Comment #21 – 9/26/13 – 8:57 a.m.

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To: The Actuarial Standards Board ERM Task Force

From: Tobias E. Bradley, FCAS, CERA, MAAA

Comments: Exposure Draft on Modeling

First, I thank the board for their work and efforts in putting this document together and presenting it for comments. I also hope that the extent of my comments does not in any way diminish the extent and quality of the committee's efforts in putting together this draft ASOP.

Overall Concerns

Assumptions as Input: It is my experience that assumptions are not necessarily model input. The on-line Merriam-Webster dictionary defines assumption(s) as: "a fact or statement (as a proposition, axiom, postulate, or notion) taken for granted." There are assumptions about data, assumptions about parameters, assumptions about model methodology, assumptions about distributions, etc.; however, I do not think assumptions are model input per se. As such, assumptions need to be separate from model input.

Validation, Checking, & Analysis: all of these functions are lumped together while I believe they are actually separate functions. I propose that this section be rewritten to recognize that model verification (checking) is a separate function & process than model validation.

A. **Model Verification:** this is the checking part in the current section. Verification deals with "is the model built/implemented/operating correctly": (1) correct programming and/or formulas, (2) error-free algorithms, (3) input data as intended (no material shortcomings), (4) etc. Verification is not necessarily concerned if the model is giving reasonable results.

B. Model Validation: is the model giving reasonable results or in the words of George Box, "is the model useful": (1) accurate representation of reality and/or (2) model errors reasonable in light of assumptions. <u>One very important point that needs to be addressed</u>: model validation is NOT attempting to build or find a better model. Validation needs to focus on reasonableness of outcomes and not preferences in approaches. The validator is validating results and pointing out potential issues.

Note: Model validation is sometimes used in a broader sense and may include some model verification. In my experience model verification rarely, if ever, crosses the line into model validation.

Model Review: there is no direct mention of Model Review except indirectly through Model validation, checking, and analysis. This is an important area of practice for actuaries whether they are acting as a peer reviewer or acting as an independent model reviewer. This needs to be addressed in this ASOP. I have offered suggestions on were model review might be appropriate in specific paragraphs (see "comments by paragraph number").

The following are comments by paragraph number.

Section 2 - Definitions

2.1 – Assumptions: see comments above under "Overall Concerns".

2.3 - Granularity: I have a very difficult time understanding this definition, especially the use of the term "cell". What is a "cell"? You may want to consider defining the term "cell". In the context of data, granularity makes sense through the "cake cutting" analogy (i.e. each cut of the cake gives me a more granular unit until finally I may only have crumbs). However, I am not sure I can agree with assumptions being granular or more granular; the same is true of model components. How do I slice an assumption into "cells"? Also, what about dimensionality? Is that included in granularity? This definition needs additional work in my opinion.

2.4 – Implementation – I suggest that just because I have a model that is an executable form does not imply that one has implemented a model. I contend that until a model is put into "production" or is used in decision making that one does not have an "implementation". From my own experience I can say I have built and executed many models, there are far fewer models that I have actually "implemented".

2.5 – Input: This definition is quite different from how I think of the term. I view input as: "information fed into a model to get output". For example, I primarily think of input as data and parameters. Some assumptions could be considered inputs; however, I do not think all assumptions are inputs (in my opinion, most assumptions are not inputs). In addition, not all parameters are inputs to a model, some parameters could be outputs. As I discussed in my Overall Concern Section, assumptions need to be separate from Input.

2.7-Intended Purpose: add "reviewing" to the actuary's role in the second sentence.

2.8 – Margin: Suggest calling this an "**uncertainty provision**" to more accurately describe its function. Margin in my thinking is usually associated with finance and relates to an increase in the cost of capital or something similar. The revised definition is more consistent with the concept of a "contingency provision" that is used in ratemaking (and elsewhere).

2.9 – Model: I suggest that perhaps the use of "statistical, financial, economic" etc. is limiting the scope of the definition too much, especially in light of all the new developments in the modeling arena. Modelers are already using genetic and social networking algorithms as well as random forest and machine learning methodologies. Also, implementation of a model is not always achieved through mathematical formula, sometimes it is purely logic and algorithm based like decision trees and association rules. My suggested definition for Model: *A representation of relationships among entities using systematic logic, algorithm, and/or mathematical equations. Models are used for a variety of different reasons some of which are: (1) to help explain a system, (2) to study the effects of components, (3) and to derive estimates and guide decisions. In general, a model consists of (1) a specification that describes the input and the relationships among them, (2) an implementation that is achieved through, logic, a set of mathematical formulas and/or algorithms, and (3) a set of outcomes.*

Also, I am curious why the definition of model as used in ASOP #38 (Using Models Outside the Actuary's Area of Expertise) was not considered?

2.10 – Modeling: add "reviewing" to the list of "selecting, designing, building, modifying, developing, or using".

2.11 - Model Risk: Model Risk is basically the uncertainty in the appropriateness of our model. I suggest revising the definition as follows: "The risk of adverse consequences and/or decisions as a result of the model not reasonably representing the situation (reality) under study." The current definition is too narrow limiting model risk to a result of (1) flawed model, (2) inappropriate inputs, or (3) misapplication of the model.

2.13 – Neutral: this term does not seem to be clearly defined and does not appear to be consistently used in the ASOP. Comment #8 by Mary Pat Campbell also provides some reasons why this term may not be appropriate. Perhaps this section should be deleted.

2.17 – Realization – Why not use the common term "outputs"? I rarely talk about my model's realizations; however, I often talk about my model outputs. Also, ASOP #38 refers to Model Outputs not Model Realizations. I suggest replacing "realization" with "output" throughout this ASOP.

2.19 Specification: Suggest changing "inputs and their interactions" to inputs and their material interactions". Current wording is too burdensome.

Section 3 – Analysis of Issues and Recommended Practices

1. **Paragraph 3.2 – Model Meeting the Intended Purpose:** add "review" to list of "select, design, build, etc. ".

2. **Paragraph 3.2.3 - Modifying the Model**: title this "Modifying or Reviewing the Model". I think reviewing is appropriate here.

3. **Paragraph 3.2.5 - Model Structure**: Model Components is the term used in ASOP #38. Is Model Structure different? I suggest this term may need to be defined. Also, is Model Structure referring to model: inputs, methodology(s), outputs, etc.?

4. **Paragraph 3.2.5 .b**: "whether grouping **model inputs** will produce reasonable results". What does grouping mean? Since model inputs are defined as including data, assumptions, & parameters. What is meant by "grouping assumptions"? What is meant by "grouping parameters?" Are we simply referring to grouping data in different ways, such as binning or WOE (weight of evidence) coding? If so, let's be more specific. If not, we need more guidance.

5. **Paragraph 3.2.5.d:** "documenting the rational for grouping data". Seems to me that guidance on documentation should all occur in one section of this ASOP. Why is grouping of data singled out here? Suggest this may be more appropriate in paragraph 3.6.

6. **Paragraph 3.2.6: Inputs to the Model**: Again, assumptions are not necessarily inputs. Per ASOP #23, paragraph 2.4: "Assumptions are not data"; per ASOP #38, paragraph 3.4: "assumptions needed in order to apply model output". In the latter paragraph (ASOP #38, 3.4) the term assumption definitely does not refer to assumptions as input.

7. **Paragraph 3.2.7 – Assumptions and Parameters:** This paragraph seems redundant with paragraph 3.2.6? Or is Paragraph 3.2.6 just referring to data? Seems to me "Data" should also be used that is "appropriate in light of the intended purpose". Why was data left out of this paragraph?

8. **Paragraph 3.2.7.a .1– "assumptions**": I suggest replacing "assumption" with "data". This then is consistent with ASOP #25 (Credibility Procedures . . .).

9. **Paragraph 3.2.7.a.4**:
    a. Change "margin" to "uncertainty provision" as per my suggestion in the definitions section.
    b. I am not sure I want to speak of adding an "uncertainty provision" because of an assumption(s). Instead, I may be assuming an "uncertainty provision" because the data is not fully credible, etc.
    c. Why is assumption not in **bold** type: "where the assumption or **parameter** is significant"?

10. **Paragraph 3.2.7.e – Documentation.** Why is this needed since paragraph 3.6 deals with documentation**?** If want to keep this here, I suggest changing the wording to: "The actuary should document relevant and significant assumptions, data, & parameters used in the model". The current wording is too burdensome and might imply that all assumptions need to be documented. Since there are many immaterial assumptions in any model, the documentation process could be endless.

11. **Paragraph 3.3 Mitigation of Model Risk:** suggest that using multiple models is also an acceptable mitigation method that should be noted.

12. **Paragraph 3.3.1 – Validation, Checking, and Analysis**: As stated in the previous Overall Concerns section, it is my experience to speak of model verification (checking) and model validation separately. Analysis may come into play in either of these processes.

Some Other Things for Consideration

1. **Use of multiple Models:** one of the many acceptable ways to mitigate Model Risk is to use multiple models: (1) weighing the model results together for an "ensemble model", (2) cross validating between models, or (3) using multiple models to help choose a "champion" model. This ASOP should make reference to this; perhaps in paragraph 3.3.

2. **Rashomon Effect:** sometimes there are a number of different models giving approximately the same minimum error rate and that the validation process accepts as giving reasonable results. This ASOP needs to acknowledge that different actuaries may select different models for different reasons and this is acceptable. Add at the beginning of paragraph 3.2.

3. **Occam's Razor:** the conflict between simplicity (interpretability) and accounting for every detail (complexity). Because most insurance work is done in a regulated environment, interpretability may be as important as any accuracy gained through increased complexity. This ASOP should make reference to this fact; perhaps in 3.1.1.

4. **Dimensionality:** Richard Bellman's famous quote, "the curse of dimensionality" addresses the fact that in some predictive modeling there may be thousands of covariates each containing a small amount of information (i.e. signal). Traditional published advice tends to suggest that high dimensionality is to be avoided. However, more recent work questions this advice, especially with the advent of new modeling methodologies. This ASOP does not appear to address the issue of dimensionality. It may

be something the committee wishes to address by adding a definition and/or its own paragraph.

Request for Comments

1. Does the proposed standard provide sufficient guidance to actuaries working with models**? No – however, with suggested changes I have confidence in the committee & the overall review process.**
2. Is the proposed standard sufficiently flexible to allow for new developments? **Yes**
3. The draft AOP starts with a wide scope, but allows the actuary to use professional judgment to identify those instances (such as those involving minimal reliance by the user, or resulting in a non-material financial effect) where some guidance described in this ASOP is not appropriate or practical. Is clear & appropriate? **Yes**
4. In those instances where some guidance described in this ASOP is not appropriate or practical and the deviations from the guidance are "not material," the actuary does not need to disclose these deviations. Is clear and appropriate? **Yes**
5. Appropriate documentation simplifies later use and development of current models as well as allowing easier review by principals and other actuaries. Section 3 contains guidance with regard to documentation. Is this guidance clear and appropriate? **No, as drafted –Yes with suggested changes.**
6. Does the use of bold font to identify defined terms improve the readability and clarity of the standard? If not, what suggestions do you have to improve the recognition of defined terms in the standard? **Yes – I felt the bold font was very helpful.**