SOCIETY OF ACTUARIES Forecasting and Futurism Section

ISSUE 1 | SEPTEMBER 2009

Forecasting & Futurism NEWSLETTER

The New Forecasting and Futurism Professional Interest Section

By Ben Wolzenski and Alan Mills

Actuaries
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Forecasting & Futurism

NEWSLETTER

FROM THE EDITOR

Forecasting & Futurism Newsletter —A New Name and a New Dimension for Our Section

By Dave Snell

Many mathematicians are familiar with a classic book from 1884 (still in print) by Edwin Abbott called *Flatland: A Romance of Many Dimensions.* The hero, a square (in the geometrical sense, not a personality trait) is visited by a being from spaceland, a sphere, and together they explore the concept of multiple dimensions.

In a similar theme, the former Futurism Section has added an important new dimension to its charter. We are now the Forecasting and Futurism Section and to emphasize how much of an expansion this is, we have chosen to call our newsletter, *Forecasting & Futurism* to signify that we have added a new dimension to our sphere of influence and focus.

In this first issue of the *Forecasting & Futurism Newsletter,* formally called *Actuarial Futures*, we have some articles from Forecasting and Futurism Section council members that further explain these exciting changes.

In "The New Forecasting and Futurism Professional Interest Section," Alan Mills, vice chair and Ben Wolzenski, chair of the Section, list some of the new (and old) tools associated with forecasting that ought to be part of your toolbox. They also alert us to upcoming events—including a special panel discussion at the SOA Annual Meeting with Nassim Nicholas Taleb, the author of *The Black Swan.*

Scott McInturff gives a detailed but highly readable description of the Delphi Method. Quoting from Scott's article,

> "For many, Delphi conjures up images of a priestess possessed of mystical powers, reeking of sulphur, seated on a stool over a fissure that radiates from the center of the earth, and making indecipherable proclamations about the how the future will unfold."

Scott demystifies the Delphi Method; and he does it by describing a practical case study he coordinated. He gives us first-hand advice based on what went well, and what didn't.

Did you know that the Chinese term for actuary translates as master of accurate calculations? Our Section recently published a Delphi report called "Blue Ocean Strategies In Technology For Business Acquisition By The Life Insurance Industry" where we discuss some good, and perhaps not so good implications of that definition. We chose not to reproduce the 280-page report here in this newsletter, but here is a link to it: *http://www.soa.org/research/life/research-blue-ocean-strat.aspx*

Our incoming chair for the Section, Alan Mills, has contributed three articles for us as well as collaborating on another with Ben Wolzenski. His "White, Gray and Black Swans—Identifying, Forecasting and Managing Medical Expenditure Trend Drivers in a Complex World," differentiates the three types of swans and the challenges they pose for quants (quantitative analysts) trying to make sense of complex adaptive systems. Then, he describes forecasting methods to address these challenges. He supplements his description with anecdotes, quotes and diagrams for a succinct but understandable exposition.

Alan's "Introduction To Forecasting Methods For Actuaries," briefly lists some of the forecasting methods actuaries commonly use; and then tells us about several more that are in common use by other professionals in the business community—methods we ought to be considering even though they were not in the study note we might have read years ago.

In "Should Actuaries Get Another Job? Nassim Taleb's Work and Its Significance for Actuaries," Alan reviews the recent work of Nassim Taleb—who is clearly not a fan of actuaries—including the very popular books *The Black Swan* and *Fooled By Randomness*.

> "To support his thesis, Taleb cites numerous instances when we have been suckers, when dire consequences flowed from our inability to forecast in the fourth quadrant, among which are the

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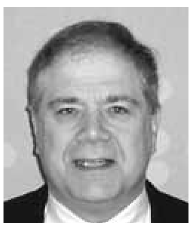
collapse of the Soviet Union, U.S. stock market collapses, and the current financial crisis. He also observes that in the areas of security analysis, political science, and economics, no one seems to be checking forecast accuracy."



Dave Snell

Are we suckers, as suggested by Taleb, or can we still "substitute facts for appearances, and demonstrations for impressions," as we so often like to quote from John Ruskin?

I have also included a book review. After reading "Fortune's Formula: The Untold Story of the Scientific Betting System That Beat the Casinos and Wall Street," by William Poundstone, I came away with the feeling that: *It takes exceptionally smart people to make truly massive blunders!* I think this ought to be a required read for actuaries. Fortunately, it is also a very entertaining read. I hope my review does it justice and piques your interest enough to read it.

Read through these articles. Think about how they may impact you, and how they may impact our industry. As actuaries, we have the basic mathematical and financial background at our disposal to learn to be better forecasters and futurists … or we can be complacent and watch as other disciplines assume these roles. ▼

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Introducing the New Forecasting and Futurism Professional Interest Section

By Ben Wolzenski and Alan Mills

Actuaries in many fields need to stay current with best practices in forecasting. To help accomplish this, the old Futurism Section has expanded its scope to include *all* forecasting practices applicable to actuarial work—not just futurism techniques. The new section is called the Forecasting and Futurism Section.

The new Forecasting and Futurism Section helps us stay current, and facilitates our professional development, by providing information about, and training in, forecasting and futurism methods and tools, including:

- What the methods and tools are (including basic forecasting techniques, such as time-series exponential smoothing and Box-Jenkins methods, as well as more advanced techniques such as Bayesian methods, agent-based modeling, and futurism techniques, many of which are not on the SOA exam syllabus),
- When to use them and when not to (based on experiential evidence),
- How to use them (including practical examples of their use, and best-practice guidelines), and
- How to present the results.

This change in the Section mirrors what is happening in the field of applied forecasting: traditional futurism techniques are now being combined with traditional statistical methods and newer modeling techniques (like agent-based modeling) to produce more powerful ways to explore the future.

Following are upcoming events and activities of the new Forecasting and Futurism Section:

- There will be a special panel-discussion session at the SOA Annual Meeting with Nassim Nicholas Taleb. Watch Annual Meeting announcements for details.
- Members of our Section are working with lead ERM actuaries from the United States, Germany and Australia to forecast the impact of emerging international risks.
- We are in the process of establishing a Web-based facility for Section members to exchange ideas. For the latest Section news, visit our home page at *http://www.soa.org/professional-interests/futurism/fut-detail.aspx.*

We invite your inquiries about the Forecasting and Futurism Section and encourage you to join! Questions can be sent to Alan Mills at *Alan.Mills@earthlink.net.* To join our Section, complete the Section Membership Enrollment form which can be found at *www.soa.org/files/pdf/SOAMembershipForm.pdf*. We look forward to hearing from you. ▼

Ben Wolzenski

Alan Mills

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Introduction to Forecasting Methods for Actuaries

By Alan Mills

Nearly all actuaries employ some form of forecasting: Life insurance actuaries forecast population mortality and company assets over lifetimes; retirement actuaries forecast pension plan payouts and plan assets during retirement; and health insurance actuaries forecast medical expenditures and premium income for two or three years. But actuaries employ only a small subset of the forecasting methods used by the general business community. This article provides a brief introduction to forecasting methods that are potentially relevant to actuarial work.

RELEVANT FORECASTING METHODS

Table 1 on page 7 and 8 provides an overview of forecasting methods potentially applicable to the work of actuaries, with references for further study. It is organized as follows:

A. **Extrapolative methods:** methods based on data patterns rather than explanatory variables.
B. **Explanatory variable methods:** methods incorporating causal variables to forecast (explain) dependent variables.
C. **Simulation modeling methods:** methods using the computer to simulate real-world agents, behaviors and events.
D. **Judgmental methods:** methods based on expert opinion or intuition.
E. **Composite methods:** methods involving a combination of the above.

The table describes each method and its preferable application. The table also includes an assessment of each method's current usage both among actuaries and within the general business community. For further study, it cites references with basic information about the method, as well as references covering more advanced information and applications. For each method, there is at least one reference that can be easily accessed online. A current version of the table and its references will be found on the Forecasting and Futurism Section's Web site, accessed through "Find a Section" on the SOA home page, *www.soa.org*. As our understanding of actuarial forecasting methods and usage evolves, the table and references will be updated.

M competitions
In several places, Table 1 refers to forecasting competitions. These are the "M forecasting competitions." Sponsored by the *International Journal of Forecasting*, and inspired by Spiros Makridakis (thus, the M in their name), these competitions (of which there have been three—M1, M2 and M3—in 1982, 1993 and 1998) compared the forecast accuracy of dozens of forecasting methods applied to thousands of historical data sets.

The table highlights an interesting observation: It appears that actuaries typically do not use forecasting methods that the general business community finds useful. Examples are:

- Exponential smoothing
- Autoregressive moving average
- Econometric modeling
- System dynamics simulation
- Multi-agent simulation

In an upcoming survey of actuaries, the Forecasting and Futurism Section will seek to substantiate and better understand this observation.

Perhaps one reason that actuaries use a limited range of forecasting methods is that the actuarial exams do not cover the forecasting methods that are potentially applicable to actuarial work. For example, it appears that the only comment about simulation models for health actuaries on the exam syllabus is, "Simulation is less commonly used for forecasting due to its complexity and time constraints. There are often strong competing priorities between the level of detail at which forecasting is necessary and the ability to apply simulation techniques successfully." This is perhaps practical advice, but will hardly encourage actuaries to explore the powerful simulation forecasting methods.

Alan Mills

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TABLE 1: OVERVIEW OF FORECASTING METHODS

Forecasting method	Description/preferred application	Current usage		References	
		Among actuaries	Within business generally	Basic	More advanced
A. Extrapolative methods					
1. Simple moving average	This method averages the last n observations of a time series. It is appropriate only for very short or very irregular data sets, where features like trend and seasonality cannot be meaningfully determined, and where the mean changes slowly.	Widely used	Widely used	[1, 2]	
2. Exponential smoothing, such as the Holt-Winters method	A more complex moving average method, involving parameters reflecting the level, trend and seasonality of historical data, usually giving more weight to recent data. Widely used in general business because of its simplicity, accuracy and ease of use. This method's robustness makes it useful even when historic data are few or volatile. It is a frequent winner in forecasting competitions.	Generally not used	Widely used for time-series analysis.	[2-5]	[6]
3. Autoregressive moving average (ARMA)—aka Box-Jenkins	An even more complex class of moving average models, capable of reflecting autocorrelations inherent in data. It can outperform exponential smoothing when the historical data period is long and data are nonvolatile. But it doesn't perform as well when the data are statistically "messy."	Generally not used	Widely used	[2, 7]	[6]
B. Explanatory variable methods					
1. Regression analysis	Fitting a curve to historical data using a formula based on independent variables (explanatory variables) and an error term. Although these methods are relatively simple, and are helpful both in analyzing patterns of historical data and for correlation analysis, they are not generally recommended for forecasting. They have performed poorly in forecasting competitions.	Widely used	Widely used	[2, 8, 9]	[6, 10]
2. Predictive modeling	An area of statistical analysis and data mining, that deals with extracting information from data and using it to predict future behavior patterns or other results. A predictive model is made up of a number of predictors, variables that are likely to influence future behavior.	Gaining in popularity	Widely used	[11-13]	
3. Artificial neural networks	Patterned after the neural architecture of the brain, these methods allow for nonlinear connections between input and output variables, and for learning patterns in data.	Generally not used	Sometimes used	[2, 14-16]	
4. Econometric modeling	Systems of simultaneous equations to represent economic relationships.	Generally not used	Widely used	[17, 18]	[19]

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TABLE 1: OVERVIEW OF FORECASTING METHODS continued

Forecasting method	Description/preferred application	Current usage		References	
		Among actuaries	Within business generally	Basic	More advanced
C. Simulation modeling methods					
1. Cell-based modeling	Modeling of individual homogeneous units (cells) over time, such as age/sex cells in pension forecasting. These models are usually deterministic, but may be stochastic. They are useful to model large systems.	Frequently used	Frequently used	[20]	
2. System dynamics simulation	Simulation of a system as a whole over time, incorporating feedback loops as well as stocks and flows. Such methods are useful for complex systems.	Generally not used	Becoming more widely used	[21]	[22]
3. Multi-agent simulation	A computer representation that employs multiple interacting agents and behavioral rules to mimic the behavior of a real system. This method is especially useful for modeling complex adaptive systems.	Generally not used	Becoming more widely used	[23-25]	[26, 27]
D. Judgmental methods	These methods rely on expertise and intuition, rather than on statistical analysis of historical data. Such methods are particularly useful when historical data is scarce. Many of the methods of "futurism"—such as the Delphi method, visioning and scenario building—fall under this category.	Frequently used, usually on an informal basis	Frequently used, often on a structured basis	[2, 28-30]	
E. Composite methods					
1. Bayesian forecasting	This family of methods combines statistical methodology with structured integration of human judgment: new evidence is used to update a statistical forecast, based on application of Bayes' theorem. These methods are good for highly seasonal data with short history.	Generally not used	Generally not used	[31]	[32]
2. Other	Combinations of forecasting methods usually perform better in forecasting competitions. The use of composite methods will increase as decision makers are increasingly called on to combine their intuitions with data-based decision making from forecasting models.	Generally not used	Generally not used	[2, 33, 34]	

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The Delphi Method

By Scott McInturff

Actuaries are paid handsomely to use their expertise to evaluate the likelihood of uncertain future events. Empirical data that can be shaped and molded to produce a range of expected future outcomes is typically the actuary's willing partner in this work. Data-based decision making is a bedrock of our profession as evidenced by the Society of Actuaries' use of the Ruskin quote, "The work of science is to substitute facts for appearances, and demonstrations for impressions," to describe our responsibilities as actuaries.

At times actuaries are asked to make pronouncements about futures for which established facts do not exist. Evaluations of this sort require a toolkit quite distinct from the one used to maneuver data since the raw materials are of a different nature. When data is not available, the actuary must often rely on the judgment of experts. Whereas data is objective and public, judgments are subjective and personal. Just as the process for extracting diamonds from the earth is distinct from the process of extracting crude oil, so too the means of gathering expert judgment is distinct from the methodology of assembling data. The nature of judgments requires that human interaction be engaged for this raw material to be mined.

THOUSANDS OF YEARS OF SOCIETAL EVOLUTION HAVE CAUSED HUMAN INTERACTIONS TO BE EXTREMELY COMPLEX AND GREATLY INFLUENCED BY NUMEROUS SOCIETAL HIERARCHIES.

Thousands of years of societal evolution have caused human interactions to be extremely complex and greatly influenced by numerous societal hierarchies. In this societal milieu characterized by verbal and nonverbal jousting, the result of face-to-face discussions is often the convergence of group opinion to the individual opinion of the most powerful member of the group. The Delphi method attempts to filter out the consensus bias that can result from societal forces by employing a technique whereby an anonymous collection of opinions is used supplemented by feedback loops that can be used to influence outcomes.

The Delphi method is relatively straightforward in its application and has a wide variety of business and professional applications. The Delphi approach requires a planned iterative process to support the anonymous gathering of input from a selected group of experts and the anonymous dissemination of summarized information to all participants. A stated objective of the Delphi method is that it purports to form an unbiased consensus of opinion on a specified topic. The reality is that though bias may be eliminated, convergence of consensus may never occur. This lack of convergence may be considered a strength of the Delphi process rather than a weakness as a diversity of opinion on a particular topic may best describe the collective thinking of the participants. For many issues a convergence of opinion is indicative of a process designed to produce conformity of opinion, either overtly or subtly. The Delphi method validates that divergence of opinion may be the best reflection of the range of possibilities for some issues for which there are no known outcomes.

The individual opinions of every participant are anonymously summarized and distributed after each round of the process. The absence of face-to-face interaction means that personalities will not influence the outcome to converge on the opinion of the most vocal, most articulate, most charismatic, most feared or most respected of the participants. Separating ideas apart from the personalities from which they emanate better allows each idea to be judged on their own merit. By preserving anonymity of all participants, the Delphi method allows even the most extreme opinions to be voiced and recorded without fear of embarrassment because of their nonconformance with the norm.

The iterative aspect of the Delphi method is designed to allow the perspectives of each participant to be summarized in an anonymous manner so that they can be used to influence the thinking of the other participants. Without this aspect, the Delphi method would be no more than a collection of independent ideas, no more useful than an election in which each candidate votes only for themselves. The value of the Delphi method is the collection of thinking of the individual experts with regard to options and possibilities in solving the problem or situation presented to them. Although the final summary may be a recounting of the final ranking of various solutions, the true gems may be found in the collective thoughts documented by the group of participants.

Giving validity to all ideas is an objective of the Delphi method. Therefore, rather than stating that the goal of the Delphi method is consensus of opinion, a more accurate perspective is that the end result of the Delphi method is to produce a stability of opinion, such that as a result of all input into the process views are no longer changing.

THE DELPHI METHOD DESCRIBED

The Delphi method can be applied to numerous areas of research that are of interest to actuaries. The key elements for using the Delphi method are: 1) a topic for research; 2) a group of experts willing to participate; and 3) an individual sponsor or planning committee to control the flow of information.

The topic for research should be on a subject for which there is little or no existing data on which to base an objective decision. The possible subjects for study could range from those that cannot be known at the present time, such as predictions about possible future events, to much more practical activities such as making an informed choice between a number of competing priorities or opportunities. Whatever topic is chosen, for the process to be truly effective, it is essential that the research is on a topic that is of vital interest to the participants.

The experts should cover as broad a spectrum of professional views as possible to avoid narrow thinking that may emerge if the participants are relatively homogeneous in their backgrounds. Participants must commit to active participation within the prescribed timeframes, to providing candid and anonymous opinions, and to reading and assessing the anonymous comments of their peers before completing each round of the Delphi process.

The planning committee serves a critical role in the Delphi method since all participants rely on this central group to frame the issues and provide an anonymous summary of feedback as the opinions unfold. The planning committee is responsible for the original positioning of the issue and for distributing, coordinating and summarizing all information

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received in the process. The planning committee must commit to guiding the process and providing a summary of the findings of the process at the end of the research.

The careful framing of the research question by the planning committee is an essential first step in the Delphi method. The topic must be clearly positioned with the participants to provide ample background to underscore the value of the research, the importance of each member's participation and the nature of the process that will be used to gather information.

The planning committee is also responsible for identifying and soliciting experts to participate in the research process. The number of participants can range from a handful of experts to more than one hundred. The greater the number of participants, the greater the effort required to manage the information flow. Once the number of participants exceeds more than a dozen or so, the use of available software to facilitate the compilation and summarization of the data will be essential to the process.

The planning committee is responsible for all communication with the participants starting with the initial framing of the issue, providing the subsequent anonymous summaries of results received from each round of the process and sending clear instructions for each round. The strength of a committee over a single individual is the opportunity to get a broader perspective on how questions will be interpreted and responded to so as to ensure that each round is as effective as possible.

The exact process used with the Delphi method can vary as suited to the issue being researched. Some topics lend themselves to the following approach: Participants review an issue; suggest a range of solutions; evaluate the total set of solutions developed by all participants; and rank the solutions based on the collective input. Other topics may not so neatly lead to a ranking of a set of solutions. For these topics, iterative collection of comments until some sort of stability of opinion occurs may be the best approach. Whatever approach is appropriate, a key element of the Delphi method is that the comments of each participant will be used to influence the end result.

Using the first of the two approaches just described, a typical process for the Delphi method involves several distinct stages. The first stage is to develop a questionnaire to be sent to the participants that presents the issue and poses an open-ended question or questions to be answered in a specified timeframe. Some guidance may be offered to the participants that responses should be short, concise bullets, rather than rambling responses, in order to facilitate the summary process.

The planning committee collects the responses to this first round of questions and summarizes the results anonymously, being careful not to unintentionally bias the result during the summarization. This summary is distributed to the participants who are asked to review the responses and evaluate each one by providing a short commentary on each, again preferably in bullet form.

The planning committee summarizes the round two responses and distributes them to the participants asking for additional feedback. In the first of two approaches, this third round will require some sort of ranking of the options developed in the first two rounds. This ranking will most likely be the basis of the final conclusions from the study.

If there is no convergence of opinion as a result of this ranking round, the planning committee may choose to continue beyond three rounds by constructing a means to have additional input filtered to the participants. When the planning committee determines there is stability in opinion, even if there is no convergence, they will gather the collected data and determine the findings of the study which they will document in a report.

THE DELPHI METHOD: A CASE STUDY

To provide a view as to how the Delphi method can be executed and to demonstrate its versatility as a means to collect data and gain understanding of an issue, I will describe my recent experience in using the Delphi method to gather information concerning which product development projects to pursue within the business I work in.

While the Delphi method is ideal to gather input from a dispersed group of experts, it is also useful to assemble information from a resident group of experts who are unable to gather together for whatever reason. The Ideation Committee at the company that employs me is composed of members from marketing, distribution, systems and product management. This group is responsible for providing input into the company's product development planning process. The travel requirements of many members of the committee would not allow them all to commit to meeting every other week. However, all members agreed that they could provide written feedback via e-mail as part of a Product Development Delphi method designed to gather information about which product development projects our company should pursue.

The approach used in this exercise is described as a Modified Delphi Technique based on a template developed by University of Illinois Extension and available online. The Modified Delphi Technique is designed to use "mail or e-mail to gather information, provide feedback, and report conclusions" and is similar in operation to the Delphi methodology previously described. The approach of the Modified Delphi Technique involves three rounds: Round One collects a range of solutions to an identified issue; Round Two evaluates the ideas proposed in Round One; and Round Three ranks the ideas using the commentary provided in Round Two.

Round One requires a questionnaire to be developed by the Sponsor or Planning Committee. This questionnaire frames the issue being investigated and solicits as many responses to the issue as the participants can muster. One key to this first step is for the Sponsor or Planning Committee to be extremely thoughtful in developing the initial questionnaire to clearly frame the issue and to provide enough instructional detail to avoid vague or ambiguous responses.

In the Product Development Delphi method, it wasn't difficult to clearly frame the issue to solicit appropriate responses from the participants. The Round One question was framed as, "What product development projects, including developing new products and riders and enhancing existing products, should Individual Insurance undertake to produce (profitable) sales growth, both currently and in the future?"

As the Sponsor of the study, I both developed and distributed the initial questionnaire and collected the responses from all participants via e-mail. I also summarized the Round One results making sure that there was no attribution to any participant. For a number of reasons there is generally a benefit in forming a planning committee. In this situation, however, I had willingly become a planning committee of one.

In this exercise, compiling the ideas from the first round and maintaining anonymity of responses was not especially difficult. The nine participants produced 40 distinct product

> WHILE THE DELPHI METHOD IS IDEAL TO GATHER INPUT FROM A DISPERSED GROUP OF EXPERTS, IT IS ALSO USEFUL TO ASSEMBLE INFORMATION FROM A RESIDENT GROUP OF EXPERTS. …

development ideas that were easily compiled into a single list. Originally I thought it would be important to list the ideas in random order so as to not introduce any unintentional bias into the process, but I quickly realized that with 40 ideas, some sort of grouping of ideas would help facili-

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tate soliciting commentary in the second round. Since many of the ideas involved enhancements to existing products, a natural grouping was to collect the enhancement ideas by product type with the rest of the ideas grouped separately if they represented a new product or rider.

Round Two in the Modified Delphi Technique requires participants to comment on feasibility of each idea, that is, to evaluate the ideas. The objective of Round Two is to gather text around the collective thoughts of the participants on each idea that will subsequently be used as input into the ranking of the ideas in Round Three. Hence clarity of instructions with regard to evaluation in Round Two is essential to allow for an effective ranking in Round Three.

In the Product Development Delphi method, the primary Round Two participant instruction was, "For each product development project listed below, clarify, add to, and comment on the feasibility or opportunity, etc., as you feel appropriate." While this instruction seemed consistent with the guidance of the Modified Delphi Technique, the actual responses received showed signs that it would have been productive for me to have spent more time in developing the Round Two instructions to describe more clearly the nature of responses required in Round Two. This is evidence that a planning committee may have been more effective than the use of an individual sponsor to manage the process.

Round Two did generate a significant amount of appropriate feedback that when summarized would be useful to participants in Round Three. The weakness of Round Two in the Product Development Delphi method was that many responses were too general to be useful. In particular, responses of "Like this idea" or "Don't like this idea" have no value in a Delphi study because of their anonymity, whereas the same comments might be weighty and influential in a face-to-face discussion depending on their source. Since there were adequate responses of a more substantial nature that were received in Round Two, it was unnecessary to restart Round Two to provide further direction.

Summarizing the results of Round Two and maintaining anonymity was no more difficult than for Round One. The challenge was that many of the Round Two comments required material interpretation on my part to be useful for the next Round. I tried to be as true as possible to represent the commentary presented by the participant while modifying the comment without adding undue bias so that it could be interpreted by other participants. The resulting summary spanned eight typed pages, a lengthy document for participants to absorb as part of Round Three.

Round Three is designed to provide some sort of ranking of the ideas using the collective Round Two evaluation and commentary of the participants. Since a straight ranking of 40 possible product development projects did not seem like a productive activity, in the Product Development Delphi method I chose to collect the ideas into logical groupings, similar to those of Round Two, and ask participants to rank within each of these subsets of ideas. The categories I created were: 1) Repricing of products in the existing portfolio; 2) Development of new products not currently in portfolio; 3) Development of riders not currently in the portfolio; and 4) Enhancements to existing products in the existing portfolio. Since product development resources are limited and the scope of projects in the ideation list ranged from small to large efforts, rather than request a pure top to bottom ranking within each category, I requested that, within each grouping, participants identify those projects (no more than half of total projects in the grouping) that they felt should be worked on currently and those projects that should not be worked on currently.

With these results I was easily able to tabulate the rankings and use these tallies to establish a view of the group's thinking as to priorities that the company should pursue. From this list, we have advanced the four top ideas to the next phase of activity in the product development process wherein we research each idea deeply enough to create a "charter" for the product which will be reviewed and a decision made before the product moves to the feasibility stage of the product development process.

The ideation phase is just the beginning of the product development process. For various reasons not every good idea makes it into the product development queue. However, it was extremely useful to collect specific input from stakeholders about every product development idea on the list of possible projects. The use of the Delphi method in this situation was a pragmatic solution to a scheduling problem. However, the resulting information and subsequent discussion of the findings as a result of using the method gave a significant base on which to build future product development activity.

Round One was distributed to the Ideation Committee on April 20th and the last Round Three response was received on May 15th. A draft report was produced and distributed within a week and the results were discussed at a June 1st Ideation Committee meeting. The first charters were presented to the Individual Insurance Product Committee on June 9th and one charter was moved to the Feasibility Stage of the product development process. Relatively speaking this Product Development Delphi Process was more efficient than I had originally anticipated.

CONCLUSIONS

The Delphi method has been used in the past by the Futurism Section (recently rechartered as the Forecasting and Futurism Section to expand its impact on the actuarial profession) in several studies as a means of exploring possible futures. A recent use of the Delphi technique by the Futurism Section, in conjunction with the Investment Section, the Committee on Finance Research and the Committee on Knowledge Extension was completed in 2005. The results of this study are documented in a report entitled, "Forecasting Selected U.S. Economic Variables and Determining Rationales for Judgments," which is available on the SOA Web site.

For many, Delphi conjures up images of a priestess possessed of mystical powers, reeking of sulphur, seated on a stool over a fissure that radiates from the center of the earth, and making indecipherable proclamations about how the future will unfold. The application of the term "Delphi" to a method that gathers information using anonymous feedback is clearly intended as irony. Usage of a methodology that was named after a ranting Oracle will not compromise or diminish our professional stature as long as we communicate our findings clearly.

The Delphi method can be a useful approach to explore issues when the opinions of experts are needed. Its strength is in its ability to solicit a wide range of opinions and to allow consensus to form without forcing it to do so. The method has an efficiency and efficacy that makes it a valuable tool to actuaries and other professionals. ▼

Scott McInturff

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White, Gray and Black Swans

IDENTIFYING, FORECASTING AND MANAGING MEDICAL EXPENDITURE TREND DRIVERS IN A COMPLEX WORLD

By Alan Mills

Many of us assume that current actuarial methods for identifying, forecasting and managing medical expenditure trend drivers are effective and adequate. But this assumption may be mistaken: Just as economists and Wall Street quants (quantitative analysts) were recently shocked to discover that their methods were inadequate to avoid dramatic upheaval in highly complex financial systems, our actuarial methods may be inadequate for equally complex healthcare systems. This paper explores how health care complexity challenges us to expand our repertoire of actuarial methods—and even recast our trend driver paradigm—in order to do our jobs better and maintain our credibility.

HEALTH CARE COMPLEXITY

Advanced health care systems, such as those in the United States and Canada, are examples of so-called complex adaptive systems (CAS), a fact that has profound implications for actuarial work. For more than 30 years, eminent scientists have studied CAS at research centers such as the Center for Complex Systems at the University of Michigan, the New England Complex Systems Institute, and the prestigious Santa Fe Institute. These scientists discovered that CAS have several identifying features.[1]

Interdependent adaptable agents. CAS have locally interdependent agents that adapt their behavior to respond to environmental changes. More complex systems have more—and more diverse—agents with more complicated interactions and more levels of organizational hierarchy. Because advanced health care systems have myriad interlocking institutions, businesses, governmental agencies and people at many hierarchical levels, and because each agent of these systems can adapt to environmental changes, such systems can be highly complex.[2] Figure 1 shows that the U.S. health care system in general, and its consumer component in particular, is more complex than several other U.S. economic systems: to determine the agents involved in an average medical expenditure transaction, one must answer about a billion binary questions.[3]

> I THINK THE NEXT CENTURY WILL BE THE CENTURY OF COMPLEXITY.
>
> —Stephen Hawking, Jan. 23, 2000

A challenge

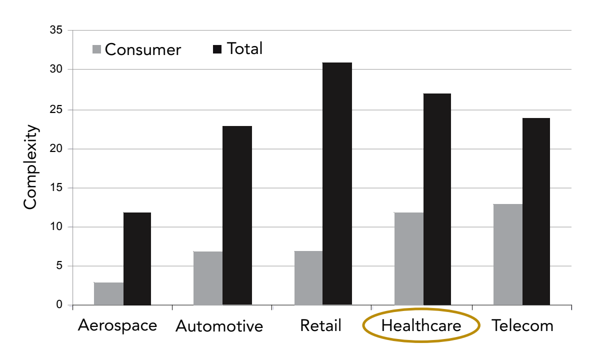
If social worlds are truly complex, then we might need to recast our various attempts at understanding, predicting, and manipulating their behavior. In some cases, this recasting may require a radical revision of the various approaches that we traditionally employ to meet these ends.

John Miller and Scott Page
Complex Adaptive Systems

No central controller. CAS lack a central authority controlling agent behavior; rather, agents self-organize. Health care systems also lack a central controller. For example, no central agency dictates how patients flow to doctors.

Open. CAS are open to the influence of the outside environment, which includes other CAS. Because health care systems are affected by general inflation, politics, unemployment, demographics and other environmental characteristics, they are open systems.

Figure 1: Relative complexity of U.S. health care

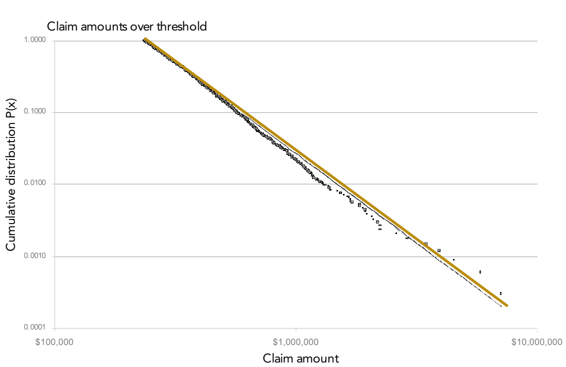


Feedback. Agent interactions include positive and negative feedback loops.[4] That is, Agent A behavior affects Agent B behavior, which feeds back to affect Agent A behavior (A ⇆ B). Health care systems have a rich web of feedback loops. For example, in contracting with providers, one health insurer's behavior affects the actions of other insurers (and Medicare), which then feed back to affect the original insurer: Insurer A ⇆ Insurer B.

Power Law distributions. CAS produce outputs with frequencies conforming to Power Law (Pareto) statistical distributions ($p(x) \approx 1/x^n \Rightarrow \ln p(x) = a + b * \ln x$).[5] Health care systems are replete with Power Law outputs, from the incidence of epidemics to pharmaceutical sales.[6, 7] For example, Figure 2 is a log-log graph showing that medical expenditures above a threshold are Power Law distributed.

Thus, a health care system will exhibit common CAS characteristics, such as.[8]

Figure 2: Power Law distribution of the SOA 1991/1992 large claims database (author's unpublished work)



Emergence. The system's behavior as a whole will be qualitatively different than the behavior of its parts.[9] Therefore, to understand the system's behavior, we must do more than analyze its components.

Hidden causality. Because of the system's rich web of interactions and feedback, identifying causal chains (or even trend drivers) is generally impossible.

Unpredictability. Because of openness and interdependent non-linear dynamics, system behavior is fundamentally unpredictable for more than a short period of time (and cannot be modeled using the Gaussian family of probability distributions, the Law of Large Numbers, or the Central Limit Theorem).[10]

Punctuated equilibria. The system will have periods of relative quiescence punctuated by abrupt and dramatic upheavals, or catastrophes.

The remainder of this paper examines the impact of these CAS characteristics on how we identify, forecast and man-

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age medical expenditure trend drivers. For this purpose, it is useful to classify trend drivers as agent behaviors organized in three groups (borrowing classification terminology from Taleb[10] and Rumsfeld[11]):

White Swans (known knowns): Agent behaviors we believe we can identify, forecast and manage. Examples are consumer utilization, physician coding practice and provider contracting demands.

Gray Swans (known unknowns): Agent behaviors we can identify as having potentially significant impact. But we cannot accurately forecast their impact, and so cannot effectively manage them. Examples are production of blockbuster drugs, emerging medical technologies, flu epidemics and health care reform.

Black Swans (unknown unknowns): Behaviors we cannot identify, much less forecast or directly manage, such as the onset of AIDS. (But we can indirectly manage their risk, and the risk of Gray Swans, as discussed below.)

When one is lost, any map will do

This incident, related by the Hungarian Nobel Laureate Albert Szent-Gyorti and preserved in a poem by Holub (1977), happened during military maneuvers in Switzerland. The young lieutenant of a small Hungarian detachment in the Alps sent a reconnaissance unit into the icy wilderness. It began to snow immediately, snowed for 2 days, and the unit did not return. The lieutenant suffered, fearing that he had dispatched his own people to death. But on the third day the unit came back. Where had they been? How had they made their way? Yes, they said, we considered ourselves lost and waited for the end. And then one of us found a map in his pocket. That calmed us down. We pitched camp, lasted out the snowstorm, and then with the map we discovered our bearings. And here we are. The lieutenant borrowed this remarkable map and had a good look at it. He discovered to his astonishment that it was not a map of the Alps, but a map of the Pyrenees. This incident raises the intriguing possibility that when you are lost, any map will do.

Karl E. Weick
Sensemaking in Organizations

I AM CONVINCED THAT THE NATIONS AND PEOPLE WHO MASTER THE NEW SCIENCES OF COMPLEXITY WILL BECOME THE ECONOMIC, CULTURAL, AND POLITICAL SUPERPOWERS OF THE NEXT CENTURY.—Heinz Pagels, 1988

IDENTIFYING TREND DRIVERS

Because of the complex nature of health care, traditional statistical methods cannot explicitly identify trend driver causal chains. For example, in 1992 the Lewin Group conducted two major regression studies analyzing more than 250 potential trend drivers for outpatient and physician expenditures, but appropriately cautioned that the results, although interesting, did not establish any causal relationships.[12, 13] Indeed, the only scientific method that can establish causal relationships from data is the randomized controlled experiment[14] (a method outside of the actuarial repertoire), but even this method often fails to establish causal chains in a complex system.

To better understand and identify trend drivers, we can expand our repertoire of methods:

White Swans: We will better understand the known knowns if we study the behavioral rules governing health care agent interactions (perhaps with controlled experiments), then develop simulations and games[15] based on these rules. Economics has taken significant strides in this direction with behavioral economics.[16]

Gray Swans: To better identify emerging known unknowns we can implement continual formal environmental scanning (periodic scans are insufficient),[17] Bayesian classifier data mining,[18] and Delphi methods.[19, 20]

Black Swans: By definition, unknown unknowns are unidentifiable in advance.

FORECASTING TREND DRIVER IMPACT

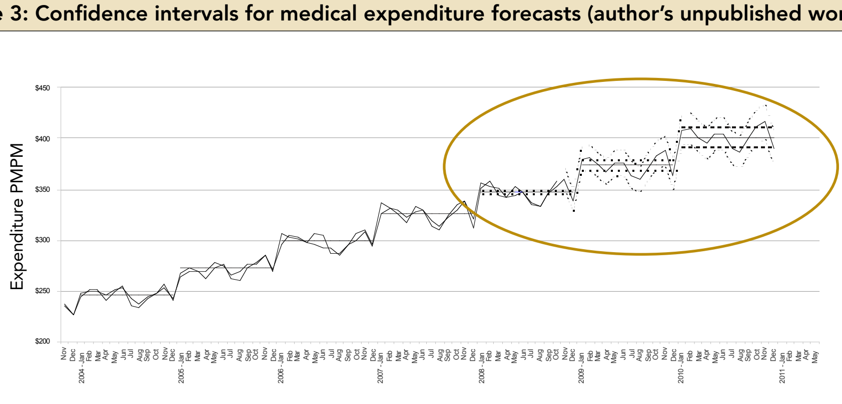
Despite monumental efforts, medical expenditure trend forecasts are notoriously inaccurate. For example, CMS one-year NHE drug trend projections during 1997-2007 missed actual trends by 2.7 percent on average,[21] and other actuarial forecasts appear to be equally error prone. We now know why: Complex system behavior is unpredictable beyond a near-term horizon. But here's what we can do:

White Swans: Simplify our forecasting methods (simpler methods usually perform better[22]), perform more frequent forecasts (monthly), include confidence intervals (see Figure 3), and analyze experience. Keep in mind: almost any map will do (see sidebar on page 18).

Gray Swans: Widen confidence intervals to reflect Power Law distributions and potential Gray Swans; employ simulation models and Delphi techniques to determine the fan of possible outcomes.

Black Swans: By definition, they cannot be identified or forecasted.

Figure 3: Confidence intervals for medical expenditure forecasts (author's unpublished work)



MANAGING TREND DRIVERS

Health care executives often lament that managing medical expenditures is like squeezing the proverbial balloon: Expenditures always pop out somewhere else. It is true: Our current management methods may be inadequate to contain adverse risks posed even by White Swan trends, much less the potentially catastrophic risks posed by Gray and Black Swans. Complex adaptive systems require a different management approach, because agents readily adapt to being squeezed (see sidebar below).

White Swans: Revise the management approach: Rather than impose detailed rules on individual system agents, provide general strategy, incentives and resources,[23] all informed by behavioral research and simulation modeling results.

Gray Swans: Introduce an Enterprise Risk Management program focused on emerging trend drivers.[17]

Black Swans: In light of the knowledge that health care is subject to periodic dramatic upheavals similar to what we recently experienced in the financial sector, and that these upheavals can

Think like a farmer

It is more helpful to think like a farmer than an engineer or architect in designing a health care system. Engineers and architects need to design every detail of a system. This approach is possible because the responses of the component parts are mechanical and, therefore, predictable. In contrast, the farmer knows that he or she can do only so much. The farmer uses knowledge and evidence from past experience, and desires an optimum crop. However, in the end, the farmer simply creates the conditions under which a good crop is possible. The outcome is an emergent property of the natural system and cannot be predicted in detail.

Paul Plsek
Crossing the Quality Chasm

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WHITE, GRAY AND BLACK SWANS | FROM PAGE 19

come in clusters, reexamine the reserving, reinsurance, exclusion, risk-decoupling, and lifetime maximum policies of large insurers, reinsurers, and self-insured employers. And not least: relinquish the illusion of control.[24] ▼

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BOOK REVIEW

Fortune's Formula: *The Untold Story of the Scientific Betting System That Beat the Casinos and Wall Street*—by William Poundstone

Review by Dave Snell

This book is a concise look at the evolution of formal investment theory and related financial forecasting, with continual contextual references to its ties to gambling and to organized crime. Additionally, it is a hilarious and insightful history of gambling from the Bernoulli's in the 1700s through the hedge fund traders of the late 1990s.

The author devotes over 50 pages to notes and the index. This was appreciated since I wanted to look up more about so many of the anecdotes he included.

Poundstone poignantly describes the downfall of high-flying firms such as LTCM, where the investment wizards went from the darlings of Wall Street to the dredges of the investment community in large part because they were so clever; and they started to believe they were infallible.

> One LTCM road-show presentation was held at the insurance company Conseco in Indianapolis. Andrew Chow, a Conseco derivatives trader, interrupted Scholes. "There aren't that many opportunities," Chow objected. "You can't make that kind of money in Treasury markets." Scholes snapped: "You're the reason - because of fools like you we can." (Page 281)

Soon afterwards, the derivatives market started to implode and LTCM lost hundreds of millions of dollars in a matter of weeks.

Warren Buffett marveled at how "ten or 15 guys with an average IQ of maybe 170" could get themselves "into a position where they can lose all their money." That was much the sentiment of Daniel Bernoulli, way back in 1738, when he wrote: "A man who risks his entire fortune acts like a simpleton, however great may be the possible gain." (Page 291)

Poundstone also points out the real world flaws in some theoretically appealing scams. The St. Petersburg Wager seems mathematically correct; yet it overlooks a vitally important constraint (pages 182-184). Another is the unfounded weight we unconsciously give to historical returns, as evidenced by his retelling of another Warren Buffett story:

> In a 1984 speech, Buffett asked his listeners to imagine that all 215 million Americans pair off and bet a dollar on the outcome of a coin toss. The one who calls the toss incorrectly is eliminated and pays his dollar to the one who was correct. The next day, the winners pair off and play the same game with each other, each now betting \$2. Losers are eliminated and that day's winners end up with \$4. The game continues with a new toss at doubled stakes each day. After twenty tosses, 215 people will be left in the game. Each will have over a million dollars. According to Buffett, some of these people will write books on their methods: "How I Turned a Dollar into a Million in Twenty Days Working Thirty Seconds a Morning." Some will badger ivory-tower economists who say it can't be done: "If it can't be done, why are there 215 us?" "Then some business school professor will probably be rude enough to bring up the fact that if 215 million orangutans had engaged in a similar exercise, the result would be the same - 215 egotistical orangutans with 20 straight winning flips." (Page 314)

The author follows the lives of a few major contributors to investment theory, information theory, and betting theory: Claude Shannon, who invented Information Theory and paved the way for the digital computer age; John Kelly, who developed the formula for gains with no possibility of ruin; and Edward Thorpe, who built upon these findings and beat the roulette wheels, the blackjack tables and the investment fund managers.

It's a fast read—only 329 pages before the notes and index. You bet I recommend it! ▼


Dave Snell

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Should Actuaries Get Another Job?

NASSIM TALEB'S WORK AND ITS SIGNIFICANCE FOR ACTUARIES

By Alan Mills

MY PRODUCT LINE IS COMING UP WITH A SYSTEMATIC AND UNIFIED WAY TO DEAL WITH WHAT WE DON'T KNOW.—Nassim Taleb

INTRODUCTION

Nassim Nicholas Taleb is not kind to forecasters. In fact, he states—with characteristic candor—that forecasters are little better than "fools or liars," that they "can cause more damage to society than criminals," and that they should "get another job."[1] Because much of actuarial work involves forecasting, this article examines Taleb's assertions in detail, the justifications for them, and their significance for actuaries. Most importantly, I will submit that, rather than search for other employment, perhaps we should approach Taleb's work as a challenge to improve our work as actuaries. I conclude this article with suggestions for how we might incorporate Taleb's ideas in our work.

Drawing on Taleb's books, articles, presentations and interviews, this article distills the results of his work that apply to actuaries. Because his focus is the finance sector, and not specifically insurance or pensions, the comments in this article relating to actuarial work are mine and not Taleb's. Indeed, in his work, Taleb only mentions actuaries once, as a model for the wrong kind of forecaster (the pathetic Dr. John in *The Black Swan*). Concerning insurance and pensions, in *Fooled by Randomness,* he writes derisively, "… pension funds and insurance companies in the United States and in Europe somehow bought the argument that 'in the long term equities always pay off 9%' and back it up with statistics." We may safely conclude that actuaries are not Taleb's heroes.

Be forewarned: it is not easy to reach the germ of Taleb's ideas, partly because Taleb himself—and, by extension, his writing—is unusually multilayered, complex, and yes,

Perhaps we should pay attention

Taleb has changed the way many people think about uncertainty, particularly in the financial markets. His book, *The Black Swan*, is an original and audacious analysis of the ways in which humans try to make sense of unexpected events.

Danel Kahneman, Nobel Laureate
Foreign Policy July/August 2008

I think Taleb is the real thing. … [he] rightly understands that what's brought the global banking system to its knees isn't simply greed or wickedness, but—and this is far more frightening—intellectual hubris.

John Gray, British philosopher
Quoted by Will Self in *Nassim Taleb*
GQ May 2009

Taleb is now the hottest thinker in the world. … with two books—*Fooled by Randomness: The Hidden Role of Chance in the Markets* and in *Life, and The Black Swan*—and a stream of academic papers, he turned himself into one of the giants of modern thought.

Brian Appleyard
The Sunday Times June 1, 2008

entertaining. Perhaps more importantly, though, it is not easy to communicate paradigm-shifting ideas. As one critic stated, "His writing is full of irrelevances, asides and colloquialisms, reading like the conversation of a raconteur rather than a tightly argued thesis."[2] Since Taleb says that his hero of heroes is Montaigne, it is hardly surprising that his style is that of a raconteur, mixing autobiographical material, philosophy, narrative fiction and history with science and statistics. Indeed, Taleb calls himself a literary essayist and epistemologist.[3] But he is also a researcher, a professor of Risk Analysis, and a former Wall Street trader specializing in derivatives, as well as a polyglot (but because he was born in Lebanon, and grew up partly in France, he is naturally more comfortable in Arabic and French than English.) He characterizes his books *The Black Swan* and *Fooled by Randomness* as literary works, rather than technical expositions, and he encourages serious students to read his scholarly works (many of which are referenced on his Web site, *www.FooledByRandomness.com*). I concur.

WE ARE SUCKERS

Taleb's main point is that our most important financial, political and other social decisions are based on forecasts that share a fatal flaw, thus leading to disastrous consequences. Or, as he says more concisely, "We are suckers." His contribution is to vividly and vociferously expose this flaw, and then suggest how to mitigate its negative impact.

Specifically, Taleb says that forecasts are flawed when applied to support decisions in the "fourth quadrant." He divides the decision-making domain into four quadrants, as shown in Table 1.[4]

Taleb divides the decision-making domain according to whether the decision payoff, or result, is simple or complex, and whether the underlying probability distribution (or frequency) of relevant events on which the decision is based is Type I or Type II.

Simple payoffs are binary, true or false. For example, to determine headcounts for a population census, it only matters whether a person is alive or dead. Very alive or very

WE ARE SUCKERS FOR THOSE WHO HELP US NAVIGATE UNCERTAINTY, WHETHER THE FORTUNE-TELLER OR THE 'WELL-PUBLISHED' (DULL) ACADEMICS OR CIVIL SERVANTS USING PHONY MATHEMATICS.—Nassim Taleb

Table 1: Four quadrants of the decision-making domain

Underlying probability distribution	Payoff	
	Simple (binary)	Complex
Type I	**I (safe)**	**II (safe)**
Type II	**III (safe)**	**IV (dangerous)**

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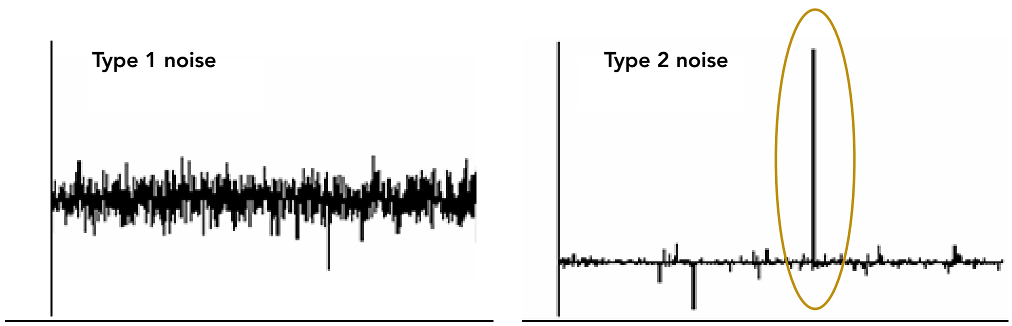
Figure 1: Type 1 (Gaussian) noise and Type 2 (Power-law) noise



dead does not matter. Simple payoffs only depend on the zeroth moment, the event probability. (In a moment, we'll look at the importance of moments.) For complex payoffs, frequency and magnitude both matter. Thus, with complex payoffs, there is another layer of uncertainty. Actuarial work typically supports decisions with complex payoffs, such as decisions related to medical expenditures, life insurance proceeds, property and casualty claims, and pension payouts. For complex payoffs with linear magnitudes, payoffs depend on the first moment, whereas for non-linear magnitudes (such as highly-leveraged reinsurance) higher moments are important.

ANY SYSTEM SUSCEPTIBLE TO A BLACK SWAN WILL EVENTUALLY BLOW UP.—Nassim Taleb

Borrowing from the work of Benoit Mandelbrot, Taleb divides probability distributions into Type I and Type II (Mandelbrot calls them, respectively, mild chance and wild chance[5]). Type I distributions are thin-tailed distributions common to the Gaussian family of probability distributions (normal, Poisson, etc.). Type II distributions are fat-tailed distributions (such as Power-law, Pareto, or Lévy distributions). Type II distributions are commonly found in complex adaptive systems such as social economies, health care systems and property/casualty disasters (earthquakes, hurricanes, etc.).[6] Importantly, for fat-tailed distributions, higher moments are often unstable over time, or are undefined; they are wildly different from thin-tailed distribution moments. And, for Type II distributions, the Central Limit Theorem fails: aggregations of fat-tailed distributions are often fat-tailed.[4]

Figure 1 above illustrates the difference between Type 1 and Type 2 distributions. On the left is Type 1 noise (white noise) which is Gaussian distributed. On the right is Type 2 noise

The scandal of prediction

Writing about forecasting in security analysis, political science and economics:

I am surprised that so little introspection has been done to check on the usefulness of these professions. There are a few—but not many—formal tests in three domains: security analysis, political science and economics. We will no doubt have more in a few years. Or perhaps not—the author of such papers might become stigmatized by his colleagues. Out of close to a million papers published in politics, finance and economics, there have been only a small number of checks on the predictive quality of such knowledge. … Why don't we talk about our record in predicting? Why don't we see how we (almost) always miss the big events? I call this the scandal of prediction.

Nassim Taleb
The Black Swan

All the cognitive biases are one idea
You can think about a subject for a long time, to the point of being possessed by it. Somehow you have a lot of ideas, but they do not seem explicitly connected; the logic linking them remains concealed from you. Yet you know deep down that all these are the same idea.

[One morning] I jumped out of bed with the following idea: *the cosmetic and the Platonic rise naturally to the surface.* This is a simple extension of the problem of knowledge. … This is also the problem of silent evidence. It is why we do not see Black Swans: we worry about those that happened, not those that may happen but did not. It is why we Platonify, liking known schemas and well-organized knowledge—to the point of blindness to reality. It is why we fall for the problem of induction, why we confirm. It is why those who 'study' and fare well in school have a tendency to be suckers for the ludic fallacy. And it is why we have Black Swans and never learn from their occurrence, because the ones that did not happen were too abstract.

We love the tangible, the confirmation, … the pompous Gaussian economist, the mathematical crap, the pomp, the Académie Française, Harvard Business School, the Nobel Prize, dark business suits with white shirts and Ferragamo ties, … Most of all, we favor *the narrated.*

Alas, we are not manufactured, in our current edition of the human race, to understand abstract matters … we are naturally shallow and superficial—and we do not know it.

Nassim Taleb
The Black Swan

(typical of electronic signal noise) which is Power-law distributed. The striking difference between the two is that Type 2 noise has one spike of extreme magnitude that dwarfs all other events, and that is not predictable. This spike is a Black Swan. Such Type 2 patterns are typical of complex adaptive systems.

Thus, the problematic fourth quadrant refers to decision making where payoffs are complex (i.e., not binary) and underlying probability distributions are fat-tailed and wild. In this area, according to Taleb, our forecasts fail: They cannot predict events that have massively adverse (or positive) consequences (the Black Swans). Because most decisions in our world fall squarely in the fourth quadrant, most actuarial work supports fourth quadrant decision making and is subject to the forecasting flaw.

To support his thesis, Taleb cites numerous instances when we have been suckers, when dire consequences flowed from our inability to forecast in the fourth quadrant, among which are the collapse of the Soviet Union, U.S. stock market collapses, and the current financial crisis. He also observes that in the areas of security analysis, political science and economics, no one seems to be checking forecast accuracy (see sidebar on page 24).

Although the consequences have not yet been as dramatic as those cited by Taleb, many actuarial forecasts are notorious for their inaccuracy. For example, actual 1990 Medicare costs were 7.39 times higher than original projections.[7] More recently, CMS reports that one-year NHE drug trend projections during 1997-2007 missed actual trends by 2.7 percent on average.[8] And, although experience studies are certainly more prevalent in actuarial work than in security analysis, political science or economics, in many areas of actuarial work we are perhaps also negligent in assessing and reporting our prediction accuracy.

WHY FORECASTS FAIL

Taleb gives three interrelated reasons why our fourth quadrant forecasts (and, thus, decisions based on these forecasts) fail:

1. Our minds have significant cognitive biases that cloud our ability to reason accurately.
2. We do not understand that our world is increasingly complex and unpredictable.
3. Our forecasting methods are inappropriate for quadrant IV decisions.

THE PROBLEM WITH EXPERTS IS THAT THEY DO NOT KNOW WHAT THEY DO NOT KNOW.
—Nassim Taleb

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COGNITIVE BIASES

Drawing on the work of behavioral economists, evolutionary psychologists and neurobiologists, Taleb takes considerable pains to demonstrate that human mental makeup is not suitable for dealing with important decisions in the modern world. He shows that we have significant cognitive biases that cloud our reasoning ability, such as:

Confirmation bias: Humans focus on aspects of the past that conform to our views, and generalize from these to the future. We are blind to what would refute our views. We only look for corroboration. This is the central problem of induction: We generalize when we should not. For example, as actuaries, we often base our expenditure projections on a couple of years of recent data from limited sources that conform to our expectations.

Narrative bias: People like to fabricate stories, to weave narrative explanation into a sequence of historical facts, and thereby deceive ourselves that we understand historical causes and effects and can apply this understanding to the future. This bias gives us a false sense of forecasting confidence, a sense that the world is less random and complex than it really is—a complacency leading to forecast error. As actuaries, we think we understand trend drivers, when perhaps we really do not.

Survivorship bias: We follow what we see, because it happened to survive. We don't follow the alternatives that did not have the luck to survive, even though they may be superior.[9] As actuaries, we often use the actuarial methods that continue to be used by our colleagues, even though other methods may be superior.

THE WORLD WE LIVE IN IS VASTLY DIFFERENT FROM THE WORLD WE THINK WE LIVE IN.
—Nassim Taleb

Poincaré's three body problem and the limits of prediction

As you project into the future you may need an increasing amount of precision about the dynamics of the process that you are modeling, since your error rate grows very rapidly. The problem is that near precision is not possible since the degradation of your forecast compounds abruptly—you would eventually need to figure out the past with infinite precision. Poincaré showed this in a very simple case, famously known as the "three body problem." If you have only two planets in a solar-style system, with nothing else affecting their course, then you may be able to indefinitely predict the behavior of these planets, no sweat. But add a third body, say a comet, ever so small, between the planets. … Small differences in where this tiny body is located will eventually dictate the future of the behemoth planets.

Our world, unfortunately, is far more complicated than the three body problem; it contains far more than three objects. We are dealing with what is now called a dynamical system. … In a dynamical system, where you are considering more than a ball on its own, where trajectories in a way depend on one another, the ability to project into the future is not just reduced, but is subjected to a fundamental limitation. Poincaré proposed that we can only work with qualitative matters—some properties of systems can be discussed, but not computed. You can think rigorously, but you cannot use numbers. … Prediction and forecasting are a more complicated business than is commonly accepted, but it takes someone who knows mathematics to understand that. To accept it takes both understanding and courage.

Nassim Taleb
The Black Swan

Tunneling: We focus on a few well-organized sources of knowledge, at the expense of others that are messy or do not easily come to mind. For example, it is not common to find actuaries who perform complete risk analyses, running through an exhaustive set of potentially harmful scenarios. In the main, we stay to well-worn paths, the tried and true. This is natural. As Taleb says, "The dark side of the moon is harder to see; beaming light on it costs energy. In the same way, beaming light on the unseen is costly in both computational and mental effort."[1]

MISUNDERSTANDING OUR COMPLEX UNPREDICTABLE WORLD

As scientists are coming to realize, we live in a world more and more characterized by complex adaptive systems that are on the edge of chaos.[10] A corollary to this realization is that more and more modern decisions are in Quadrant IV, because complex adaptive systems are replete with Type 2 probability distributions, and because modern decisions typically have complex payoffs.

The key point about complex adaptive systems is that their behavior is not forecastable over more than a short time horizon. For example, we cannot forecast weather for more than 14 days, or even the trajectories of billiard balls on a table (see sidebar on page 26). Even less can we forecast complex social systems where the vagaries of human desire are involved. Yet, we continue to act as if events in our world are forecastable, and we base our important decisions on flawed forecasts. As our world becomes increasingly interconnected and complex, our forecasting flaws become more consequential. "The gains in our ability to model (and predict) the world may be dwarfed by the increases in its complexity."[1]

INAPPROPRIATE FORECASTING METHODS

Taleb's ludic fallacy is that we use Quadrant I and II statistical methods to prepare forecasts for Quadrant IV decisions. Ludic comes from ludus, Latin for "game." Because of familiarity and tractability, we use forecasting methods based on our knowledge of games of chance—methods and analyses largely based on the Gaussian family of probability distributions that are appropriate for Quadrants I and II—to generate forecasts for Quadrant IV decisions, a domain where such methods are completely inappropriate. These methods—including such esteemed methods as value-at-risk, Extreme Value Theory, modern portfolio management, linear regression, other least-squares methods, methods relying on variance as a measure of dispersion, Gaussian Copulas, Black-Sholes, and GARCH—are incapable of prediction where fat-tailed distributions are concerned. Part of the problem is that these methods miscalculate higher statistical moments (which, as we saw above, matter a great deal in the Quadrant IV), and thus lead to catastrophic estimation errors. And, of course, the point is not that we need better forecasting methods in Quadrant IV, the point is that no method will work for more than a short time horizon.

RETHINKING OUR APPROACH

Rather than get new jobs, perhaps we can accept Taleb's work as a challenge to rethink how we approach our work. This section summaries Taleb's suggestions for correcting faulty forecasts, and their application to actuaries:

1. CORRECT OUR COGNITIVE BIASES

Taleb suggests several ways to correct our cognitive biases:

Confirmation bias: Use the method of conjecture and refutation introduced by Karl Popper: formulate a conjecture and search for observations that would prove it wrong. This is the opposite of our search for confirmation. For actuaries, this might mean casting wider nets: using much larger data samples over much longer time periods to form our opinions, and seriously searching for counter-examples to our preliminary results.

Actuaries in the womb of Mediocristan

(In *The Black Swan*, Taleb calls Quadrants I and II "Mediocristan," a place where Gaussian distributions are applicable. By contrast, he calls Quadrant IV "Extremistan.")

Actuaries like to build their models on the Gaussian distribution. When they make 40-year projections for Medicare and Social Security solvency, sign Schedule B's for airline and steel company defined benefit pension plans, or do cash flow testing for life insurance company solvency, they aren't displaying professional expertise as much as they are fooling themselves by retreating to the comfort and safety of the womb of Mediocristan. That's what they learned in the agonizing process of studying for those exams. And it's easier to double your 25-year projection for the price of oil than to quit your job and admit that what you've learned and devoted your life to is largely nonsense.

Gerry Smedinghoff
Contingencies May/June 2008

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> I PROPOSE THAT IF YOU WANT TO STEP TO A HIGHER FORM OF LIFE, AS DISTANT FROM THE ANIMAL AS YOU CAN GET, THEN YOU MAY HAVE TO DENARRRATE, THAT IS, SHUT DOWN THE TELEVISION SET, MINIMIZE TIME SPENT READING NEWSPAPERS, IGNORE THE BLOGS.
> —Nassim Taleb

Narrative bias: Favor experimentation over stories, the empirical over the narrative. For actuaries, this means that we should consider performing controlled experiments (as behavioral economists are doing) to tease out causes and effects, and that we should carefully record the accuracy of our predictions. We should avoid thinking that our correlation studies provide meaningful insights into causality.

Survivorship bias: Open the mind to alternatives that are not readily apparent and that may not have had the good fortune to survive, and adopt a skeptical attitude towards popular truths. Are our current actuarial methods really the best?

Tunneling: Train ourselves to explore the unexplored. As actuaries, perhaps we could make a greater effort—perhaps using new tools such as data mining—to make sense of our messy data.

2. STUDY THE INCREASING COMPLEXITY AND UNPREDICTABILITY OF OUR WORLD

To appreciate the complexity and unpredictability of our world, it helps to read a lot and to dispassionately observe the behavior of complex adaptive systems such as stock markets:

- Taleb provides excellent bibliographies in his works. He reads voraciously (60 hours a week) and lists the best resources in his bibliographies. For example, *The Black Swan's* bibliography lists about 1,000 references. Those related to complexity and unpredictability include the works listed in footnotes six and 11 through 16.[6, 11-16]
- He also suggests that we "study the intense, uncharted, humbling uncertainty in the markets as a means to get insights about the nature of randomness that is applicable to psychology, probability, mathematics, decision theory, and even statistical physics."[1]

I would add that it helps to learn from agent-based simulation models of relevant complex adaptive systems. The purpose of such models is not to predict, but rather to learn about potential behaviors of complex systems.[17]

3. MITIGATE FORECAST ERRORS AND THEIR IMPACT

Taleb's suggestions to mitigate forecast errors fall into three classes:

- **Use forecasting methods appropriate to the quadrant.** In Quadrant IV, it is best to not even try to predict. The best we can do is apply

Mandelbrotian fractal models (which are based on Power laws) to better understand the behavior of Black Swans.[18] Mandelbrotian models will not help with prediction, but they aid our understanding. According to Taleb:

> "… we use Power laws as risk-management tools; they allow us to quantify sensitivity to left- and right-tail measurement errors and rank situations based on the full effect of the unseen. We can effectively get information about our vulnerability to the tails by varying the Power-law exponent alpha and looking at the effect on the moments or the shortfall (expected losses in excess of some threshold). This is a fully structured stress testing, as the tail exponent alpha decreases, all possible states of the world are encompassed. And skepticism about the tails can lead to action and allow ranking situations based on the fragility of knowledge."[19]

In the other quadrants, our common Gaussian-based models do just fine. But simple models are generally better than complicated ones.

- **Be transparent and provide full disclosure.** Once we understand that we cannot accurately predict in Quadrant IV, we need to communicate this to those who rely on our work. Even though actuaries must provide point predictions in order to price insurance products, determine funding amounts, etc., we can effectively communicate our ignorance of the future by providing rigorous experience studies and confidence intervals around our predictions (ideally based on Power law distributions). As Taleb says, "Provide a full tableau of potential decision payoffs," and "rank beliefs, not according to their plausibility, but by the harm they may cause."[1]

- **Exit Quadrant IV.** Because Quadrant IV is where Black Swans lurk, if possible we should exit the quadrant. Although we can attempt to do this through payoff truncation (reinsurance and payoff maximums) and by changing complex payoffs to more simple payoffs (reducing leverage), nevertheless we often remain stuck in Quadrant IV. For example, health insurers try to exit Quadrant IV by reinsuring individual medical expenditures; but, they neglect to purchase aggregate catastrophic reinsurance, and so ignore the fact that aggregations of fat-tailed distributions are themselves fat-tailed distributions, and so remain in Quadrant IV.

Taleb also suggests that organizations should introduce buffers of redundancy "by having more idle 'inefficient'

WHEN INSTITUTIONS SUCH AS BANKS OPTIMIZE, THEY OFTEN DO NOT REALIZE THAT A SIMPLE MODEL ERROR CAN BLOW THROUGH THEIR CAPITAL (AS IT JUST DID).—Nassim Taleb

capital on the side. Such 'idle' capital can help organizations benefit from opportunities."[4] Unfortunately, again using health insurers as examples, as companies grow larger, it appears that their capitalization is becoming thinner. Also, contrary to common wisdom, as such companies grow, they more thoroughly optimize their financial operations and thus generally become more susceptible to Black Swans.

One final piece of advice from Taleb: "Go to parties! … casual chance discussions at cocktail parties—not dry correspondence or telephone conversations—usually lead to big breakthroughs."[1] ▼

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SHOULD ACTUARIES … | FROM PAGE 29

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