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Managing Model Risk

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Actuarial models have always been an important tool for helping companies project future results and understand risks. As complex models have started to become critical components of the reporting and compliance processes, however, models have vaulted to new levels of importance—and of scrutiny. This has raised everyone's interest in the management of models, and by implication, in their ability to control the inherent model risk.

Why is this a growing challenge? The primary reason is that the models now coming into play are not the actuarial models we have grown up with. And that in part has happened because the products and risks that companies are concerned with are not the same traditional products and risks of yesterday. Faced with dynamic flexible products sensitive to interest rates, market shifts, creative guarantees of price and/or benefits realized and policyholder options that impact the costs to the company, models must be increasingly detailed, holistic and able to test thousands of scenario alternatives. And they must be flexible and adaptable because everything about them keeps changing to reflect current conditions, actual experience, new approaches to product design and guarantees, and evolving regulatory and professional standards about how these risks could and should be measured.

And there's the rub. An incredibly complex process is evolving to produce critical financial results that must be robust and reliable yet is constantly changing.

"All Models Are Wrong. Some Are Useful."

My Web research tells me that George Box *(http://www.skymark.com/resources/leaders/box.asp)*, the industrial statistician, is credited with the quote: "All models are wrong. Some are useful." I had assumed he was an actuary, but in fact he was a chemist trying to develop defenses against chemical weapons in wartime England. What I take from his quote is the reminder that a complex model is not right just because it appears to produce numbers, and that we need a healthy respect for all the approximations to reality and subjective assumptions, explicit and implicit, that are built in. Our job is to make sure that the inaccuracies are resulting from known assumptions and approximations, whose impact is understood, or can be explored, and not from unintended errors during design, implementation and subsequent change.

Faced with this responsibility, one reaction is to conclude that this is a problem of adequate control, in an accounting sense. Some actuaries with painful experiences of Sarbanes-Oxley (SOX) or similar past projects where the word "controls" has been central might now turn off, maybe because that implies to them red tape and paperwork, restricted rights and permissions, formal sign-offs, and other drudge-work that seems of little direct benefit. But you should know that accounting controls, like newly evolving actuarial measures, should be principle-based and not rules-based. Their fundamental purpose is to promote and protect sound management practices, both general and financial. While some controls simply address the risk that company assets, records and resources are not intentionally or inadvertently lost, corrupted, stolen or misused, a good system of controls will increase the likelihood that all financial information is reliable and accurate, so that managers and the board can make sound strategic and operational decisions. It's hard to argue with that.

So what should you do to maximize the likelihood that your models work as intended?

Model Management Begins Before There Is a Model

First, don't make the mistake of assuming that thinking about proper model management can be put off until the model is in place and working. To be effective, planning for management must start right at the beginning when the model is a

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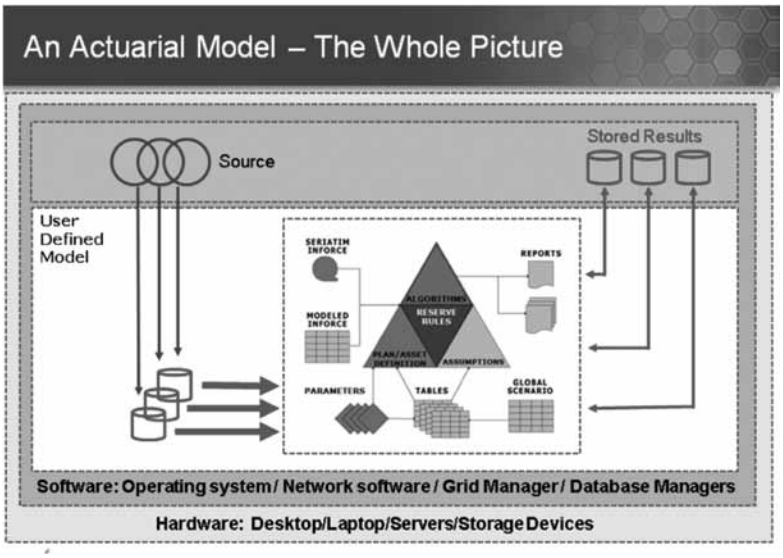
collection of concepts and imagined processes. By thinking ahead to potential challenges of use and maintenance and the control problems they might generate, you may be able to positively impact the way in which the model is designed and implemented, so as to make those future challenges more manageable.

But what exactly is this model that must be managed? The word "model" can be used in many different ways. Sometimes we are referring to a mathematical model, or set of rules that we intend to use to explain the probabilities of different events occurring, such as scenarios of yield curves or equity markets over time. Sometimes we use "model" to refer to a condensed and representative set of liability data used to represent the actual seriatim in-force book of business. And even that full seriatim set, when represented in software, is really a model of the actual liabilities themselves. But for managing the risk of actuarial models we need to look at the big picture, of the entire systems construct in which the business model, the various mathematical models and the whole actuarial modeling software that performs key calculations, are implemented and operated in real time.

It may be that the actuaries maintaining the model spend most of their time tweaking assumptions, or adjusting the rules coded in the model to reflect new products being sold. When these changes require actual programming, the control issues are obvious, and that process will clearly attract attention in model governance. However it is important to keep the whole picture in mind. There are several layers of technology, soft and hard, that enable a financial reporting process involving a model to be executed (see Figure 1), and sometimes changes in one of these outer layers will unexpectedly impact the robustness or even the calculated results independently of any of the more routine changes in the actuarial model itself. It thus pays to isolate changes in the outer IT layers and validate that the model is still producing the same answers after any change or update in operating system, hardware peripheral, grid management system or process that extracts data from administration systems. Similarly, you should consider any aggregation, query tool, or reporting routine that assembles numbers generated by the main actuarial calculator, to be part of the model and apply proper management to the back-end processing as well.

Figure 1. The Whole Picture



Three Dimensions of Model Management

When your goal is to increase your confidence that the model is providing answers it was intended to provide, I suggest the task can be viewed as three separate components:

1. Confirm that the design and theoretical principle behind the model were properly conceived and selected to achieve its purpose.

2. Verify that the design and theoretical principles were correctly and faithfully implemented in the actual modeling software, when the modeling system was created.

3. Establish controls to prevent unauthorized or inadvertent change in the modeling system, and to verify that the results of the system are only changing as a result of normal and expected changes in business data from one reporting date to the next, or to changes in assumptions about future experience.

Model Validation

Steps 1 and 2 are often combined in thought and action and described as validation of the model. At the initial creation of the model, validation requires a careful review of its purpose and intended use, and if major system elements are developed in-house, a comprehensive set of design specifications will likely be needed, along with a rigorous review of both the specifications themselves, including all formulas used, and of the programming that attempted to faithfully implement those specifications. If the modeling software is purchased, review of design specifications and vendor coding may not be practical; but then again, for sophisticated software of either type, review of code is of limited benefit, and should never be considered sufficient. Proper validation will require scrutiny of the actual output of the model under various controlled inputs, with independent verification that the results are materially as expected for the inputs tested.

Of course the operation and the validation of a model involve more than just the calculation engine. It is necessary to validate the generation of the business data used by the model, the inputs, interpretation and application of assumptions feeding the model calculations, and the generation of reports based on those calculations.

While some representative calculations should be independently verified if at all possible, it is not possible to verify all calculations based on all reasonable values of input data. Generally, model validation will come down to the verification of selected model points, combined with one or more less rigorous but still useful techniques. Here are some examples:

- Reasonability checks compared to other models that are well known or previously validated, or even to other software such as illustration systems.
- Inspection of calculated results with simplistic and possibly unrealistic input values (e.g., lapse or mortality of zero).
- Comparison of repeated runs, or independent runs of subsets of business, or runs with altered business data order to verify identical total results.
- "Backtesting" a model by entering business data and assumptions reflecting historic values and comparing model results to actual results.

Another technique that is valuable yet not often thought of as being validation, per se, is to ensure that the model or components of the model are used for other purposes, hopefully regularly, within the company. The more different eyes are on a model, inspecting and stressing it with different assumptions and looking at different parts of the model, the more likely it is that any flaws in its design and implementation will be caught and corrected. The developing standards for advanced "internal models" envisaged by European regulatory bodies for use under Solvency II refer to this as "pervasive use."

Another valuable tip is to carefully save all validation work, especially any test models and the independent calculations that verify the test results. If software components of the model are updated, such as by a vendor, or other technology components are changed, then rerunning the test models to verify that the same results are obtained or that the differences can be rationalized is easier than performing a completely new validation.

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Change Control

Once a thorough validation is performed, ongoing management is generally considered to come down to change control. The objectives of this are:

- To prevent any unintended and unapproved changes, usually by installing access permission control processes, and by employing secure production sites with separate test and development sites and a careful promotion process.

- To identify and approve all intended changes, with proper review of documentation, testing, approvals and sign-offs.

- To validate the impact of any changes made, often using attribution analysis to break down complex changes into incremental impacts.

- To confirm that the results are consistent from period to period when and where no model changes have occurred, using regression analysis as appropriate to verify consistency and to pinpoint changed values.

The Challenge of Complex Model Management

Unfortunately, as models have become more complex and more dynamic, requiring market-consistent or current assumption approaches, the challenges of managing models and validating the impact of constant change have increased. Furthermore, actuaries have often preferred to keep control of the design and even the programming of the modeling software, which can pose additional challenges in ongoing maintenance and validation.

Regardless of who has programmed the modeling software, I would suggest it is imperative to design the software so that model assumptions are separately maintained in objects and files, and model code that extracts, combines and applies assumptions and performs actuarial calculations never contains any of those assumptions that users might conceivably adjust. With this approach, control over objects containing assumptions and the identification of changed or inconsistent assumptions is simplified and the management and maintenance of the system code can be completely separated and independently performed, and even outsourced to a specialized programming team or a vendor, if appropriate.

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Another challenge in validating modern models is the increasing motivation to build in approximations and shortcuts, especially when specialized models performing stochastic calculations are needed. The painful resource cost versus run-time trade-off will motivate many to seek model efficiencies of various types in search of an acceptable accuracy/cost/run-time balance. When those efficiencies involve compression of the model, or simplifications in the way a benefit is reflected in the model, validation of the impact of that efficiency is problematic yet essential, and must be constantly repeated as the impact will change as in-force composition and economic variables change and as the business ages. Accordingly, it is wise to build in any such shortcuts as selectable options and not forced defaults, so that the model can be run both ways and the impact verified whenever necessary. This also permits the choice of greater simplification and shorter run-times for testing and analysis, with a more appropriate and fully understood level of accuracy when the model is used for production reporting, and when cheaper, more powerful technology removes the need for shortcuts.

A helpful approach to reducing model validation pain is to design the model with modular, reusable components if possible. Many elements of assumption storage, extraction and preparation and the generation of product cash flows from those assumptions are core operations that can well contribute to other actuarial applications. Common use of these elements across the enterprise increases the comfort and confidence in them, and lessens the need for independent validation. However, this can increase the design challenge in each of the systems sharing components.

Look to International Practices and References

Advanced models are being introduced around the globe, especially for emerging International Accounting Standards and for Solvency II and enterprise risk management (ERM) purposes. The study of the design and management of these models has therefore been of great interest to the International Actuarial Association (IAA) and to regulatory authorities. The IAA released a paper on "The Use of Internal Models for Risk and Capital Management Purposes by Insurers" in November 2010, which may be helpful reading *(www.actuaries.org/CTTEES_SOLV/Documents/Internal_Models_EN.pdf).*

Powerful and complex models will soon be a way of life, and with careful model management, we actuaries can spend our time improving and exploiting these models to better understand and manage the risks inherent in the products we sell, and not have to explain with some embarrassment how we introduced new risks in the models we built but failed to manage properly. ●

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