. “Cat bonds” pay a sizeable coupon, but in a disaster the bond defaults and instead pays to the victim.

Framing a medical crisis as a catastrophe allows similar solutions to unfold. The ability to tap into financial markets makes resources available.

A bewildering example of inflexibility is found in the insurance coverage for anti-rejection drugs; Medicare, for example, ends coverage after a fixed three-year term. This sharp cutoff assumes two things: first, that the recipient will have

fully recovered with the new organ by a preset deadline and will no longer be disabled; second, that the recipient will resume employment with health insurance or earnings to accommodate the high cost of the organ-sustaining medication. But, if those assumptions should not hold, all the good of the costly procedure will be instantly undone. The body will reject the organ. A patient who might have benefited for upward of 20 years from an organ sustained by meds is instead returned—redundantly—to the waitlist.

A brighter future could be in store by using existing financial practices, and from new methods begging to be tested and tried. For decades, investors have diversified portfolios to minimize risk. By now, weather is being traded on markets, because atmospheric patterns have no prospective correlation to the rest of the market. Risk has been reduced, transferred, and diversified, with new twists on age-old financial products. What if risk itself could be exchanged?

Cost-Benefit Analysis

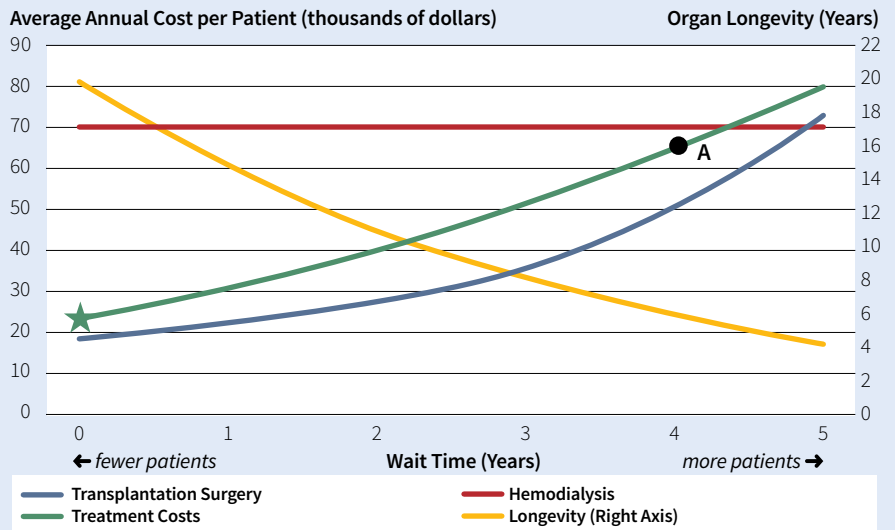
To arrive at a solution to the organ shortage, a simple numerical system can be created, optimized, and enhanced:

1. The most basic model begins with medical costs alone.
2. Income earnings and disability payments amplify the initial results.
3. A quasi-financial value may be established for quality of life, portraying the overarching goal of medicine. The subjective nature of this element dictates flexibility within the system.

Medical Costs

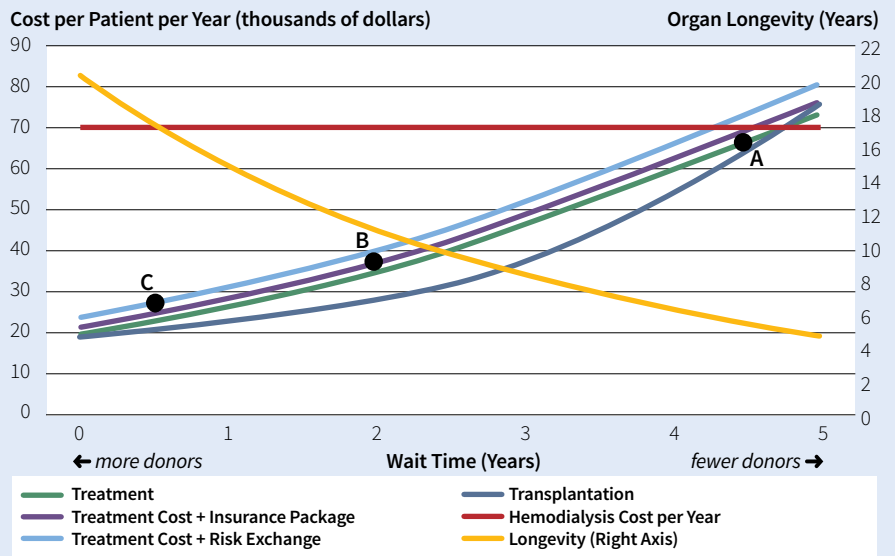
Transplantation should be long-lasting, so costs are given as an annual average over the organ's lifespan. Any delays necessitate the imperfect alternative of

FIGURE 1. Transplantation Cost vs. Wait Time
Recognizing organ longevity



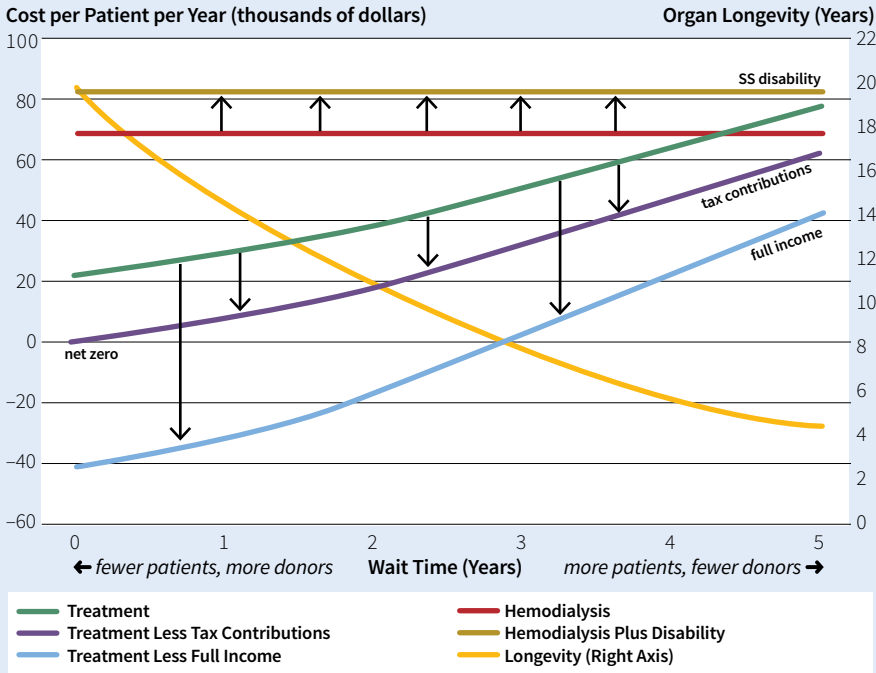
Treatment cost per year considers the full term of hemodialysis preceding surgery plus the future longevity of the organ, and incorporates costs for anti-rejection drugs. At point A, the average considers the past four years of hemodialysis, transplantation surgery, and future six years of anti-rejection drugs; at this point, the patient has had to wait too long for the transplantation option to realize many advantages.

FIGURE 2. Transplantation Cost vs. Wait Time
Recognizing organ longevity



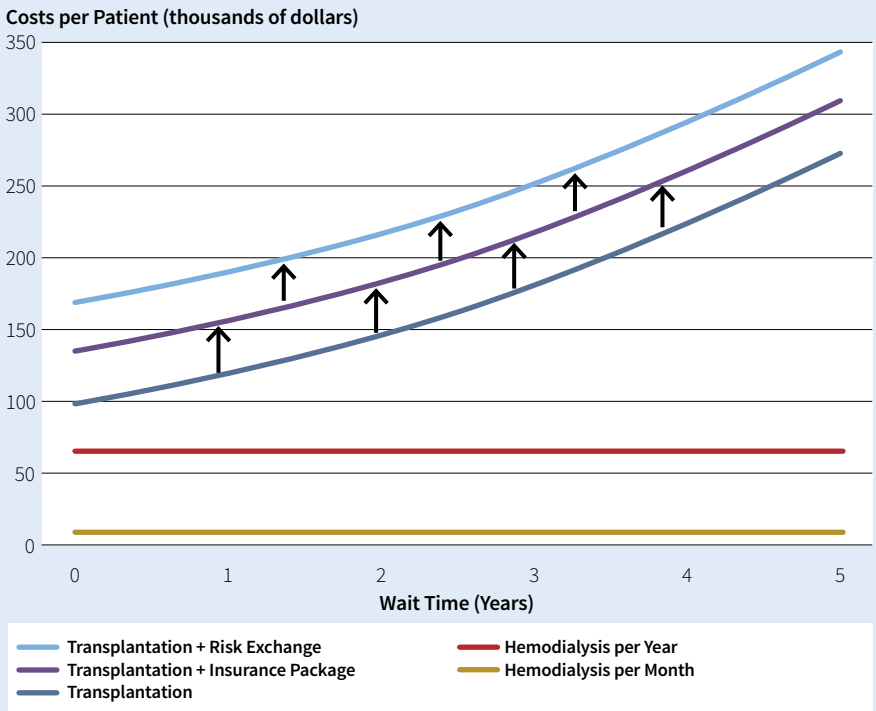
As more donors enter the system in response to investment, the added costs are more than offset by leftward movements in wait time. This hypothetical example begins at Point A, where transplantation does not realize any sizeable cost savings. Investment in an insurance package for donors shifts the cost curve up and the wait time leftward to Point B. Investment in a full risk exchange solution shifts the cost curve up more and the wait time further leftward to Point C.

FIGURE 3. Transplantation Cost vs. Wait Time
Recognizing Organ Longevity & Income



A net-zero cost solution is achieved from the transplant patient's renewed ability to work and contribute to society.

FIGURE 4. Transplantation / Donor Cost Fallacy—Neglecting Longevity



Term budgets may view investment in donors as adding to total costs, if organ longevity is ignored.

dialysis, which does not completely filter the blood as a human kidney does. As a result, the patient's health will deteriorate, increasing the complexity and cost of surgery the longer the recipient must wait. The longevity of the organ can be markedly lower for a less healthy recipient. All three factors drive average costs up with wait time: the increasing cost of the surgery, the high cost of interim dialysis, and the diminishing longevity of the organ. Fitted cost curves will vary by patient profile, but the illustrative example describes the predicament.

The "first-come first-served" nature of the waitlist means that patients entering the queue will produce a rightward movement in wait time. That means that any growth to the list will bump up wait times to the full sequence of new entrants. Yet success of the procedure in terms of costs and organ longevity would dictate otherwise—that organs go to the newest members entering the waitlist. Skipping over waiting patients would seem unconscionable. The length of the waitlist relative to available donors is represented by movements in the wait time. To reach the desired zero wait time, the supply must equal the demand, that is, the number of donors must equal the number of waitlist patients.

Optimization of organ longevity represents the lowest risk to organ recipients. Notice that contrary to most common problems, higher costs here do not produce better results; rather, poor results are costly. Optimization of risk and costs follow the same direction to the solution with no trade-offs or conflicts. Solving the optimum at zero wait time appears trivial but is not possible without living donors.

New donors are essential to an optimal solution at a one-to-one ratio—one donor to each patient presently waiting.



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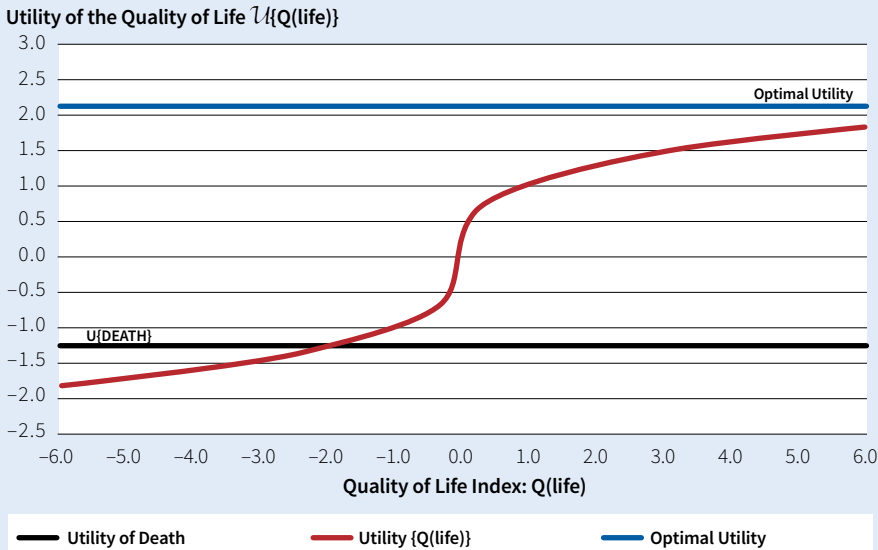


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FIGURE 5. Utility of Quality of Life



This adds risks and costs to the donors, revising the system equation. This direct one-to-one transfer of life vitality—from an otherwise healthy donor to an unhealthy patient—has confounded present-day logic and led to massive system failure.

In the first article in this two-part series, risk ranking showed that risk of donation is ordinary, compared to common occupations in present practice. Based on death rates alone, the risk of donation was seen to be similar to a year of employment as a roofer, garbage collector, firefighter, or long-haul trucker, and safer than being a fisher, logger, or pilot over the same time span. These results suggest that, theoretically, a much-needed organ could be no farther away than the nearest fire station, and no later than the next trash pickup.

The donor may also be viewed as an emergency responder with an excellent chance for saving or extending exactly one life. But donation is an elective procedure (akin to rhinoplasty), requiring the donor to sacrifice not only an organ but a month’s income for recovery plus the risk of financial ruin in the event of complications. It would be preposterous

to send firefighters to rescue others with no insurance protection for themselves and no promise of stable income and employment.

The Net-Zero Solution

The initial results are amplified remarkably by income considerations. An early recipient is likely to enjoy an active, high quality of life over longer years while earning income. Contributions toward Social Security, income taxes, and health care premiums will offset the treatment costs, where the treatment is the very foundation for such paybacks. In stark contrast, most hemodialysis patients are disabled. Social Security disability payments benefit them much like income, but at a hefty price to society.

A net-zero cost is shown at a zero wait time. This basic result represents the total self-sufficiency of successful organ recipients.

Full earnings can also be substantiated as a measure of costs versus benefits to society, where the recipient’s productivity is valued in a simplified manner according to salary. Negative costs represent an overall gain.

A new organ can cost as much as a house—and perhaps should be treated like one. Since an organ may last as long as common mortgage terms of 15 to 30 years, costs could be amortized with guaranty insurance features built in to the loan. A sudden increase of donors by the thousands might otherwise cause shock losses to term budgets like Medicare. Savings arise from proper allocation. If payers are individuals, full tax credits could cover the recipient’s “second mortgage” and eliminate all burdens of disability costs to society.

Quality of Life

Analysis is only complete when we add quality-of-life implications. This element emphasizes the actual purpose of medicine: not merely to keep people alive, but to allow them to thrive. Quality of life correlates strongly to health and income, but may be evaluated differently among individuals, for instance, between scientists and athletes. More individualized is the personal value—the utility—that is derived at each state. Life itself is “priceless,” yet there are only so many resources that can feasibly be invested in improving quality of life, regardless of how highly such improvements may be valued.

Valuating utility is inexact but may be deduced by comparison. Maintaining a prosthetic arm has cost an average of \$800,000 per veteran. Such a value may serve as a gauge for allocating resources toward self-sufficiency. Huge quality-of-life improvements are evidence of room to invest in living donors. To this end, costs and risks must be well managed, through prevention, reduction, transfer, compensation, and innovatively through “risk exchange.”

A complete utility equation for transplantation (or hemodialysis) can be written as shown in Figure 6.



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FIGURE 6. A Complete Utility Equation for Transplantation

$$\begin{aligned}
 \mathcal{U}_{(t)} = & - \frac{\text{Total Medical Costs}}{\substack{-(\text{Fixed Cost}_t) \\ -(\text{Annual Cost}_t)}} - \frac{\text{Living Donor Expenses}}{-(\text{Fixed Cost}_e)} + \frac{\text{Total Income (Contributions)}}{[\text{+income}]} - \frac{\text{Total Disability Payments}}{[\text{-income}]} + \frac{\text{Value of Life Enjoyment}}{\mathcal{U}\{Q(\text{life}_t)\}} \\
 \mathcal{U}_{(t)} = & - (\text{Fixed Cost}_t) - (\text{Fixed Cost}_e) - (\text{Annual Cost}_t) \times (\text{years}_t) + \sum_{i=1}^{\text{years}_t} [\text{+/- income}_i + \mathcal{U}\{Q(\text{life}_i)\}] \\
 \text{The per-year utility can then be written:} \\
 \mathcal{U}_{(t)} = & - [(\text{Fixed Cost}_t) + (\text{Fixed Cost}_e)] / (\text{years}_t) - (\text{Annual Cost}_t) + \frac{\sum_{i=1}^{\text{years}_t} [\text{+/- income}_i + \mathcal{U}\{Q(\text{life}_i)\}]}{(\text{years}_t)}
 \end{aligned}$$

Prevention. Not all cases of ESRD are preventable, but prevention is cost-effective for eliminating overall risk. The costs of prevention lie outside of a “per patient” optimization. Instead, prevention is shown as a leftward movement in wait time as a result of fewer patients waiting. Prevention ultimately supports the capability of donors to optimize the system.

Reduction. In Part I, the risk of death to a donor was shown to be 0.03 percent historically, with most risk within a year of the procedure. But the risk is not evenly spread among donors, or among transplantation centers. “Risk exchange” seeks to not only trade risk but to reduce it. This reduction may come about by seeking donors of the greatest resilience, access to the safest and most reputable surgeons and facilities, and improved geographic coordination for paired matching.

Transfer. In a broad range of cases, insurance products provide a support system that might otherwise not be available to individuals at a time of need. For risky occupations, workers’ compensation coverage provides an indemnity component that reimburses lost wages during the period a covered person is unable to work, and a medical component to cover medical costs of workplace

injuries. From a pure risk standpoint, the workers’ comp policy provides nearly all the protections a living donor would require. Additionally, an expense component of a complete donor policy package could provide a fixed reimbursement for lost wages during the anticipated recovery.

Under such a framework, the donor may be considered an employee of the hospital, as essential to the procedure as the surgeon and staff. The legal liability spurs the hospital to transfer its risk—as it does with its other employees—to an insurance company. The workers’ comp policy format may be tailored to the unique circumstances of living donation, covering a caregiver or travel costs to the transplantation center. A secondary class code may apply to the donor’s primary occupation and indemnity levels for lost wages. Attention should be given to ideal policy mechanisms built in to the workers’ comp model: experience rating, which encourages safety of the transplantation center, and rehabilitation, which accelerates an injured donor’s return to work. These mechanisms contribute toward risk and cost reduction.

Given the imperative for financial security, it is possible that wage replacement and insurance protection might be the only tools needed to forever eliminate the organ shortage. If not, risk exchange tools can be tailored.

Compensation. In undeveloped countries, the poor have been coerced into selling organs. In many cases, these vendors eventually return to the original state of desperation. Establishing the practice as illegal was intended to prevent exploitation. Such laws have backfired, because the most desperate now face unsafe conditions and may be deceived out of payment. Bioethicists study the controversies brought about by advances in biology and medicine. Because risk to organ vendors is similar to that of other common occupations, most bioethicists agree that compensation need not be illegal; rather, the problem is that compensation is inadequate.

Clearly, in the organ trade, the vendor has only one kidney to offer. A risk exchange will only be effective if the vendor has stable employment to return to. Otherwise, the donor may become desperate again and will be without another organ to sell. Such an outcome suggests that the fair trade for an organ may be a living wage lifetime annuity. From a risk exchange perspective, the organ donor would be permanently removed from risks of poverty.

Ironically, such an arrangement is financially feasible when the exchange rate between nations is uneven. Wealthy countries can provide a living wage life annuity to donors in poor countries, as long as stable banks can



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The miraculous medical solution of transplantation has advanced to the point where it could restore life and livelihood to thousands of people.

provide this financial product. The cost of the transaction may be no greater than risk exchange for the roofer within the wealthy country, but it may be vastly more beneficial to the poor. To remove the flow of organs in one direction between countries, a fund for local procedures could be established as part of the risk-exchange provision.

Compensation for organ donation is a complicated subject, both ethically and pragmatically. A national discussion about the ethics and implications of compensation, including consideration of the risks and potential for alleviating suffering, is appropriate.

Exchange

The Concept of Risk Exchange

Insurance is a classic example of a risk transfer, which includes financial consequences of a risk, for reimbursement. Actual transfers and exchanges of risk—not the financial consequences, but risk itself—are taking place constantly. As an everyday example, a young adult may give up a seat on a bus to a senior or carry luggage for a frailer person. We tend to see these actions as common courtesy borne from intergenerational cooperation and human diversity. In these examples, the young adult has a risk advantage: His potential for injury is considerably less than another's.

Notice that the value of a person's well-being is not measured by a future stream of income, as may be used for approximating human worth in some business applications. There is an intuitive appreciation for sheltering the vulnerable person. The young adult may have the larger stream of future income and could be assigned the higher "economic" value. Yet risk is not transferred away from—but rather onto—that person.

Risk exchange has enormous potential benefits when it reduces risk overall; that is, when the activity can be performed by someone to whom the risk is negligible, so that detrimental outcomes diminish. Thus, if a risk component were a financial instrument, it could not be represented by a fixed value; rather, its value would depend upon its holder.

The Basics of Risk Exchange

Imagine, for any trade, a time period exists that would make the insurer indifferent to "exchanging" the risks with a living donor. If the time period were one year for a roofer earning \$50,000 per year with a workers' comp premium rate of 40 percent of payroll, then the monetary value of this risk exchange would be \$70,000 in theory.

Note from this result that the dollar amount in the exchange does not represent a fixed market price nor a commodity price for an organ. A flat payment would not be effective. Rather, the value defines a set of conditions that maintains a steady level of risk and income for the donor. The arrangement is based partly on insurance protections but also requires a stable occupation to return to at the end of the established risk period. Because the exchange is donor-focused, its valuation must vary with conditions. The insurer continues covering the financial consequences of risk, so it exchanges the type of risk that is being transferred while its accounts are unchanged. The tradesperson is exposed to the risk directly, and therefore is engaging in an exchange of actual risk. Whether an agreement was made would depend upon the specific risk preferences of the individual, toward both levels and types of risk.

Notice that an exchange in which

income is stable removes potential for coercion of vulnerable poor; preference for time off is not an unfair inducement, because it keeps risk the same as for the day job. In practice, risk exchange would seek to trade risk down to its lowest bearer. However approximate it may be, this example immediately suggests a system where not only recipients could benefit enormously, but donors as well.

Should Help Come Knocking

The miraculous medical solution of transplantation—once possible only between identical twins—has advanced to the point where it could restore life and livelihood to thousands of people. Doors to access are currently closed, too solid for individuals to break down. Financial instruments can be the crowbar to open doors to collective action. The optimum will be reached if we remember these tools are meant for those who are already trying to help. One living donor reflected on the gift of a genetically well-matched kidney she gave her sister over 20 years ago, and only wished she had another to give. □

This article is solely the opinion of its author. It does not express the official policy of the American Academy of Actuaries; nor does it necessarily reflect the opinions of the Academy's individual officers, members, or staff.

GWENDOLYN ANDERSON, MAAA, ACAS, is a property/casualty actuary with background in catastrophe and workers' compensation. With special thanks to Sigrid Fry-Revere, founder of the American Living Organ Donor Network, which helps make donation possible by covering basic expenses and wages of donors; and to [Anonymous], who donated to a kidney to her sister 20 years ago and now only wishes she had another to give.

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Queen's Gambit

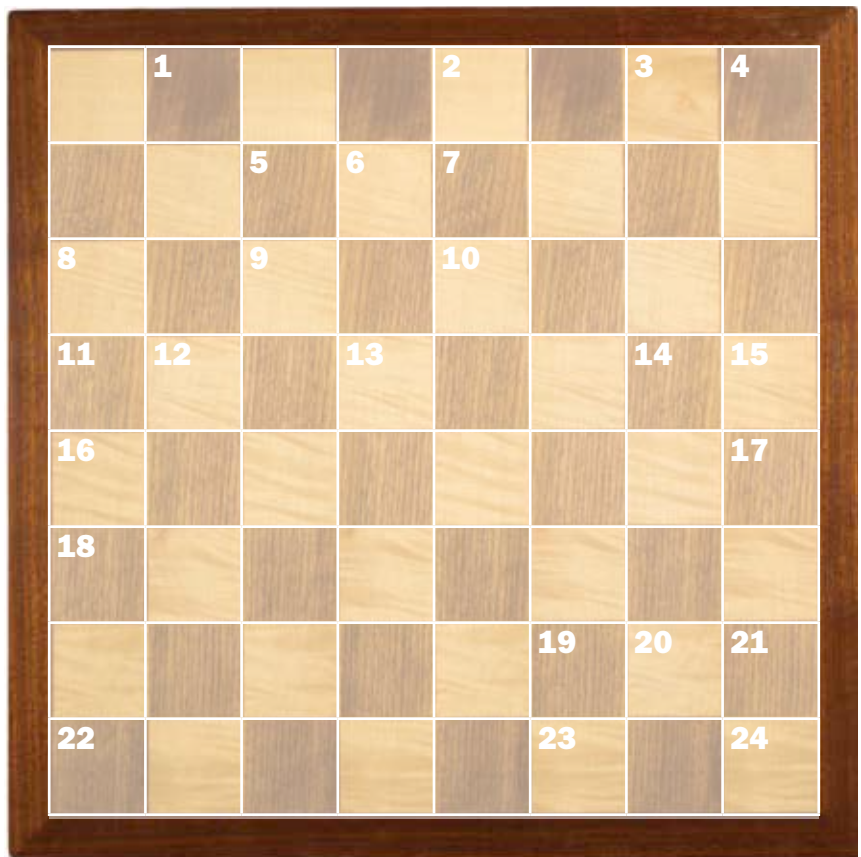
THE CHESSBOARD DIAGRAM SHOWS TWENTY-FOUR STARTING POSITIONS FOR A QUEEN. The answers to the clues will be entered into the diagram in a direction for you to determine. The movement will always be in straight lines. As an aid, there are eight directional answers, one for each of the eight possible ways an unencumbered queen can move. For example, if one of the answers were SLANT, the entry would be slanted, too. Some of the directional answers will suggest unique directions; EAST or EASTERLY would indicate horizontal movement from left to right. Other directional answers, like SLANT, will only narrow down the possibilities.

The hints provided below give the direction for each answer. Let me know whether you used the hints in solving.

There are two proper nouns and one common foreign word. All the other answers are playable in Scrabble. Ignore punctuation, which is designed to confuse.

Thanks to Eric Klis, Bob Fink, and Jerry Miccolis for test-solving and editorial suggestions.

1. Elmer Fudd's progressive woof
2. Inconsequential ironwork
3. Organization of American States taking temperature of grain
4. Hairs I hear found in smoked salmon
5. Poles akimbo on ski trail
6. Colors affixed to mug
7. Duplicity cut short by Uwe's wife
8. Identify one with extra pay as an imbecile
9. Twilight for First Lady
10. Blue feathers
11. Buffet for Spanish king
12. Ted's getting a failing grade: this needs to be reversed—and quick
13. Chips off the old block with overtones of arrogance
14. Sandbar with a bunch of fish
15. Encounter bosom enhanced with a bit of lift
16. Inadequate dexterity with bow
17. Belgrade resident appearing in capitals of Slovenia, Estonia, Romania, and Bosnia



18. Big Brown I'd expect in first place with a big potential payoff
19. Take on a story of Galen, post-surgery
20. Churchgoer beheaded for robbery
21. Untroubled after fluster gets put to rights

22. Long Aida directed with bias
23. Guerrilla leader in pain after inauguration
24. Hesitant to support protégé

| | | | | | | | | | | | | | | | | | | | | | | | |
|-------|-------|-------|-------|--------|-------|-------|--------|--------|--------|---------|---------|---------|--------|---------|---------|--------|--------|---------|--------|--------|---------|---------|--------|
| 1. LR | 2. LR | 3. TB | 4. RL | 5. DLR | 6. TB | 7. LR | 8. DLR | 9. URL | 10. TB | 11. DLR | 12. VLR | 13. DRL | 14. RL | 15. DRL | 16. DLR | 17. TB | 18. BT | 19. URL | 20. BT | 21. BT | 22. URL | 23. URL | 24. RL |
|-------|-------|-------|-------|--------|-------|-------|--------|--------|--------|---------|---------|---------|--------|---------|---------|--------|--------|---------|--------|--------|---------|---------|--------|

Directional hints

Previous Issue's Puzzle—Are You Sirius?

A Star Is Born

An artisan (let's stretch the definition)

Did wonders with a soup can he had drained.

His model sat near looking mighty pained

And gave no indication of contrition.

"I hate to brag, but I nailed my audition.

My tardiness is easily explained:

You sing; present a scene; then get detained.

My costar calls it 'Broadway Inquisition.'"

The way one sees an ox pull on a yoke.

The way a Lee ad makes one overpay.

You give a gal an inch, pal, and you're through.

So April Fools! She stopped to do some coke.

Now empty your gelée tubes while ye may;

A new star lives on old stars' residue.

artisan = SINATRA

soup cans = CANOPUS

sat near = ANTARES

gave = VEGA

to brag = BOGART

tardiness = STREISAND

sing present = SPRINGSTEEN

costar = CASTOR

ox pull = POLLUX

Lee ad = ADELE

Inch pal = CHAPLIN

So April = POLARIS

gelée tubes = BETELGEUSE

lives = ELVIS

Solvers

Not many solvers this time around. I know it's a hard puzzle when my test solvers need to use reference sources! The star that threw most people was Canopus. I didn't know that one before I started, either. It's surprising how few stars' names are widely known. One of the joys of cryptic puzzles, as opposed to crosswords, is that they don't deal in arcana. A couple of solvers sent lists containing some very obscure stars (Rana, Theta, Ensis). I don't think these can be anagrammed from one or two words; in order to get them you have to make partial anagrams, which wasn't the deal—or at least not the deal as I conceived it. I try in my puzzles to avoid really obscure things. Okay, sometimes to fill out a grid

I have to use a rare or foreign word or something, but for the most part, the difficulty in cryptic puzzles is untangling the wordplay. Difficult wordplay coupled with obscure answers would lead to misery, in my opinion. Because there aren't enough commonly known celestial stars, I used only seven (with apologies for Canopus) and chose stars of a different sort for the other seven. Solvers who realized that early had a much easier time of it. "Lee ad" was the most common entry for identifying the trick.

Solvers at the Excruciating Level:

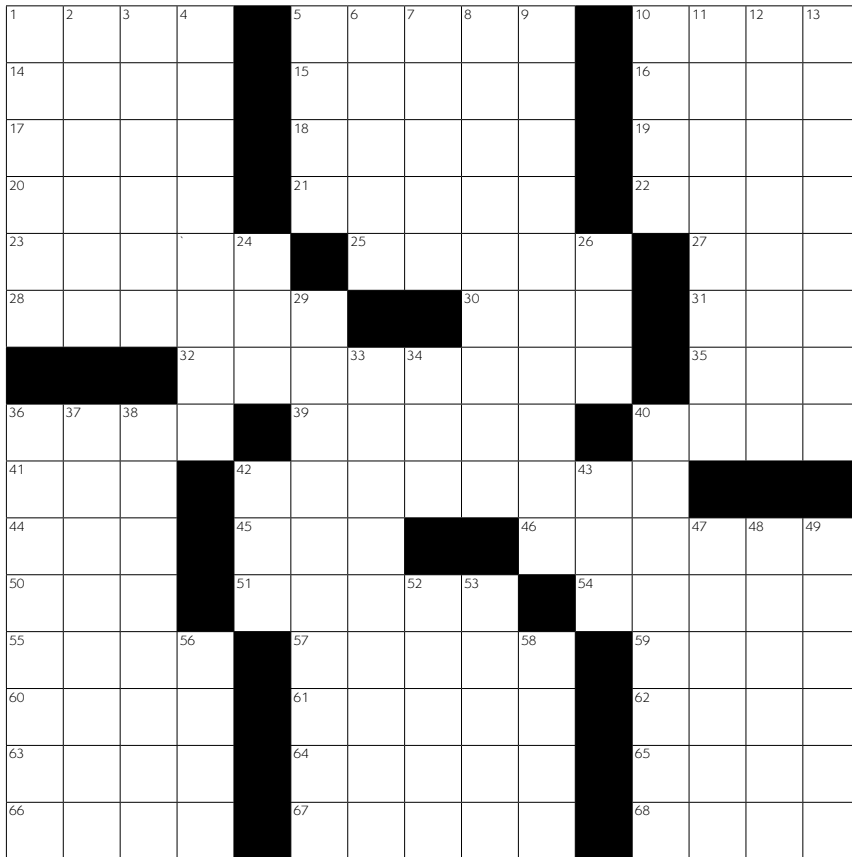
Dean Apps, Bates, Buckner & Zurhellen, J&J Holloman, Jim Muza, Doug Szper

Solvers using some hints (or not saying):

Todd Dashoff, Sean Donohoe and Josh DenHartog, dba T.O.C.E (The Thousand Oaks Cryptic Enthusiasts), Bob Fink, Phil Gollance, Eric Klis, David Lovit, Tim Luker, Jerry Miccolis, David & Corinne Promislow

TOM TOCE is a senior manager for actuarial services with Ernst & Young in New York and is a member of the Jeopardy Hall of Fame. Solutions may be emailed to thomas.toce@ey.com. In order to make the solver list, your solutions must be received by Sept. 30, 2016.

Stockholm Visitors



Across

1. Eastern title
5. Plant opening
10. Late-braking development?
14. Awesome!
15. Rover
16. Generic term for 40 across
17. Energy bar
18. Pacify
19. Drunk and dull endings
20. LIC governance board
21. Fleecing operation
22. Captive Ins. Assoc. of big sky country
23. Macro or micro follower; related to limbs
25. Ten or pen follower
27. Chance
28. Heat, informally
30. ___ Fit
31. Fed. med. org.

32. Dispossess
35. Naval CIA
36. Frontier friend
39. Kind of charge
40. Rabbit relative
41. PEI to Newfoundland dir.
42. Nationals
44. Check
45. Earlier
46. Jerks
50. ER setting
51. Opulent
54. New parent craving
55. Drudge
57. Musical stress
59. Earthy deposit
60. On Vine St., say
61. Only one of 53 down
62. Incan sun god
63. Sports figures
64. 5-sided flag waver
65. Tam sporter
66. A "beautiful" prize winner
67. i.e.
68. XXX

Down

1. Pitch

2. 1990 winner
3. Eaves dropper
4. Wrapped lunch again
5. ___ nose
6. Normal muscle tension
7. Saudi neighbor
8. 1990 winner
9. Upbraids
10. Castigates
11. Chess grandmaster
12. Calligrapher's medium
13. Impaired sense of touch
24. ___-les-Bains
26. You, to Goethe
29. 1985 winner
33. Corrected
34. Infl. indic.
36. It might have many names
37. Tight wrapper?
38. Overhauls
40. King David, to some scholars
42. Tube top
43. Doc. certifiers
47. Medium medium
48. 1997 winner
49. Shoves off
52. Hot compress
53. Norville Barnes inventions
56. Castigate
58. Celery follower

Previous Issue's Puzzle: Blacktie Swan




Solvers

Anthony Amodeo, Dean Apps, Andrew Boyer, Charles Chacosky, Joshua DenHartog, J&J Holloman, Matt Kranovich, Renee Kudrak, Timothy Luker, Jim Muza, Zig Swistunowicz, and Doug Szper.

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Marbles in Boxes

I REALLY ENJOYED THE PUZZLE FROM MARTIN GARDNER that was used as a warm-up in the May/June issue (“4x4”). The only concern was that it was relatively easy for this group. It led me to consider possible generalizations. Here are two generalizations of that problem that may be more challenging. The first increases the number of colors to three. The second stays with two colors but increases the number of marbles in each box to three and the number of boxes to four.

1. Imagine that you have three boxes, one containing a red and a blue marble, one containing a blue and a green marble, and the third, one green marble and one red marble. The boxes were labeled for their contents—RB, BG, and GR—but someone has switched the labels so that every box is now incorrectly labeled. You are allowed to take (i.e., draw) one marble at a time out of any box, without looking inside, and by this process of sampling you are to determine the contents of all three boxes. What is the smallest number of drawings needed to do this?

2. Imagine now that you have four boxes, each containing three marbles. One with no black marbles, one containing one black marble, one with two black marbles, and the fourth box, three black marbles. The remaining marbles in each box are white. The boxes were labeled for their contents—WWW, BWW, BBW, and BBB—but someone has switched the labels so that every box is now incorrectly labeled. You are allowed to take (i.e., draw) one marble at a time out of any box, without looking inside, and by this process of sampling you are to determine the contents of all four boxes. What is the smallest number of drawings needed to do this?

A certain amount of chance is involved in both of these problems. That is, the number of draws you need will vary depending on things you won’t know in advance—how the boxes are (mis)labeled, which boxes you select, and which marbles you pick from those boxes. Of course, the answer for each problem is the smallest over all possible values of the unknowns. And to justify your answers, you must provide a single strategy for each problem that works no matter what the situation is. The strategy can vary depending on the knowledge gained from prior draws.

If you find these problems too easy, you

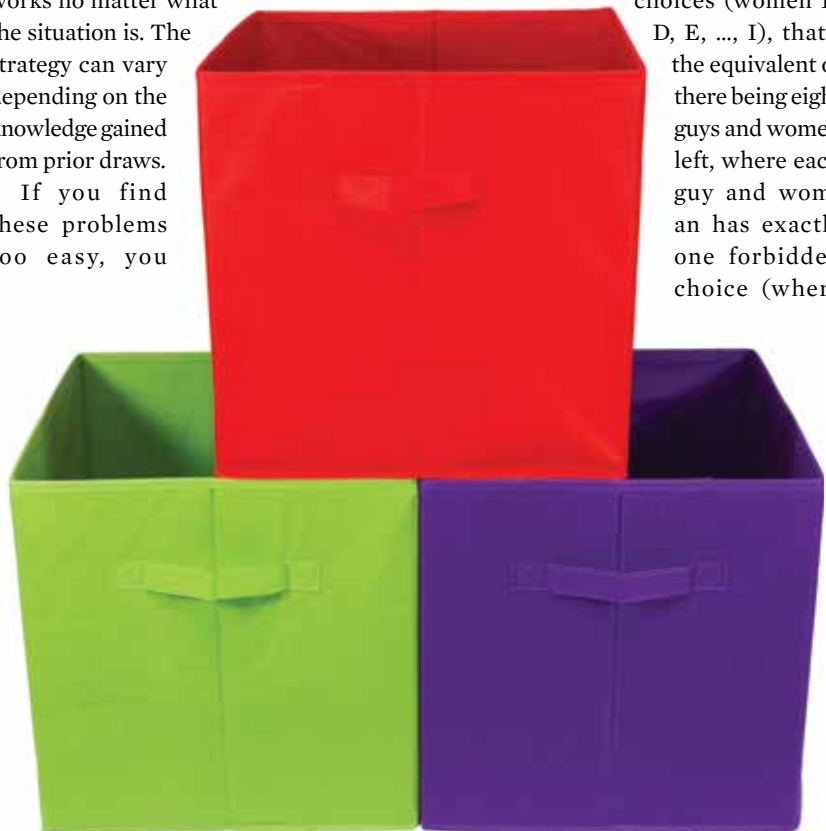
might try to generalize them even further or determine the minimum expected number of draws.

Previous Issue’s Puzzle: Mix and Match

1. If the Truth Booth shows a match, what is the probability of a blackout?

As one couple is a match, there are nine guys and gals left. Mark the guys as A, B, C, ..., I, and the ladies A, B, C, ..., I, where guy A and gal A are a perfect match. Assume guy A picks a woman who is not his match. There are eight women the guy could pick. Assume he selects woman C. Next, let man C pick his match. If man C picks woman A, then there are seven women and men left, and each guy/gal has one forbidden choice. However, if man C picks any of the sev-

en remaining wrong choices (women B, D, E, ..., I), that’s the equivalent of there being eight guys and women left, where each guy and woman has exactly one forbidden choice (where



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man C's forbidden choice is woman A). Recursively, the number of blackout possibilities equals $D_n = (n-1) * (D_{n-1} + D_{n-2})$. If you solve this recursively, D_9 equals 133,496. As originally there are $9!$, or 362,880, number of match possibilities, the probability of a blackout is $133,496/362,880=0.3679$. This is the probability of getting a derangement.

2. *If the Truth Booth shows not a match, what is the probability of a blackout?*

Before the results of the Truth Booth, from No. 1, there are D_{10} , or 1,334,961 possible blackout cases, and $10!$, or 3,628,800 total cases. Let's assume guy A goes into the Truth Booth and comes away unsuccessful. Now, guy A only has eight, not nine, possible wrong women to choose from in the matchup ceremony. So we must multiply 1,334,961 by $8/9$ to get the new number of potential blackout cases. Similarly, there is a 10 percent chance that guy A would have correctly selected woman A. So we can get rid of these 10 percent of cases from the denominator ($0.9*3,628,800=3,265,920$). So the probability of a blackout now is $1,334,961/3,265,920$, or 0.3633. Notice how similar this answer is to the answer of No. 1!

3. *What is the probability of a blackout before the show begins?*

As there is a 10 percent chance of getting a perfect match in the Truth Booth, the answer is just $0.1 * [\text{No. 1 answer}] + 0.9 * [\text{No. 2 answer}]$, or 0.3638. □

Solvers

Robert Bartholomew, Bob Byrne,
William Carroll, Samantha Casanova,
Yan Fridman, Sean Fulton, Rui Guo,
Philip Hughes, Chi Kwok, David
Lovit, Timothy Luker, Lee Michelson,
Paul Navratil, David Oakden, David
Promislow, Noam Segal, Tomasz
Serbinowski, John Snyder, Al Spooner.

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Sins of the Father

MY FATHER GAVE ME A DISEASE that is familiar to most people who live on the North Side of Chicago. Although it's not genetic, it is definitely passed from father to son. "Hi, my name is Bob, and I'm a Cubbie fan." Las Vegas had the Cubs as preseason favorites to win the 2016 World Series. Will this team break my heart like so many earlier squads?

I have fond memories of attending games in the Friendly Confines with Dad in the 1950s and 1960s. Those were brutal years for Cubs fans, though he convinced me every year that the Cubs were only one good starting pitcher away from the World Series. I believed him until the Cubs traded Lou Brock for Ernie Broglio in 1964, a trade that baseball historians rank as one of the most lopsided trades in the sport. Brock helped the Cardinals win the World Series in 1964 and 1967 and entered the Hall of Fame in 1985. Broglio pitched only two more years.

The Cubs had the National League pennant sewn up in 1969. They were 9.5 games ahead of the woeful New York Mets on August 19. Leo Durocher had Banks, Williams, Santo, et al., firing on all cylinders—until they ran out of gas in September. The Amazin' Mets won the pennant by eight games and went on to beat the Orioles in the World Series. Afterward, the running joke was the Cubs were moving to the Philippines and would be renamed the Manila Folders.

I got excited in 1978 when the Cubs acquired Dave Kingman, a prodigious slugger. He hit three home runs on May 17, 1979, and the Cubs scored 22 runs in that game. Unfortunately, the Phillies scored 23.

I lived in Detroit most of my adult life, and the 1984 World Series looked like it would feature two Rust Belt teams, the Cubs and the Tigers. I would be torn (not really) between my two favorite teams. What could possibly go wrong, especially after the Cubs won the first two games of the National League Championship Series (NLCS)? But they lost the next three games to the San Diego Padres. I still remember the line drive in Game 5 that handcuffed Ryne Sandberg, who would win nine consecutive Gold Gloves, and the easy grounder going through Leon Durham's legs. I was crushed.

I attended the first night game in Wrigley Field on August 8, 1988, with my daughter. Only a Cubs fan can appreciate the irony of paying an enormous fee to a

ticket broker, then sitting in literally the worst seat in the upper deck ... only to have the game rained out.

Then there was 2003. The Cubs were leading the Florida Marlins three games to two in the NLCS and were ahead 3-0 with one out in the eighth inning of the sixth game at Wrigley Field. Only five more outs to go! The Marlin batter lifted a soft foul fly down the left field line and Moises Alou was poised to reach over the railing an grab it. But a fan reached out and caused the ball to ricochet off Alou's mitt. Two batters later, Alex Gonzalez (who led the National League in fielding percentage that year) braced himself to field a potential double play ground ball. Inning over! Except he muffed the easy grounder, and the Fighting Fish scored eight runs to win Game 6. You could hear the air escaping out of the Cubs' balloon, and they then lost Game 7, denied again a trip to the Fall Classic.

My father was born in 1916 and never saw the Cubs win a World Series. But hope springs eternal. Their record is 69 wins and 41 losses as we go to print in early August, and they are in first place in the Central Division, 11 games up on the second-place Cardinals. Is this finally the year? As Dad said every spring, "You gotta believe!" □

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