

**1997 VALUATION ACTUARY  
SYMPOSIUM PROCEEDINGS**

**SESSION 15**

**Life Modeling**

**Harold E. Forbes, Moderator**

**Douglas J. Knowling**

**Thomas Nace**

**Louis M. Pirog**



## LIFE MODELING

**MR. HAROLD E. FORBES:** In assembling this panel, I wanted to bring together a group of individuals with reasonably different backgrounds from both the insurance industry and the consulting arena. I quickly obtained the support of Lou Pirog from The Aetna and Doug Knowling from Tillinghast, both of whom have an extensive background in life modeling including asset adequacy analysis, asset/liability modeling, and corporate projections for a variety of needs. In my continuing search, a colleague suggested that, if I wanted someone with a diverse modeling background, to try someone who was with one of the companies that write software. He suggested Bob LaLonde at PolySystems, who is one of Tom Nace's colleagues.

When I began explaining my needs and started to discuss the session topics with Bob, in particular, the subject of minimizing the number of model cells, his reaction was something along the lines of, "Gee, we don't like to minimize cells, we like large models with lots of different policies represented." I thought it was great to have a contrarian opinion -- there might possibly be some controversy to spark some discussion or at least a different approach or perspective on the panel. As our discussion continued, I discovered that much of their modeling was related to financial reporting, particularly with short-term time horizons, which requires a much greater amount of precision in the results than your typical corporate models. I welcome this for three reasons: The first is that I believe that we get fairly complacent in our approach and sedentary in our ways, and being exposed to different perspectives prods us out of complacency and stirs the creative juices.

Second, companies have been complaining for years about the cost associated with cash-flow testing and the desire to get more bang for the buck. This really is nothing new. We've heard this expressed in years past at prior valuation actuary symposia. Models that are set up for long-term planning, don't take this into consideration. Perhaps this approach will give us some ideas and insights that can possibly be blended in with current modeling techniques.

Third, I personally believe that, as computer hardware evolves, we're going to get to the point where seriatim modeling or something approaching it may be possible, thus enabling the core model to be built in sufficient detail that it can be used as a basis for a number of different objectives.

As I said before, I think we have an excellent panel; it's well rounded, and I'd like to introduce them in the order in which they will speak. The first will be Lou Pirog. He's the corporate and appointed actuary for Aetna Life and Annuity Company. This is the subsidiary that writes the majority of Aetna's individual life and annuity business. He has an extensive background, including stints in group pensions, individual life pricing and product development, and annuity product development. He is currently in the corporate actuarial area. Except for a one-year stint at another Hartford area insurer, he has been at Aetna for his entire career, serving in various capacities. He has also served on various committees, including Risk-Based Capital, the Asset Valuation Reserve/Interest Maintenance Reserve Committee, and the current Valuation Task Force. He'll be discussing general considerations to be resolved when you're developing a model, including validation and assumption setting.

The second panelist will be Doug Knowling. He's a consultant with Tillinghast in its St. Louis Office. He consults primarily in areas of financial analysis and cash-flow analysis. His assignments have included developing asset/liability models for investment strategy and cash-flow testing, developing liability models for appraisals and corporate projects, and modeling collateralized mortgage obligations (CMOs) and other securities. He has been with Tillinghast for over five years. Doug will be discussing modeling considerations in detail, including an example case study that is based on a universal life block of business.

Our last speaker will be Tom Nace. He's a vice president of PolySystems and heads its eastern office in New Jersey. PolySystems specializes in software for both valuation and financial reporting purposes. The bulk of his time is spent on financial reporting issues including statutory tax and generally accepted accounting principles (GAAP) reserving. He has been with PolySystems for about a year and a half. Previously, he was with Penn Mutual where he had an extensive modeling

background, including corporate models, strategic planning, asset/liability modeling using option pricing techniques, and served as their appointed actuary for five years. He will be discussing modeling considerations from a financial reporting perspective and GAAP modeling in particular. After all the speakers have had a chance to make their presentations, we'll have time for questions at the end. So at this point I'll turn it over to Lou to start us off.

**MR. LOUIS M. PIROG:** As Harold indicated I'm going to touch on some of the more general principles for life insurance modeling. They are ones that we at the Aetna have learned through trial and error. I'm only too glad to share them with you. Some of what I'm going to say is probably obvious, but I've seen too many models developed that didn't work because we ignored the obvious.

If you look in a dictionary for the definition of model, what you're going to find is that it says it's a miniature representation of something. I think the key word there is miniature. What you really want a model to be is an aid to help you understand something. It's not a replacement for that process or that block of business.

One of the key things in building a model, before you start building it, is to understand what the model is going to be used for. You want to know who's going to be using it. You want to know what they are going to expect to get out of it. You basically have to make sure that they understand what the model is capable of, what it's not capable of, and they've got to be comfortable with that.

Some of the considerations are, will the model be used for short-term projections or for long-term projections? Obviously if you're going to use it for long-term projections, you're going to have less confidence in the assumptions that you use. Or, to put it another way, you're going to be looking at a much wider range of potential outcomes, and you're going to have less precision.

You might consider using the model for prediction versus a trend. If the purpose of the model is to make some specific financial forecasts -- maybe it's a very short-term forecast -- you're going to need a lot of precision. On the other hand, if all you want to do is analyze some trends, maybe you

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want to look at some alternative business strategies; then you can deal with a less precise model because your goal is to look at relative results, as opposed to absolute.

Last, are you running the model for some specific deterministic scenarios, or are you doing stochastic testing with randomly generated ones? If you're doing stochastic testing, obviously you're going to have to generate distributions of results. What you're really going to focus on is the dispersion of your results, as opposed to specific numbers.

It's very important to understand what's driving the business that you're modeling. What is it sensitive to? Sometimes that's kind of a Catch-22 because you're just in the process of building a model. Unfortunately, when you're building models, it's really an iterative process of building, testing, and revising them. Some of the things to look at might be, is your business driven by mortality? You need to consider the level of mortality experience and the trend of mortality experience. Is it persistency or surrenders that are important? What about expenses? On traditional business, these are probably some of the big drivers. If you're looking at a universal life product and you have the ability to pass through some or all of your actual experience, then your results may not be that sensitive to these, especially if you're looking over a short period of time.

External and environmental factors that can be important are: levels of interest rates, especially on long-term projects, financial markets, competition, and government policy. Certainly taxes can be a very important part of that. Regarding policyholder options, what contractual rights do the policyholders have? Presumably they're going to operate these to aggravate your results.

What kind of options does the company have? I mentioned a few before in terms of changing mortality charges or changing credited interest rates. How does the company operate? How is it going to exercise those options? This is probably a key one.

I know this may be counter to what some people are used to, but keep the model as simple as possible. In the old days they used to talk about parsimony; basically not making a model any more complicated than it needs to be. You run the risk of kind of overfitting your data.

Simpler models have some big advantages. They're easier to explain the results. You can look at the output, and it's easier to see relationships between the elements. Simpler models are also easier to understand. I think of it as signal versus noise; with simpler models, there's less potential for noise, more potential to see the signal, see the trend in results, and see where things are headed. What's also important is simpler models are easier to maintain. You have fewer moving parts. It's easier to make changes, it's easier to document them, and it's easier to troubleshoot them. There are fewer problems.

Another big area with models is validating them. Once you've created it, you try to find out just how well it works. That usually involves validating the model both statically and dynamically. With static validation, usually you're comparing the starting values in the model against the actual. With dynamic validation, you are usually looking at the moving parts. I'll add another one here, which is really kind of a subset of dynamic validation, called back testing.

When you're doing static validation, you're focusing on the initial balance sheet items. You're validating it at a point in time, the beginning of the projection period. You want to compare inventory items, such as reserves, face amounts, cash values, and premiums; what's in the model versus your actuals. You want to look at the big discrepancies and see if you can correct them.

Some of the things you can have would be things like systematic errors, where you have multiple values that are off in the same direction; maybe reserves and cash values are low. Those are relatively easy to correct. You can usually gross up your inventory, or you can tweak your age distribution a bit.

The more likely situation unfortunately is, when you have what I'll call distributed errors, where the errors are going in the opposite direction. Some values are low and some are high. Sometimes you can fix that by tweaking age distributions, but you usually end up having to modify something more fundamental, like funding levels if you're looking at universal life.

With dynamic validation, you're focusing on the income statement. You're looking at the level and progression of earnings over time, and you're comparing a model's earnings to recent actuals. You want to see if the model results look reasonable in aggregate. You want to see if they look reasonable by source of profit, and you want to look at some performance measures to see if they look reasonable. Measures to consider may include profits as a percentage of premiums, interest margin as a percentage of fund or reserve, and mortality margin as a percentage of net amount of risk or face amount. Depending on the structure of your company, you may have consolidation or tax issues, in which case you'll probably never get the taxes to come out right, so you may want to ignore them.

Back testing is another type of validation. It's dynamic. It has a profit-and-loss-statement focus, but you're comparing comparable periods of time. You look at how the model would perform if it had perfect knowledge. What you end up doing is plugging actual experience in for model assumptions and seeing how well the model reproduces actual results. You try and look at where they differ.

Using the same kind of comparisons that you would with the other dynamic validation testing, you want to understand why they differ. Differences can be due to one time adjustments, in which case you're probably not all that concerned. It may be that the corporation has done some restructuring, and you're being allocated some expenses. But you want to see if there are some systematic differences and make some empirical adjustments. For example, you may want to gross up your expenses modestly, if you see that you continually understate the expenses.

As I said before, models are really an aid to help you understand what's going on, and as such, you really want to have some preconceived notion of what you should expect from the model. If those model results line up with your expectations, that's great. That says that your understanding of the process is, in fact, correct. If model results don't line up, then you want to determine where the problem is. Is it with the model? If so, you need to revise the model and go through the process again. If it's with your understanding of how the process operates, then that's really good because you've expanded your understanding of the process, and the model has served its purpose.

In terms of developing assumptions, I just have some comments on sources and how to develop them. As I said before, you really want to know what the assumptions are that have the greatest impact on your results. Once you know that, you can focus your time more on those assumptions than the ones that really aren't going to have a significant impact. This is kind of like what is done in computer programming. You identify where the program spends most of its time, and that's where you spend your time trying to make it go faster. I've seen people agonize over assumptions like call provisions or mortgage prepayments, when the product is experienced rated, and then set a surrender rate just by picking a number out of the air. I refer to that as spacious precision. You're fooling yourself.

In terms of sources of data, you really want to use your own company's data. You want to use it in some shape or form, even if you don't have a lot of it, because it really reflects what's going on in your company, and contains a lot of what I'll call unquantifiables about your business. Ultimately it gives you some information on who you're selling to and what kind of experience you are having with your customers. If you don't have a lot of data, it's important to develop some confidence intervals around the data you have since that can give you information as well. You want to use industry data judiciously. One thing you can do is blend it with your own data. You may want to use industry data to set the trends and the shape of your assumptions, but let your company data set the absolute level. For example, consider mortality. You should also do some statistical testing, again with your own data, to see if you can get comfortable that your data and experience are consistent with the industry data.

Model “housekeeping” is mundane, but unless it’s done, it can end up costing a lot of additional time and effort. At the Aetna, we’ve used actuarial students to build models and run models for a long time. Unfortunately, as they rotate to other assignments with no time to document, what you find yourself doing is the same process over and over again. If you do these things right the first time and document what has been done, I believe you end up saving resources, especially as models get more sophisticated and complicated.

Additionally, you want to control who modifies your model. Otherwise you can end up with multiple versions that are inconsistent. That’s certainly more important if you’re using homegrown as opposed to industry systems. When changes are made to your models, you want to make sure you can validate those changes and that they are doing what they’re supposed to do. You also want to test to be sure that you haven’t changed any things you didn’t intend to do; you need some kind of regression testing.

Last, I think you need to maintain documentation on your model. You want to make sure, if it’s homegrown, that you have documentation of all the formulas you’re using. You want to make sure that any kind of source code is well documented. If you’re using industry models, you want to make sure that you have documentation available for formulas in there as well. The last thing I want to mention is user training. It’s especially important if you’re using homegrown models. It’s valuable, and it pays off in the long run. With most of the industry standard models, you can get some kind of training.

**MR. DOUGLAS J. KNOWLING:** I’m going to talk about “Getting it Right.” It’s very easy to just crank through the process of developing a model and not step back to think about what that things are that we really need to concentrate on. I’m going to go through the model development process. I’ll try not to cross over what Lou already mentioned. I want to talk about what I call thoughtful modeling, with an example of what I mean by that, and end with a small sampling of some modeling tips.

When we talk about the liability model development process, start off by analyzing the in-force business to find out what it is we're actually trying to model. Once we've gained some information, we're going to choose our model points by looking at what the important plans are, and what their key features are.

It's a good idea to construct some profit tests of your key model points to make sure that your individual cell development has taken place properly. Then we build the model by pushing the in-force business through the model groupings or the model plans that we've created, and finally we try to validate the model. Again, I'll try not to cross over too much what Lou has already mentioned.

So in modeling life insurance business, what are some things that we'd want to know about before we started modeling? Let's compare the process with the idea of looking at a building. We might want to walk around it and look at it from different angles. If you look at it from just the front, you might miss a whole lot of information that's going on around back. You might also want to go on inside and see what takes place there. Similarly, if you think about modeling life insurance business in the same way as you might analyze what's there, you walk around the data, so to speak, and get more familiar with them.

Here are some key features and demographic factors we might consider when we're analyzing our in-force business. What kind of insurance is it that we're going to try to model? Consider gender, smoker status, underwriting codes. Do you have special features like joint life status or unique premium frequencies? Then take it further down to what's the age distribution when it was issued?

Once we've analyzed the business, it's time to start selecting model points. First, we want to step back and define what a model point is in the context of how we want to use it. Generally speaking, we like to select model points that are representative policies. In other words, they have actual characteristics of plans of insurance that the company issues, as opposed to parts of maybe two or three kinds of insurance together and hoping that it comes out right in total. The reason for this is,

you're apt to get a more meaningful validation. In other words, reserves and premiums might move together more easily, and you can drill down to any problems you might find.

So how do we select our model points? Well, the first thing you might think of would be to look for the significant plans of insurance that are actually out there. Something we like to do is look at major plans over a number of measures. We might look at policy count, annualized premium totals, reserves, and face amount. If you map out these in-force statistics in descending order, it is possible to pick model plans so that you get a nice even representation across all statistics. Depending on the business you're looking at, you might find 50% representation; you might find 80% representation. That depends on how diverse your data are. But again, you want to get representation across key items not only to get the right snapshot, but also so that the model mechanically moves forward correctly as well.

Other things to keep in mind are to capture unique policy and plan characteristics. If you model a joint life product with a single life product, you will get some unusual results that probably wouldn't be very reliable. Also, keeping track of new plans of insurance, while they may not be significant today, they might be very important down the road. You'll tend to sell more of that business. It'll build up and become a more important part of your in-force.

I mentioned earlier it's a good idea to construct profit tests of your key model points. Why would we do this? We're not pricing products, we're developing models. Well, the answer is, if you wait to check your model until you have it all built and you have 500 or 1,000 cells, and it doesn't seem to validate, it's a little bit late in the game and harder to start drilling down to the one assumption or that one plan feature that you didn't quite code right or didn't quite understand. So if, for at least your key plans, you can construct profit tests and see how they mechanically run through and determine whether or not they give an internal rate of return that is consistent with what you're generally priced for, I think you can feel more comfortable with the way your model has been developed.

When I was talking about representation, I didn't say, start at the beginning and go all the way down to the bottom, until we get 100%. There's a certain number of cells that you have to map into your model plans. How are you going to do that? Well, you want to look for homogenous groups, so that you can group like coverages together. You want to keep in mind the size of the blocks. Certainly a lot of small plans are going to have less impact on a singular basis, as you map it into the model. Finally, you need to use some common sense and subjectivity. While it's called actuarial science, when you get into modeling your life business, oftentimes there's a bit of art involved with it. On occasion, you need to sit back and think about it.

I mentioned homogenous groups. Certainly if all we had was a basket full of apples, it would be pretty easy to model it. You'd probably model them as apples. If you had just a little bit of something else in there, oftentimes it's fine to go ahead and group it in, so we have the one orange. All and all, you still pretty much have a basket full of apples. But what happens if you've got two baskets: half of your business looks like one thing and half your business looks like another? Generally speaking, we would suggest mapping the apples into apples, and if you don't have an orange, create one and map it in. Again, if instead you created something that looked like an apple and orange together, it would be hard to validate, and hard to really prove that you have the model set up correctly.

With static validation, you built your model, and you're going to take a snapshot at a certain point in time. This is the starting point of your model. You're going to look at key statistics such as the number of policies, premiums, face amounts, reserves and so on. Generally speaking we look for an overall validation around plus or minus 3% on a model to actual ratio.

We also suggest going a little further than just the total and looking at things by plan type. Here you might have a little more leeway than the plus or minus 3%, but if you have a lot of fluctuation in the validation of your different model plans, chances are, you may have some offsetting errors that don't necessarily offset all the way through the model.

Another method that is sometimes used is to do the validation both before and after you do your assigning. This would indicate whether or not you represented that type of business properly. If I grouped too many oranges in with my apples, doing a before-and-after-type analysis can sometimes help uncover that. If it's not accurate, if you don't have a good static validation, what do you do? Well certainly you can review your model points, both the mappings that you made and the key plans that you selected. You might want to check out your assumptions. Maybe you didn't model the reserving method properly, for example. Finally, I know this is different for most people because it's your own company's data and you're very proud of it, but I found that healthy skepticism in the actual data is oftentimes very useful. The data field may have been selected for you, and it isn't exactly what you thought you were getting; so going back to ask questions to understand your data is sometimes the answer.

Dynamic validation is where you're going to check the mechanics of the model; does it reproduce your income sheet? We talked about the types of things that you might look at. What are some problems that are often incurred when you go through dynamic validation, particularly if you're doing a cash-flow-testing model, as you don't have new business. Many of these items depend on new business. One approach is to put some new business into your model to see how it works. Perhaps you have actual reported numbers that you can use to test and see if you get back to last year's new business results. Also you might have short-term fluctuations in experience. The actual reporting might not be in sufficient detail to really drill down and find out that your universal life plan issued five years ago didn't have the right experience assumption associated with it. But again, there can be an art to modeling, and without doing both the static and dynamic validation, you can't really be certain your models are credible.

Now let's compare big models versus small models. This seems to be the theme we're going to get into, at least a little bit later. Accuracy, speed, and the way you're going to use the model in terms of sensitivity testing are certainly some items that come into play. But I would suggest that it can be more than just big versus small, and this is where we get into what I call thoughtful modeling. That means you may be able to create a better model with fewer cells, strictly because they're the

right cells. I have an example with the universal life product. Let's assume it's a back-loaded universal life policy that was sold from 1990 through 1995, with a five-year minimum premium guarantee. It has commissioners' reserve valuation method reserves, and four underwriting classes: male, female, smoker, and nonsmoker. As of December 31, 1996, we had 10,800 policies, with an average face amount of \$100,000. The fund value is \$47 million, reserves are \$26 million, and the cash value is \$17 million. Keep the fund value and the cash value items in mind later as we go forward. So let's start off with a simple example. We found out that 80% of the business was male nonsmoker, so we'll crunch it all into male nonsmoker. We like to model age triplets, so I'll use 28, 42, and 53 for my ages. I grouped them into four issue years because I had a couple of years where we didn't issue much, both at the beginning and the end. Multiply those out, we have a nice tight 12-cell model. If we validate that and look at model-to-actual ratios, both on reserves and cash values, it doesn't quite hit the plus or minus 3%. So we're sitting at about 75% or just a little bit below. So it looks like we need to go back to the drawing board and work on our cells some more.

Let's use some brute strength. Instead of one plan, we are going to split it out into four. Let's try quinquennial age groups now, so we're going to have nine ages, but keep the same four issue years. Now we have 144 cells. This has got to be better, right? Well it's a little bit better. It just raised the ratio up a little bit. The question is, why? We increased the number of cells, so it ought to be more accurate, shouldn't it? The answer is, we didn't do the right thing to the model. So let's sit back and think: universal life can be sold in a number of ways. Think of it as a funding continuum, anywhere from annual renewable term (ART) insurance all the way up to single premium whole life. If it wasn't always sold under the same method, when you model things as averages, you miss some dynamics of what is actually going on in the in-force business: you have some term business and some highly funded business.

So this time we cut back to three plans, set the ages back to three groups because that didn't seem to do the trick before. But this time we split it up into two funding levels. We multiply this out, and now we have it down to 72 cells. It's quite a bit bigger than the simple model, but considerably smaller than the big model. So we split our universal life policies up into two cohorts: a fully funded

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and a lightly funded. As you review the statistics, the key ones that pop out, of course, are all the cash values sitting in the fully funded group and no cash value sitting in the lightly funded group.

That is a simple, straightforward thing to do, splitting the funding methods. Just find out those that have a positive cash value and those that don't. There are other methods that you can use to split the funding levels up. We have found that funding levels often can be the most important item to look at when you're modeling universal life. We also put in some different assumptions by funding level. For the fully funded we put some dump-in premium there. Maybe there was some rollover business from some older contracts. We put a higher premium pattern in, as well as adjusted the premium persistency between the two methods.

Of course, this is my example, so it worked really well. We got the cash value and reserve to match out this time. Again, we were trying to model an average of a surrender charge that we could never really capture properly until we split it apart. This is just an example, but then in the example we put together, we found that, when you looked at projected statutory earnings, the big model and the split up funding model ended up at the same place on earnings, but still didn't quite hit together early on. The split funding levels model ended up being the better model. That's one example of when thoughtful modeling can be useful.

What are some other items? Oftentimes, reentry products are problematic. How do you account for that? It's often best to try to split the business up into cohorts and make assumptions as to, how many will reenter and try to maintain conservation of lives with the mortality assumption?

If you have a lot of different dividend options on traditional business, it's good to try to capture all the different dividend options that are actually occurring, rather than just sort of blindly push it through. Maybe sit back and see how the dividend options are used and what the profitability of the different options might be.

Turning to dynamic assumptions, while there's generally not a lot of good data on things like interest-sensitive lapsation, if you can think through the relationship of how having a surrender charge would impact market differences and crediting rates, you're apt to get a more reliable and reasonable model. Take the time to think through those relationships.

As promised, I'm just going to end with a few random modeling tips. We've looked at a lot of models over the last few years, and I think it's fair to say that oftentimes the models end up too large. It's the approach that comes most naturally, just throw more at it and it will go on through. I think at least in this example, that isn't always the best answer. If you start combining plans together, as I mentioned, that can have an adverse effect on validation. It's hard to validate each plan at the drill down. Three issue ages are generally enough, as long as you pick what I call the right issue ages. We like to use age triplets where we split the in force on the model points statistics, (on the model plans that we're developing such that you get a third, a third and a third) in each of those ages and then come up with the average age for each triplet. It does require a certain amount of maintenance to your model going forward. While age 47 was good this year, age 49 might be the age you need a couple years down the road as the business starts to change. But if you set your model up ahead of time to anticipate that (using table-driven models), developing the new age won't be nearly as difficult. You may want to gross up for small plans that don't fit neatly into actual plans rather than mess up the plans that you have already modeled. Just leave certain pieces out. Use your own judgment.

The next point is especially important for a traditional business. When considering what mix of the annual and monthly mode to model, you can validate the result with deferred premium. Then finally multiple issue dates within a year generally are not needed unless you're doing short-term projections. You're really just adding cells to the model without adding the kind of accuracy that most actuarial models are used for. I said most models, but not all, as Tom will show us. You don't want to end up overkilling the model. If you have business that's 50 years old, oftentimes we combine ten years' worth of issues together into one average issue year.

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**MR. THOMAS NACE:** Within the financial reporting process or GAAP valuation, the GAAP accounting models that I'm going to really be talking about are the *Statement of Financial Accounting Standard (SFAS) No. 97*, as well as the *SFAS No.120* accounting models. More specifically, even within these is the issue of the amortization of deferred acquisition costs (DAC). Now on the surface, the amortization of DAC within the GAAP process is a much different application than the use of modeling for either cash-flow testing or asset/liability modeling. However, as we go through the process, it will become evident that a lot of the issues are similar to those for asset/liability modeling and cash-flow testing. In particular, model construction and validation are similar. The major difference (in terms of the GAAP valuation process) from other applications is primarily in the criteria that's used to validate or evaluate the results of your model. I'm going to point out not only some of the similarities between the modeling involved with the GAAP process, but also some of the peculiarities as the modeling relates to the GAAP valuation process and DAC. Before I get into the actual issues of discussing the modeling issues within the GAAP valuation process, I'd like to spend a minimal amount of time just highlighting the use of projections within the GAAP process. This will be helpful because it will really serve as a backdrop for my later discussions.

First of all, the role of projections comes into play within GAAP in terms of amortizing or developing a schedule of amortization for your DAC. As you know, DAC is amortized in proportion to the estimated gross margins (EGMs), in the case of *SFAS No. 120*, or the estimated gross profits (EGPs) for *SFAS No. 97*. For the remainder of my presentation, I will use the term EGMs to refer to both accounting models.

At any point in time, the stream of EGMs will consist of both historical EGMs as well as projected EGMs. Historical EGMs represent those periods from date of issue up through the current valuation date. Your projected EGMs will cover the period from the valuation date to the end of your amortization period. The amortization period can be set as a fixed number of years or over the lifetime of the contract.

The definition of estimated gross margins are basically your premium, plus your earned interest, minus your increase in benefit reserves, minus benefits, minus recurring expenses, and plus or minus your realized capital gains and losses. If you were to split the increase in benefit reserves line into the various components that make up that increase, such as your net premium, tabular costs, and so on, and rearrange them by pricing component, what you would get is basically the sum of your EGMs, which would be the sum of the various experience elements like mortality, interest, and expense. It's this latter format that really defines the basis for your EGMs for *SFAS No. 97*.

The first step in the process of developing your DAC amortization schedule is to determine the present value of your future deferrable expenses as of the issue date. This present value of deferrable expenses will include both your actual deferrable expenses up through the valuation date, and projected deferrable expenses beyond the valuation date. Similarly, the present value of future EGMs would need to be determined as of the original issue date of the policy. The amortization percentage is then calculated as the present value of deferrable expenses divided by the present value of future EGMs. This amortization percentage when applied to each period's EGMs, will determine the amount of DAC amortization for that period. Together with the DAC amortization amounts and the DAC interest rates, a DAC roll-forward can then be developed, starting from year of issue up through the end of the amortization period.

To summarize, the process of developing and maintaining a DAC schedule over time involves first an initial modeling, determining the cells that are needed to project forward future cash flows or EGMs, an initial projection, and then at each future valuation date, a reprojection, based on current in-force amounts.

Now let's take a look at the modeling process within the GAAP *SFAS No. 97* or *SFAS No. 120* accounting models. The first step in the process is very similar to steps that would be involved with any other application, such as corporate model projections, and that is determining the number of cells that will represent the model. The number of cells can impact the fit of the model, although not in all cases. The number of cells within the model will be a function of the number of different

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lines of business that a company has and the variety of plans within each line of business, and so on. Typically, in a corporate model-type projection, the number of cells have to be weighed against a lot of very serious practical issues. One is, the overall size of the model, the resultant impact on run time, the amount of time that it takes to update and maintain the model and also the availability of data within the company to actually support and validate the model at the cell level. There are a lot of issues in a corporate model-type projection.

When it comes to the number of cells in the GAAP valuation process, the tendency is to increase the number of cells in order to provide a higher degree of accuracy in the short term. It is this higher degree of accuracy versus the long-term issues that we'll be talking about a little later. After having defined the number of cells and the granularity of the model, the existing in force must be condensed into these cells based on the model rules that have been adopted.

The projection period for the GAAP process is typically at least to the extent or length of your amortization period.

Having the cells defined, the next step in the process is really to determine your projection assumptions. For GAAP *SFAS Nos. 97 or 120*, your project assumptions should be best guessed assumptions with provision for adverse deviation. These assumptions can be your pricing assumptions or your long-term corporate model type assumptions. Projection assumptions are often implied in a plan and year-of-issue breakdown. The result is a series of cash-flow or EGM vectors for each of these various breakdowns.

The resulting DAC amortization should be compared for overall reasonableness and, in particular, looking at the DAC amortization at one valuation date, versus the DAC amortization at a prior valuation date. Any major shifts in the DAC amortization schedule from period to period should be analyzed to see what the major cause was.

When the GAAP *SFAS No. 97* process was first set up, the initial model building process takes place. One of the ways to validate the model is to compare the projected EGMs with actual EGMs and notice the level of discontinuity or continuity between actual and projected. Where there is a major discontinuity, fine-tuning the assumptions or the cell structure can improve the tie between the historical and the projected results. Once the GAAP model is set up, and the process has been defined, and has been used for actual valuations, any future changes in the model structure or the model assumptions would result in an unlocking that would have an impact on your net income. Consequently, an objective when initially setting up the model is to try to avoid any major discontinuities between actual or historical EGMs and the projected EGMs.

As just stated, when reconciling the historical to projected results, one of the objectives is minimizing the level of discontinuity. The GAAP process is somewhat unique in that the model and assumptions will routinely be tested, such that, when providing a projection at the very next accounting period, one of the projected EGMs from the current accounting period will be replaced with an actual EGM. Thus, as you move through time, there will exist this constant reviewing or checking of how actual results compare to the projected results. When examining the discontinuities between the historical and the projected EGMs or the cash flows, the nature of the discontinuity or the nature of the cash-flow element that may be causing the discontinuity needs to be looked at closely. For example, death benefits from one accounting period to the next typically show a high level of volatility. So comparing one period with another in terms of evaluating continuity for death benefits may not be a reliable test. Obviously what would be needed in this case is to look at the overall level of the mortality that is projected versus the level of mortality that has actually occurred in the past; make sure that one is not significantly higher or lower than the other.

In other cases, the degree of consistency between historical and projected results depends on the cash-flow element. For example, with renewal premiums on a traditional fixed-premium-type product, you would expect a lot more consistency in the renewal premiums going from historical to projected. Consequently, the actuary should have a lower tolerance for any inconsistencies on a

cash-flow element like that. The nature of each cash flow needs to be evaluated in order to determine the level of tolerance for discontinuity between actual and projected.

The first step in tracking down a discontinuity that might be deemed to be a potential problem or modeling problem is to check the trend for the projected in-force measures. If a particular cash-flow item is off in terms of what might be expected going from historical to projected, there could be two reasons for this. One is that the overall projections of in-force amounts are off. If the projected amount of insurance or number of policies are off, then this can explain why the policy element or cash-flow element that we're talking about is off. The other possible reason for a discontinuity is that the methods or assumptions used to project the particular item are off. So you really need to first make sure that the in-force amounts look reasonable going from historical to projected before examining the actual methodology used to project the various cash-flow items.

There are a couple tools that are available to analyze the projections and the projected results versus recent actual results. The first is a gain-by-source analysis, and the latter is the use of financial ratios. Both of these tools are applicable not only for the GAAP valuation process, but also for any modeling process.

A gain-by-source analysis basically breaks down the cash-flow vector; or if producing a corporate model type projection, it breaks the net income vector into the various experience components. From an actuarial standpoint, whenever the actuary produces any type of projection, whether it be a corporate model, asset/liability modeling, cash-flow testing, or GAAP, basically what he/she is doing is projecting forward the future margins. All too often it is very easy to get bogged down by looking at the proverbial trees as opposed to standing back and looking at the forest. A gain-by-source analysis provides a way to look at the forest. The typical experience factors that are derived from a gains-by-source analysis are: interest, mortality, reinsurance, expense, surrender, and any other miscellaneous gains. The interest margin is income resulting from the difference between the earned rate and the credited rate. The mortality margin is basically the actual mortality incurred versus the expected mortality, and so on. By summarizing the cash-flow components into a gain-by-

source analysis, it is possible to see how the margins stack up and compare going from historical to projected. It also serves as a good check to make sure that the underlying projection assumptions are valid or accurate.

The second tool for analyzing projected results is the use of financial ratios. This again is appropriate regardless of the modeling application. Developing a ratio and examining the trend in this ratio over a period covering historical and projected periods can be very insightful.

Let's take a particular example scenario where this could be useful. Let's assume for example that you're looking at the renewal premiums on a traditional policy and note that the dollar amount of the renewal premiums is dramatically down from one accounting period to the next. But let's also assume during that period that there was a high level of surrenders or lapses. The issue then facing the actuary is, does the increased level of surrenders and lapses fully account for the total decrease in the premium? On the surface, it may be very difficult to answer that issue. By developing a ratio such as premium per thousand and looking at the trend in this ratio over a range of years covering both accounting periods, it may be possible to confirm that the projection is satisfactory or that there is an underlying problem.

There are many more similar ratios that can be developed, such as maintenance expenses per policy, or total amount of lapsed insurance divided by beginning of the year in-force business.

The remainder of my presentation will focus a little bit more on issues involved with the whole modeling process as it pertains to GAAP. Some of these issues do overlap and do effect other applications, but are primarily focused on the GAAP valuation process. The first issue is balancing the short-term accuracy with long-term reasonableness. Put another way, how do you determine the short-term accuracy that is needed for financial reporting versus the desire for reasonableness with other long-term assumptions that may be used in other applications?

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First, let's take a look at the short-term issues. In the financial reporting arena, the short-term horizon is extremely important for a variety of reasons. The first is the resultant impact that any kind of change in DAC will have on net income in the current period. The larger the disparity between the actual EGM and the projected EGM that is replaced, the larger the change or shift in the DAC amortization schedule, and consequently, a larger impact on the current financial reporting results. Any change in DAC runs through GAAP net income. Consequently, it is the highest priority when developing the model to make sure that the possible volatility in the DAC amortization schedule due to modeling is minimized. A related concern is the accountability that the financial reporting actuary will have to management and others in explaining the financial results. It is important that management understand the key experience drivers underlying the financial results. The actuary does not want to have to explain that the reason the results are off from expected is because of modeling.

On the other side of the issue is the long-term aspect. If GAAP projections are supposed to be best-guess assumptions, then there should be a consistency between those assumptions and the longer-term pricing assumptions, for example. In addition, the auditors will be examining the long-term assumptions to make sure that they're auditable. In other words, is there basis for this assumption? Do they tie in with actual results? Are they consistent with other applications within the company where consistency is warranted?

One of the questions to ask here is, is it possible to achieve the level of accuracy in the short-term that might be desired and also to achieve the long-term reasonableness of the assumption? The answer is, it's very difficult to balance these objectives within the GAAP financial recording process. I've outlined a couple of the options that can move one more toward a happy medium as opposed to being in an all-or-nothing situation. The first of these is to possibly increase the number of cells used in the modeling. Again, by having a larger number of cells or maybe better cells, you can improve the fit of a model in the short term, obviously without sacrificing accuracy in the long term. So trying to gear your model more to the short term should not have an adverse impact on the long term.

A second option for balancing the short term and long term issue is to vary the projection assumptions by projection year, grading to some ultimate level. This may, in some cases, be a lot more easier said than done, particularly if you have a policy year model and you want to change the results by calendar year. One instance where this could work is in terms of interest margin. Let's take the case where a company had deflated investment returns over the last couple of years, but was expected to grow out of that within a couple years either by, let's say, selling off real estate or maybe even the market returns were expected to return to some overall long-term level. In this case what the actuary could do in building or setting the assumptions initially for the GAAP process is to start off with assumptions that are very close to what had been realized in the recent past and then grade the interest margin up to some ultimate level, similar to what might have been used in pricing.

The third option for addressing the short-term and long-term issue is somewhat similar to the first, but it is different, and that is, varying the assumptions at finer breakdowns of in force. Again this might be best described by an example. Let's take a case where a company is modeling a traditional life block, and for all its traditional life cells, has used an aggregate traditional mortality. On the surface this may seem like it's satisfactory, but by varying assumptions for term versus permanent cells, it may be possible to actually improve the accuracy of the overall projected results without changing or increasing the number of cells in the model. So these are three options that exist in order to balance the short-term and long-term objectives.

The next issue I want to talk about is consistency or inconsistency with pricing. In this case I want to talk about it from a slightly different aspect. I talked before about consistency with assumptions in the long-term with pricing. What I want to talk about here is slightly different, and it relates more to products where there are new introductions in the marketplace that are similar to the universal life product in the early 1980s, or more recently, the equity-indexed annuities. The thought here is that, when the pricing is initially done for products like this, there may not be a lot of credible experience available for the pricing actuary to set the pricing assumptions. If these are the assumptions that are used for the GAAP process for these new plans, then because of the process of updating EGMs routinely by replacing projected EGMs with actual, it will become pretty apparent fairly soon or

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within a number of years whether the pricing assumptions are valid because there will be this built-in checking process within the DAC amortization process. If a company produces experience analysis, that would be another way of uncovering any discrepancies between pricing assumptions and actual results as well, but certainly the way the GAAP process is set up, it lends itself to the validation process.

The next issue I have relates to corporate model projections of GAAP financial results. A company may be doing a set of GAAP projections for an incentive compensation plan, for a strategic plan, or just for internal management. The issue is that, when the modeling actuary is developing a set of projections, he or she may actually be faced with dealing with three different sets of assumptions. The first set is the corporate model assumptions, and these assumptions should be either best guess, or, in the case of strategic planning, may be stretch objectives. Regardless, it's the underlying assumptions that fit the scenario that is being modeled. The second set of assumptions that may be involved within the corporate model are pricing assumptions. In the corporate model, with any new business cells that are being projected, it's likely that the underlying assumptions for these cells will be the pricing assumptions. Finally, if a set of GAAP financial projections is being produced, the whole development of GAAP reserves and DAC will have, inherent in those calculations, yet a third set of assumptions -- the GAAP projection assumptions. Theoretically, all three of these assumptions should converge in the long run, but the modeling actuary in this case should be aware of the different sets of assumptions and make sure that they are either consistent or can explain the differences so that the overall projection results are valid and reliable.

My last point somewhat ties into this and relates to the coordination of assumptions between various areas. It is important for the actuaries within a company who are involved in the applications of modeling (whether it be ALM, cash-flow testing, pricing, or GAAP), to define assumptions and then, consequently, address the need for internal consistency of those assumptions amongst the various applications. I believe that consistency is needed primarily for the overall integrity of the projection being produced. The second reason for the consistency goes back to the auditors. The auditors are certainly going to ask questions in terms of validating the assumptions that are used, and again will

question the use of assumptions between different applications where they might seem inconsistent. This whole process of integrating assumptions from various applications may require a change in the way that actuaries typically work together. Many years ago, you may have had a pricing actuary who basically operated independently from the valuation actuary who in turn worked independently of the corporate model actuary. Now, regardless of what the corporate structure is, these actuaries will need to be discussing and reviewing together and coordinating the use of any assumptions that are used within the company to make sure that the various outputs are consistent and credible.

To summarize then, the GAAP valuation process presents a lot of issues, many of which can be extended to other applications like cash-flow testing and ALM. Some of the tools for validating and building models apply equally as well to the other applications, but at the same time there are many issues that relate to the GAAP financial process or GAAP reporting process, which present unique challenges to the financial reporting actuary.

**MR. DONN T. TAKEBAYASHI:** I have a practical question. In working with the models, I think Doug you mentioned that, for example, when you're modeling universal life blocks, the funding banding seems to work real well, which I do agree with. At times, you're asked to justify where these assumptions come from, and depending on how you did the funding band, you can't actually get experience data to back up your assumption. So how do you handle that kind of situation?

**MR. KNOWLING:** I think I touched on that in the presentation. Assumptions such as that are difficult to get a handle on. The best bet would be, if you don't have actual experience studies available with the dynamic validation to compare against prior results, show that your model can reproduce what happened in the past and get your level of comfort. If you can do a back test like Lou talked about, that would be even better.

**MR. TAKEBAYASHI:** Typically we're working with maybe one or two years at the most before they run out of patience and say, it has to be ready. But if you're doing say a 30-year projection, and the accuracy is really important, I feel pressured to even change the structure of the model so that

you can actually line up lapse studies along the lines without banding, for example, just to alleviate that problem. I think it actually makes the model worse when they do that, but I'm kind of forced into that position. It's the only way I've been able to address that.

**MR. ROBERT J. POLILLI:** I appreciated Doug's review of the universal life case. That was a model that I had seen going down in flames for me one time, and it took a while to figure out what in the world had happened. But it involved the current funding. But as Doug went through it, one of the points to keep mind as you're building your model, is that if you have a lot of reinsurance, you can get near the end and think that you have a lot of apples, and then you realize you have to model the reinsurance and then all of a sudden half those apples are really oranges. So if you haven't taken that step-by-step approach, your project is going to take a good deal longer than you thought because you have to go back and start separating your model cells between those that are reinsured and those that aren't. So I thought that was a really good approach.

Louis mentioned something about the spacious decision making. I wanted to add a little comment. When you're looking at the assumptions and not just for the model building, to see if something goes wrong, are the assumptions tight enough. So in one case you don't want to do a lot of work by looking at all these small benefits, but occasionally, some of the small benefits are a whole lot larger than was originally planned.

**MR. PIROG:** I agree with that. My point is that you want to be careful in terms of spending a lot of time and effort to try and get one number very precise, where another number is not so precise. It's kind of like the chain; the weakest link is going to be that less precise assumption. But I agree with you completely. You really want to go through and understand what moves the model results around, and sometimes you have to dig a little deeper in the ancillary benefits.

**MR. MARK LEWIS GLICKMAN:** Could you comment on how you tend to deal with modeling effects, that is maturities, expirees, things that show up as step-wise functions when, in real life, they're nice gradual curves?

**MR. KNOWLING:** That is definitely an area where bigger might help you out rather than smaller, in that, if you have a smaller number of cells, at some point that entire cell is going to mature or expire and go away. The only thing I could really offer would be to find out if it is going to expire in the time period that you're really concerned about, and possibly try to mix the business around a little bit. Maybe an example would be picking one issue month and modeling everything in that month. If you have annual premium, on a quarter-by-quarter basis, it doesn't come out very well. I've seen people mix and match their cells so that, rather than take each cell and split it into four, they take one cell and put it in May and take another cell and put it in September and so forth, so that overall, the model does what you want it to do. Depending on what exactly you're talking about, maybe you could do something like that as well.

**MR. GLICKMAN:** As a specific example dealing with GAAP amortization, we have non-trivial EGMs, and so the projection horizon needs to go that far when all of a sudden you hit a large majority and you get a negative EGM. Well, you certainly can't report it that way, and can't amortize that DAC that way. Is it reasonable then to essentially go off system and say, hey, this million dollars of maturity really needs to be spread out over this block of years. Then, of course, you run into the problems where you have to throw the reserves back in, and then in subsequent years those reserves would tend to grow or disappear.

**MR. PIROG:** My answer to that would be, yes, that's what you have to do. Let's face it, models are not perfect. Somebody once told me, models are great, but they don't turn corners very well, and I think that's what you're talking about here.

**MR. FORBES:** Backing up to the previous question on the surrender maturity issue, instead of expanding your model to include additional ages, stagger out the issue years that you're using and get a little more precise in the points in time that you issue the business, and that will help smooth some of the results toward the tail end a little bit.

