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METHODS FOR DETERMINING AND ADJUSTING CONTINGENCY (BENCHMARK) SURPLUS

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Recorder: ERIC A. BROEDEL

- Overview of technical developments
- The role of stochastic modeling in theory and practice
- Corporate processes to determine the current year's standard
- Relating internal benchmark standards to those of rating agencies
- Business segment considerations contrasted with overall corporate needs
- Impact of corporate characteristics -- How should standards vary by company size and business acumen?
- The interplay of contingency surplus and nonguaranteed policy elements (including participating dividends)
- The role of consultants in a smaller insurance company environment
- How much refinement is enough?

MR. GERALD A. LOCKWOOD: The purpose of this session is to discuss the Methods for Determining and Adjusting Contingency (Benchmark) Surplus. The first speaker is Greg Jacobs who is a Consulting Actuary in the Indianapolis office of Milliman and Robertson. Greg is going to provide an introduction and general overview of contingency surplus and an introduction to some of the methods for determining contingency surplus. Our second speaker will be Mike Zurcher who is an Second Vice President at Lincoln National. Mike will be focusing on some of the stochastic methods used at Lincoln National for determining and adjusting the C-3 risk component of contingency surplus. The third speaker will be Dave Creswell from CUNA Mutual Insurance Group. Dave will discuss some of the stochastic methods used at CUNA Mutual for determining and adjusting the C-2 risk component of contingency surplus. Our last speaker will be Joe Buff, who is a Consulting Actuary at Tillinghast in its New York office. Joe will provide us with some observations and a wrap-up in order to tie this discussion together. He plans to stress how the technical work we can do really does support the basic needs of management, even if you don't agree with all of the "black box" modeling details.

MR. GREGORY D. JACOBS: I am going to do a brief overview and a summary of the issues surrounding contingency surplus management and development. My two colleagues are going to get into the specifics at their particular companies, and then I am going to leave it up to Joe to summarize.

Before we start talking about contingency surplus, some definitions are in order. I think there are five key terms we are going to have to discuss before we can understand what is going to be said. The five key terms are statutory reserves, statutory surplus, realistic reserves, contingency surplus, and vitality surplus.

STATUTORY RESERVES

Statutory reserves are the liability for future obligations based on conservative statutory formulas. These reserves are what the NAIC has told us we should be using when we put our annual statement together. From a valuation actuary perspective, you may or may not agree with this statement, but this is my opinion: this reserve should be good and sufficient for future unmatured obligations at least 90% of the time. I believe that is the general feeling about what statutory reserves are all about. The use of the statutory reserve basically is to determine the level of statutory surplus. There is no other value that the statutory reserve holds; at least I haven't figured out one that is worthwhile.

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STATUTORY SURPLUS
Statutory surplus is essentially the excess of the book value of assets prescribed by the NAIC over the statutory reserve and the Mandatory Securities Valuation Reserve (MSVR). Its use, and its only use in my opinion, is to determine the solvency in the eyes of the regulators. It really doesn't do much for the line or company manager to see how much statutory surplus you have. It is simply for *Best's* and the Insurance Department examiners to see if there is enough statutory surplus on the books.

REALISTIC RESERVES
"Realistic reserves" is the phrase I have been using. I am not sure if there is a better phrase. It comes from "merger and acquisition" sorts of analysis. This is the liability for future obligations based on "best guess" or realistic assumptions. It is the same thing as a statutory reserve except you're using "best guess" assumptions. It would be the value placed on this book of business if you were to sell it. Dave Carpenter asked in his talk, "Why don't you look at your balance sheet or your company in the eyes of a merger/acquisition specialist?" This is exactly what I am talking about here. Look at what you really think that you need to have on your books to pay for your future obligations under realistic assumptions. Again, another way of looking at it from a valuation actuary perspective is, this should be enough to make a good and sufficient statement at the 50% level. In other words, on the average you should have enough money around to pay for your future obligations. The whole purpose of this is to determine how much assets are needed to cover your future obligations under realistic assumptions.

CONTINGENCY SURPLUS
What contingency surplus is all about is the additional liability needed to cover the risks that the enterprise is undertaking. Our first reserve level was not intended to cover risks. It was intended to cover what we expect to happen. The risks include the familiar C-1 through C-4 risks.

Another definition for contingency surplus from the eyes of a valuation actuary, I believe, is: the contingency surplus together with realistic reserves should be good and sufficient to cover future obligations at the 99% level. This gets into the reasonable and plausible -- where reserves should be reasonable, and reserves and surplus should be plausible.

To clear up some gray areas, I believe that contingency surplus is also known as "target surplus," "benchmark surplus," "required surplus," and "risk surplus." I have heard those words used by many different people, different computer systems, different consultants, and different articles. They are different words for the same concept, I believe. I think the panel has come to the conclusion that all of these terms mean the same thing. So you will hear all of us interchange these words.

The use of contingency surplus is to determine, together with realistic reserves, the amount of vitality surplus within the company. That to me is the critical importance of why we need to be analyzing contingency surplus.

VITALITY SURPLUS
The definition of vitality surplus is the excess of the market value of assets (and I stress market value versus book) over the realistic reserves and contingency surplus. What we are trying to do here is look at the company as if it were on the block for sale -- evaluate what the value of the enterprise is. This is a critical determinant because in the eyes of management vitality surplus is the lifeblood of an insurance company.

Here are some general observations regarding each of these items:

The realistic reserves are equal to or less than (and they should be less than) the statutory reserves. There should be some equity in the statutory reserves. The statutory reserves have always been set using some reasonably conservative assumptions. Over time there should be some equity that is built up in them. We are trying to analyze how much equity is in those reserves by developing this concept of the realistic reserve.

In the current environment of NAIC accounting principles, we don't see or recognize that equity in the reserve. I believe that contingency surplus should recognize that equity. If you have Company A that is reserving its back-end load at full account value versus Company B that is reserving it at the absolute minimum reserve possible, I believe that Company A needs significantly less contingency surplus than Company B, above and beyond its statutory reserve levels.

I believe there is no exact method that computes contingency surplus. That is what we are going to do in greater detail. There basically are two common methods. One method is the simple formulas which, for lack of a better word, we will call the "Lincoln National" formula -- 3% of reserve, 25% of premium, 33% of expected claims -- you've seen and used them. Those are good starting benchmarks, but I am not sure they are the right numbers for your particular company. The more proper and appropriate way, I believe, that one needs to determine contingency surplus levels is in scenario testing stochastic modeling which will be touched upon in the remainder of the discussion. I believe also that it is extremely important that the determination of contingency surplus, should reflect the company's marketplace, its products, and its management strategy. A company that is always living on the edge with its investment strategy seems to be taking more risks. So a C-1 risk analysis of this company should have a higher component to it than a company with a less risky strategy.

Some more observations: Realistic reserves plus contingency surplus are generally greater than statutory reserves plus MSVR. The point I'm trying to make is that the risk coverage ability of MSVR and the equity in statutory reserves are generally (in my opinion) not as large as a properly computed contingency surplus level.

A direct corollary of this first observation is that vitality surplus is less greater than statutory surplus. Not only are statutory reserves and MSVR less than realistic reserves and contingency surplus, but I think in current times the market values of companies' assets are generally less than their book values.

The real key as to why we analyze contingency surplus is to determine the vitality surplus. It's the real measure of solidity. Solidity could be defined as the ability of a company to continue as a growing concern, even if some (hopefully not all) of the risks that they are undertaking have, in fact, been realized; that they do not have to have significant changes in their operations because a terrible event occurs. That to me is vitality. And if you have enough vitality surplus around, you can handle that. If vitality surplus is zero, that's very bad, even if statutorily you're okay. And there are companies, I guarantee you, that are in this situation right now.

Hopefully that kind of sets the stage for why we are talking about statutory reserves and surplus and how that interrelates with contingency reserves and vitality surplus, and so on.

Now I want to talk about why it's all important. I have come up with two reasons. One (I'm being a little bit cynical here) I'll call the "utopian" reason (everybody ought to do it because it's the right thing to do) and the other I'll call the "pragmatic" reason. Insurance is a risk-taking business. I believe everybody knows that. Capital is scarce and it's expensive. I believe everybody knows that also. Therefore, management owes it to its policyholders and stockholders to understand and manage risk. The only way you can do that is to have a proper deployment of capital and have the expectation of return on capital commensurate with the risks you are undertaking. That's the only way you can manage an enterprise properly. To do all this you must be able to determine contingency surplus. Now those are the utopian reasons. If there weren't external forces dealing with us, everybody would do it because this is the prudent thing to do. However, there are practical reasons.

The primary practical reason is to attain or retain an acceptable rating from *Best's*. Many companies I know go cruising along through life happy as a camper because they don't have problems until *Best's* notifies them that it is going to drop their A+ rating. Then they are forced into action, and they start doing some surplus analyses. That's being cynical. That's a pragmatic reason, but they should have been doing it all along. If a company has a solid A+ rating, in the eyes of some management utopia has been achieved. I think that is a false sense of utopia. You ought to be doing contingency surplus analysis.

MR. MICHAEL L. ZURCHER: My purpose on the panel is to discuss how several of the topics that are outlined in your program relate to a stock life insurance company and, specifically, Lincoln National. My presentation will lean more heavily toward the pragmatic than the theoretical as I describe how we have attempted to bridge the two with respect to surplus management. I am going to be using the term "target surplus" throughout my discussion. Once again, it is the same as contingency.

The use of a target surplus formula at Lincoln National has been pretty well documented in actuarial literature in the past. Going back and looking through a recent *Record* or *Transactions*, you can find several discussions of how we use it by authors such as Dick Robertson, Rick Kischuk, and Reed Miller. Therefore, I will highlight only the two primary uses of the formula at Lincoln National.

First and foremost, the formula is used to target the statutory surplus for the company as a whole. Theoretical considerations are important in setting this target, but practical considerations such as our competitive posture, rating agency standards, and overall perception of risk in general come into play as well. We have found over time that the formula does work pretty well in satisfying these practical constraints, although it would not necessarily do so for another company. Then, depending on how our actual statutory surplus compares to this target, different strategies can be employed to increase or decrease surplus levels, also taking into account trends and projections. For example, recent group health losses and growth in other lines had left Lincoln National Life with less surplus than our target measures suggested was necessary. As a result, additional capital was placed into the company in late 1988. This experience has made us much more aware of the need to plan and manage the statutory income statement and balance sheet to the same degree as we try to do our GAAP statements.

The second use of the formula is to allocate surplus to various profit centers within the company. This statutory allocation is the first step in developing the GAAP equity a profit center is going to employ, which is then used for capital deployment, internal management reporting, and performance measures. Each year we review the target formula in terms of the aforementioned practical considerations as well as looking at new products and assets, new risk evaluation techniques, and other relevant information. Most often we receive assistance from product line and investment personnel. Again, from the practical point of view, we attempt to keep the formula relatively simple. It should be understandable to all levels of management and easy to apply administratively and for use in your planning process. At the same time, the formula needs to promote the appropriate risk/reward relationships and incentives.

I would now like to turn to an application of the stochastic method as it relates to the C-3 component of Lincoln National's target surplus formula. First, I have a bit of history about this component for interest-sensitive lines of business. Up until 1985, the C-3 factors were static. They were designed to cover the withdrawal by policyholders of 20% of their funds when the market value of the underlying assets was 75% of book value. From 1985-1987 the factors were made more dynamic by adjusting for differing degrees of asset/liability mismatch. The development of these factors assumed an implicit yield curve and liability structure and assumed negative cash flow during a rising interest rate environment. The C-3 surplus allocated to the product line equaled the "realized losses" that would occur by a 20% liquidation of "hypothetical bonds" assumed to be equivalent to the weighted average maturity and yield of the underlying assets. This whole process would assign the highest factors to those portfolios having the highest average maturity and lowest average yield. Now for the last two years, the C-3 factors have been established based upon the modeling of asset and liability cash flows for existing blocks of business using stochastically generated interest rate scenarios.

At the beginning of this cash flow modeling process, we sought the active participation of four groups to heighten the credibility and acceptance of our modeling results. Product line people actually did the modeling, concentrating on the liability assumptions and crediting strategies. Investment personnel assisted in developing the asset-related assumptions, the investment strategies, and the interest scenario assumptions. The corporate area, of which I am a part, had oversight responsibility for the process, assuring the reasonableness in results and consistency across product lines. Finally, senior management, including our chief investment officer and chief financial officer, were given the opportunity to provide input related to major assumptions and the overall results. We did this through the modeling of several hand-made interest scenarios

across product lines. Finally, senior management, including our chief investment officer and chief financial officer, were given the opportunity to provide input related to major assumptions and the overall results. We did this through the modeling of several hand-made interest scenarios and then presenting sensitivity analysis related to withdrawal and premium suspension assumptions, investment strategies, crediting strategies, and interest scenario assumptions.

The quantification methodology we used was to derive for each interest rate scenario the amount of initial funds needed such that statutory surplus will not become negative at any time during the projection period. This was developed by first modeling the impact in statutory surplus for each year under a given interest rate scenario. We define this impact to be the sum of the after-tax statutory gain or loss plus the realized capital gain or loss. These flows were then discounted using the stream of after-tax short-term market rates for the set of yield curves that comprised the scenario. Our asset portfolios are segmented, which permits us to model the various interest-sensitive product liabilities beginning with the actual assets backing them.

I am going to supply a couple of simple numerical examples which, hopefully, will better illustrate this methodology. Let's first assume a 10-year projection period with the interest rate scenario defined here in terms of the short-term market rate. In this scenario the rates go steadily up for a few years, fall back, and then spike again in year 8. Throughout my discussion so far, I have assumed the modeling period to be one year but, obviously, you can use one-half a year, quarters, months, or whatever you want to use. In Table 1, I have made up what the statutory flows might look like for the scenario we just saw. The actual numbers for the Statutory Flow column would actually come from your modeling. As I stated earlier, they represent the impact on statutory surplus from all cash flows. The second column is the accumulated value of these flows at the end of each year. The third column is the present value (PV) of the numbers in column two, using the after-tax short-term rates for discounting. What you have then is the largest negative value from this third column as the amount of initial surplus you need to set aside, so that along with the subsequent statutory flows your statutory surplus is never negative over the entire projection period. The last column, the end-of-year (EOY) surplus column, demonstrates this. In this scenario, by setting aside $47 and then accumulating the subsequent statutory flows, it provides positive surplus positions throughout the entire projection period, except in Year 4 when it drops down to zero. Now assuming the beginning liability for this product was $1,000, the value we would capture from this trial would suggest surplus needs equal to 4.7% of initial liability.

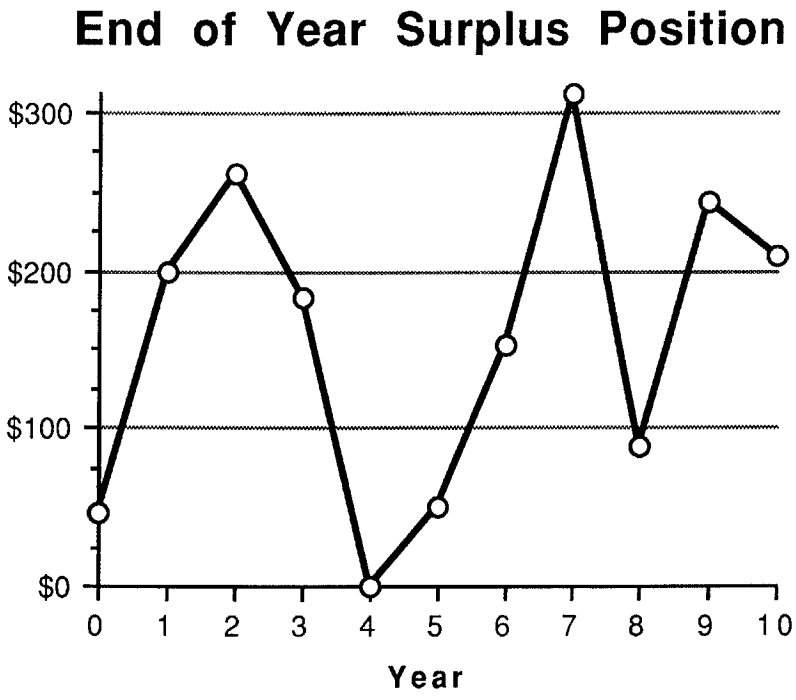
TABLE 1

Year	Stat. Flow	Accum. of Flows	PV of Accum.	EOY Surplus
0				$ 47
1	$150	$150	$142	199
2	50	210	187	262
3	-100	127	104	183
4	-200	-62	-47	0
5	50	-16	-11	50
6	100	83	56	153
7	150	238	151	311
8	-250	8	5	88
9	150	158	88	243
10	-50	119	62	209

Graphically, the end-of-year surplus position looks like Graph 1. You start off once again with $47, accumulate the statutory flows throughout the period until Year 4 when they are needed. The surplus would drop down to zero, and thereafter you're in a positive position.

Table 2 gives another example. Here, $125 of initial surplus will fund both the heavy early outflows as well as the large outflow in Year 8 when end-of-year surplus becomes zero again. As you can see, this approach protects solvency at the end of each year during the projection period. This is slightly different than the analysis that looks at surplus position at the end of the projection period only. Using this latter approach for this scenario, this example would suggest that your initial surplus need only be the $68 from year 10. Using $68 would lead to a negative

GRAPH 1


End of Year Surplus Position
$300
$200
$100
$0
0
1
2
3
4
5
6
7
8
9
10
Year

surplus position by year 4 in this example. A company in this situation may not survive to recover the positive flows that occur later in the projection period. For a large number of scenarios, the accumulated values in column 3 are going to be all positive. What this indicates is that the initial surplus needed for such a scenario would be zero.

TABLE 2

Year	Stat. Flow	Accum. of Flows	PV of Accum.	EOY Surplus
0				$125
1	$100	$100	$ 95	232
2	-50	57	50	197
3	-100	-39	-32	113
4	-100	-143	-108	23
5	0	-152	-108	25
6	50	-111	-74	76
7	150	33	21	230
8	-250	-214	-125	0
9	150	-77	-42	150
10	-50	-132	-68	110

Graph 2 shows the end-of-year surplus position for the second example. Here you start off with $125, have enough accumulated to stay positive during years 3, 4, and 5 when you had outflows, and then still have enough to remain at only zero during the 8th year.

Now I will briefly describe some of the assumptions that are implicit in this technique.

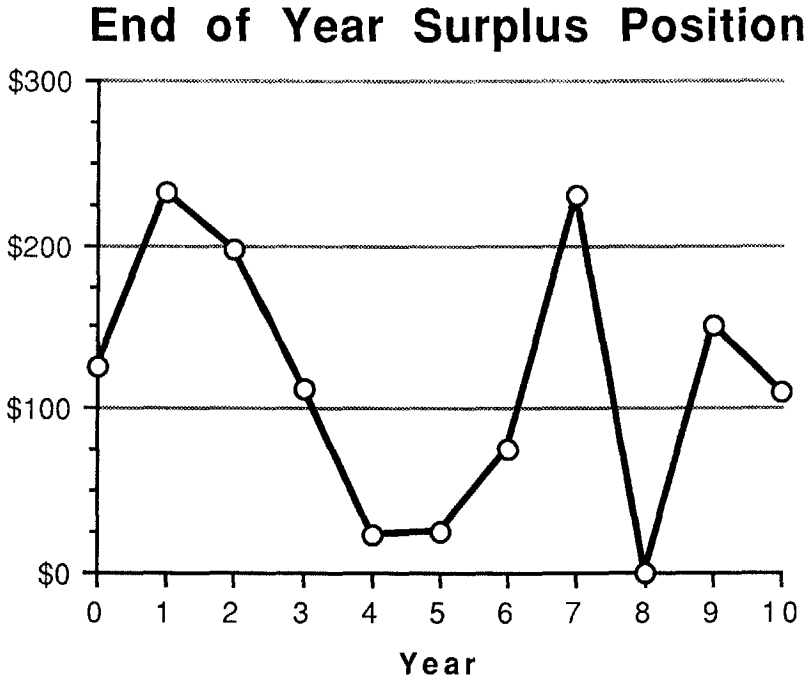
First, because required surplus at time zero is what you are trying to develop, we ran the model without any initial surplus by setting the beginning asset portfolio equal to the liabilities. Second, the statutory flows are assumed to occur at the end of the year. Using the short-term rate to discount assumes that your surplus assets are invested in short-term securities, which is probably not the case. However, this assumption will probably give you a more conservative level or higher amount of surplus than if you were discounting based upon higher-yielding, longer-duration investments. Another implicit assumption is that positive statutory flows are retained as surplus funds to accumulate toward meeting any future outflows. In other words, they are not available to be used to support new product writings or perhaps to be released as a dividend. Finally, the losses in the model line were on an after-tax basis under the assumption that other lines of business within the company were generating offsetting taxable gains.

I won't spend much time discussing how to generate interest scenarios, except to state the obvious -- the process is very, very critical to your overall results. Whether you used the approach of specifying a set of yield curves and the probabilities of jumping from one curve to another, some form of log-normal curve generation, or possibly another technique, it is important to take the time and effort to analyze the curves that your technique is generating. One way to do this is to create a large number of scenarios, and then review them in terms of historical relationships, your perceptions of future relationships, the volatility of the rates, the frequency and degree of high and low rates, and especially any biases for high and low rates to remain at these extreme levels for long periods of time. In the first year that we did modeling, we spent very little time analyzing the scenarios we were creating. In retrospect, the scenarios weren't very consistent with the scenario universe we were trying to evaluate. This obviously can, in turn, lead to establishing surplus requirements different from the risks that you were trying to quantify.

To establish the surplus factors, we ran 1,000 scenarios for each product line. We didn't determine that 1,000 was the right number by some extensive probability theory exercise. Rather, we applied some practical considerations such as how we were going to evaluate the results, our economic and time limitations in making the runs, and whether we got similar sample distributions of surplus needs if we made multiple 1,000-scenario runs.

The results of the 1,000 scenarios were presented in terms of the initial surplus required as a percent of beginning statutory liabilities. We basically looked at the surplus needs at various

GRAPH 2


End of Year Surplus Position
$300
$200
$100
$0
0
1
2
3
4
5
6
7
8
9
10
Year

percentile levels. This may not be as robust as trying to develop confidence intervals or ruin probabilities based upon the sample distribution, but we were satisfied that it provided enough information to set surplus standards for our formula. Percentile evaluation is easy to explain and precludes the problem of identifying the statistical distribution form and attendant statistical analysis. The use of percentile evaluation was also one of the reasons that we ran so many scenario trials.

When you are all done with this process, you can't set the target surplus factors without taking a step back into the real world again. You have to look at: Are the results reasonable? How would their application affect your competitive posture and rating agency ratings? Are they consistent with other components of your target surplus formula and the factors for other lines of business? Do they promote the appropriate risk/reward relationship?

Our intent would be to perform this form of surplus analysis once a year, piggybacking on our New York valuation modeling. The factors are likely to change with changes in the interest rate environment and with changes in the makeup of the liabilities and their supporting assets. For example, we would expect our block of universal life liabilities to be much more subject to disintermediation risk as they mature and lose some of the surrender charge protection they now have.

I would now like to move on to another short example of how we have used stochastic modeling for evaluating target surplus needs. One form of risk that exists in certain types of reinsurance agreements is that of a ceding company becoming insolvent. While insolvency has a very low probability of occurring, if it does occur, the losses potentially could be very large. The analysis was complicated by the fact that the number of client companies was relatively small and had a wide variety of risk characteristics and amounts at risk. We developed a simple Monte Carlo model that permitted the integration of three probability distributions into a single simulation. For each ceding company contract, assumptions were made relative to the following. First, the probability of insolvency -- ceding companies were put into one of several categories based upon the financial characteristics of the company. Next, given that insolvency had occurred, there was a probability that we as the reinsurer would lose our right of offset through an unfavorable judicial ruling. Several categories were set up based upon the ceding company's state of domicile. Finally, actual loss distributions related to the at-risk amount were assumed for each of the insolvency categories.

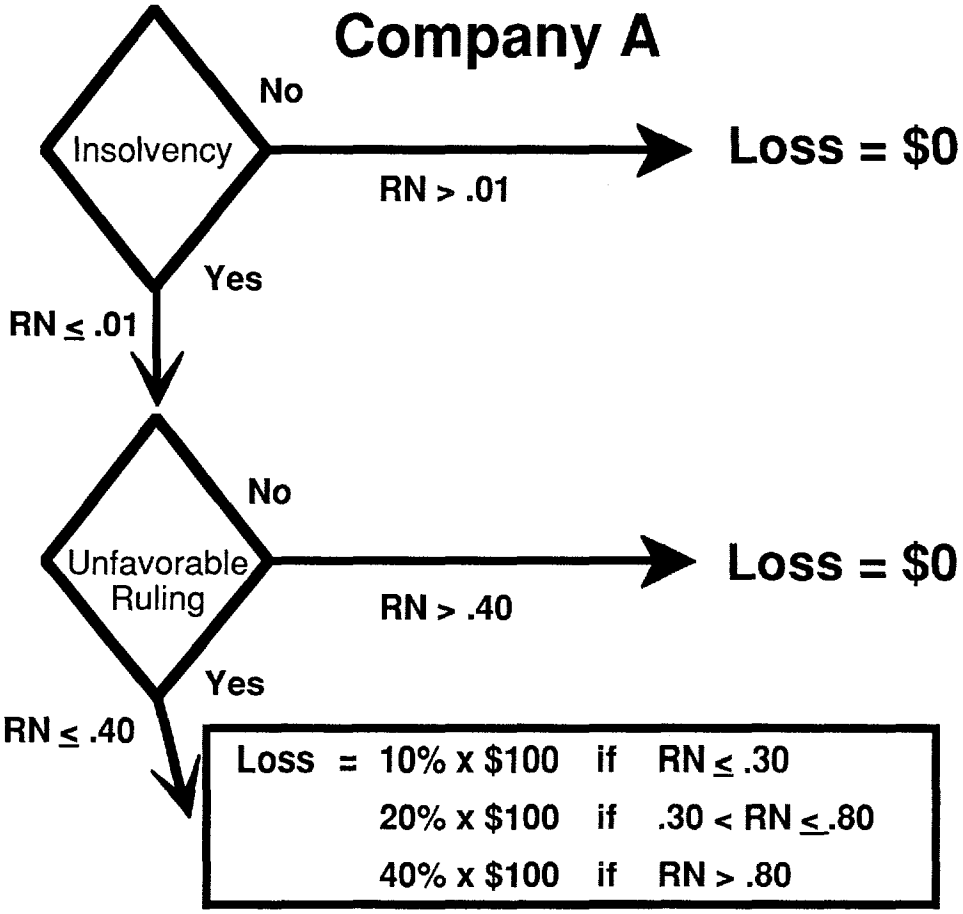
To illustrate how this model worked, let's assume that Company A has a 1% chance of insolvency and has a 40% chance of an unfavorable ruling. Company A has an at-risk amount of $100 with a 30% chance of losing 10% of the value, a 50% chance of losing 20% of the value, and a 20% chance of losing 40% of the value. Graph 3 illustrates the simple logic the model employs. The model first generates a random number (RN). If the random number is greater than .01, the company remains solvent and no loss has occurred.

If the random number is less than or equal to .01, insolvency is assumed to have occurred, and we generate a second random number. If the second random number is greater than .4, we assume we have received a favorable offset ruling in the state and no loss has occurred. If the random number is less than or equal to .4, we have a loss. Then, we generate a third random number to determine the extent of our loss relative to the amount of risk. We went through this same process and applied it to every ceding company, each having a different probability of insolvency and offset as well as having varying loss distributions and at-risk amounts.

The sum of the losses then from all of the ceding companies becomes the sample value for one trial. Running thousands of these trials provided a sample distribution to evaluate the potential losses for the block as a whole related to this risk. We then evaluated these losses in the same manner as I discussed in the C-3 process, by linking it to higher percentile levels. What have we learned from using stochastic techniques to assist us in establishing target surplus standards?

One thing that is clear is that we have only scratched the surface in our ability to effectively apply these techniques. I will mention a couple of potential disadvantages you can have in using stochastic modeling that you should consider. One that you can easily fall prey to is that you place too much reliance on the results. As with just about everything else we actuaries do, the results are going to be only as good as the assumptions. Along these same lines, expectations can become unreasonable in terms of how exact your modeling results really are. If stochastic analysis

GRAPH 3


Company A
Insolvency
No
Loss = $0
RN > .01
Yes
RN ≤ .01
Unfavorable Ruling
No
Loss = $0
RN > .40
Yes
RN ≤ .40
Loss = 10% x $100 if RN ≤ .30
20% x $100 if .30 < RN ≤ .80
40% x $100 if RN > .80

is used to establish surplus levels at, say, the 99th percentile, a problem of consistency can arise relative to other surplus factors that aren't derived stochastically. For example, with your C-2 mortality factors that might be based upon the once-in-a-century 1918 influenza epidemic, it would be different if you had analyzed this C-2 factor using stochastic methods. A related inconsistency among surplus factors can also arise from setting some factors based upon these one-year catastrophes, like the influenza epidemic, while others are developed based upon the present value of future accumulated losses, such as the C-3 process I described.

However, I believe the scales are certainly tipped in favor of utilizing stochastic methods for analyzing surplus requirements. The process itself affords you a greater understanding of the risks, especially at the tails of the loss distribution. Also, stochastic modeling often permits better formulation of the loss distribution relative to mathematical functions. It is easy to combine a multitude of distributions into a single simulation. One of the biggest advantages of stochastic modeling is the facilitation of sensitivity analysis. It is much easier to evaluate assumption changes relative to using a mathematical model. At the same time, all the players can be involved in the process of assumption making. In our insolvency analysis, there was a wide range of opinions as to what the assumptions should be. By using the Monte Carlo model we were able to test all of them and then compare results, both in absolute and relative terms. Stochastic modeling is also good for setting reasonable bounds and for evaluating the potential cost of using the wrong assumptions. There is some benefit to your analysis, even if the assumptions you have used have little factual basis, as they can later be used as benchmarks as actual experience develops. Making the target formula dynamic by periodically measuring risk levels with stochastic methods, as we are now doing with the C-3 factors, should indent the proper management of these risks. If these risks are not properly managed, increasing surplus requirements over time will soon make it difficult for profit centers to meet long-term pricing objectives and performance standards. Finally, stochastic modeling can improve the explanation of results and overall communication with nonactuaries and actuaries alike. Better communication can only lead to more effective surplus formulas.

MR. DAVID L. CRESWELL: My presentation is going to be a low-tech and high-touch one. I think each of us is going to look at the concepts of contingency or required surplus differently depending upon our circumstances. My hope is that by describing the experience of my particular company I will be able to shed some light on these issues.

My company is medium-sized. We are limited in the resources that we can allocate to surplus analysis. On the other hand, we have some definite advantages that allowed us to simplify our approach. First of all, the individual lines are not the dominant ones in our company, and the individual coverage we do have tends to be term insurance. The dividends on the individual life coverage do not tend to be a major item for the company. We do have significant pension business, but an effective market value adjustment on termination allows us to limit quite a bit of our C-3 risk on that business. Our investments are very conservative, even by industry standards. Our MSVR is low relative to our surplus level. Now that leaves us with a dozen or so credit insurance, property and casualty, and group insurance lines of business, which are predominant both in terms of revenue and in terms of risk.

We defined our company required surplus as that amount necessary to keep the probability of insolvency in the foreseeable future at or below 1%. We did this looking only at existing business, which means we do not consider new issues in the individual life or the pension lines, and we project a constant number of insureds in our other lines of business. Then we took advantage of our special characteristics by taking three shortcuts in our approach. First, for individual life we assumed that in the absence of acquired immune deficiency syndrome (AIDS), the amount of surplus that is necessary for us to keep our A. M. Best rating would be an appropriate level for required surplus. Second, for the pension line, we relied upon the valuation actuary's judgment as to what the cushion for the C-3 risk in that line should be and used that as our required surplus level. Finally, for the C-1 risk, we assumed that this is exactly matched by our MSVR levels. We deemed this to be part of required surplus. This left us then with the major task of constructing a model to measure our C-2, or our pricing risk.

Now the core of that model is that part which we set up to measure each line of business in isolation and ignoring the AIDS risk. For this part of the model I am going to describe next, the sources of deviation from expected financial results were modeled along two different dimensions. The first one was by income statement component, and for us the most important sources of

deviation along this dimension are: 1) loss ratio (which we measure net of the cushioning effect of dividends), 2) expense ratio, and then, to a lesser extent, 3) investment income rates.

Now the second dimension along which we measure sources of deviation is in terms of the correlation among years as we project out. Here we separate, first of all, uncertainty as to the long-term underlying profitability in each line of business, and this uncertainty we assume to be 100% correlated among years. Secondly, we look at the multiple-year underwriting cycles, and finally, all other kinds of uncertainty we assume have no correlation among the different years.

Now we sought three major types of input from the line of business actuaries in order to accomplish this. First of all, to accompany our normal 5-year financial projections, we asked for year-by-year standard deviation figures for the loss ratio and the expense ratio. Then for investment income rates, we looked on a corporate level. Beyond five years, we asked for long-term profitability estimates, both in terms of the best estimate of the actuary and a 66% confidence interval which we then used along with a normal probability curve assumption to give us our measure of standard deviation. The third thing we asked for were correlation coefficients among adjacent and among near-adjacent years. These were used to model underwriting cycles which occur in several of our lines of business.

Now the running of the model begins with an input of an initial guess at what we think required surplus might be. With this as a starting surplus level, we estimate for each projected year the probability of surviving through that year, given that we have survived up to the beginning of the year. This gets accomplished by looking at the expected value and the standard deviation of the conditional distribution of gain in each year, given beginning-of-year surplus in that year. So it is the conditional distribution of gain given beginning-of-year surplus. Then, through repeated applications of a normal distribution assumption and through numerical integration techniques, we were able to calculate the probability of survival in each year. Then through a trial-and-error process, we find the starting surplus such that the product of the survival probabilities is equal to 99%. This then becomes our required surplus figure for that line of business.

Now our AIDS module is folded into the core model that I have just described to you, but it has certain distinct characteristics. First of all, it is built from long-term scenarios. Therefore, we work on the assumption that all years are 100% correlated when it comes to the AIDS risk. Our expected value scenario is now based on the new ACLI/HIAA projections which came out in the last few months. Then for our worst 1-in-100 scenario, we have now moderated that down to where we are looking at 20 million eventual infections in the U.S. This was arrived at through conversations with experts inside and outside the profession, and with a great deal of speculation on my part. We then used a distinctly non-normal curve to fit these two 1-in-100 and expected scenarios in order to get ourselves to believable intermediate values. We found that by using a normal curve, we could have believable 1-in-100 and believable expectation, but the intermediate values just didn't seem reasonable.

Finally, we translate this into the financial effect on our various lines of business by, in addition to looking at expected claims, projecting what our reaction would be in terms of pricing, dividend policy and, in extreme circumstances, in terms of actually pulling out of lines of business if things were to get too bad.

Now, to combine the lines of business, we estimated the correlation among the different lines of business for the non-AIDS risks. We worked on the assumption that the AIDS risk is 100% correlated among the different lines of business. This allowed us to run the model on the company and the subsidiaries as if the aggregation were itself one large line of business.

From this entire process then, we got three relevant measures. The first one is the stand-alone required surplus. This for each line of business measures what the required surplus would be if that line were to stand by itself and have to cover all of its risks out of its own surplus. Second, we have the aggregate required surplus for the company and its subsidiaries combined. Third, we have marginal required surplus. The marginal required surplus for a line of business is the difference between the aggregate including that line of business and the aggregate excluding that line of business. So it is the amount of surplus which could be freed up if we were not in that line of business.

We felt that the most theoretically justifiable way to take the aggregate surplus and to allocate it down into the various lines of business would be to use an interpolation between the marginal figure and the stand-alone figure. However, we wound up settling for a constant percentage of the stand-alone required surplus as being a more acceptable technique because it was more understandable to management, while retaining the important return on equity implications that we did not want to lose.

Now we put this study to two major uses at my company. First of all, in looking at strategic plans and different alternatives for the insurance group as a whole, we were able to project actual surplus out into the future and also project required surplus out into the future, and to see whether free surplus, which we define as the excess of actual over required, is expected to grow, to shrink, or even to become negative. And also we were able to look at each line of business to see whether this line is projected to be a net contributor of free surplus or a net consumer of free surplus. The answers to these questions are then fed back into the strategic planning process.

The second use that we make of the study is in measuring financial performance. Here we use a measure that I call "marginal return on equity." I mean marginal here in terms of the use of surplus -- what is the marginal benefit being derived on an ongoing basis by having our money tied up in required surplus or having it invested in new business as opposed to what we would be earning if we simply left the money in free surplus? In other words, what are we earning strictly in return for having put our money at risk? Now because we are looking at the marginal benefit, we are excluding investment income on statutory surplus from our results. We are also subtracting opportunity costs of the investment income which we have to forfeit when we invest our money in new business.

These two then yield our equation of:

$$\text{Marginal Return on Equity} = \frac{\text{Modified GAAP Earnings - Investment Opportunity Cost}}{\text{Modified GAAP Equity}}$$

Here earnings exclude investment income on surplus and modified GAAP equity is simply invested surplus plus required surplus. By using the marginal approach, we were able to look at the pure effect of the line of business. This also facilitates consistency among lines in a company like mine where there is significant low yield in corporate assets.

When a company has a rich mixture of C-1, C-2, and C-3 risks and a rich mixture of individual products and group products, and all of these are interspersed with significant dividends, I don't believe that the approach that we have used at our company can work. I also think that a danger exists under these circumstances in using separate calculations of the various risks and then attempting to combine them with a formula-based combination. Some of the factors I think that rule against this and toward a more complicated approach include the following:

1. Reserves being short term but risks being long term, thus predicting multiple turnover of reserves during the risk time horizon.

2. Reserves, and thus assets, being small or moderate compared to present value of future profits.

3. Different projected timing of various future risks, especially in combination with the two above factors.

4. Accumulation of surplus being itself seen as subject to C-1 and C-3 risk.

5. Dividends acting as a significant cushion against a combination of risks.

We see ourselves evolving into just such a company. Therefore, we see the necessity to switch to a different kind of model, the core of which will be a Monte Carlo sampling from an interest scenario generator. We see the necessity of taking each of the interest scenarios and having these scenarios drive a year-by-year integration of C-1, C-2, and C-3 risk modules, where some of the variables are deterministic based on the interest scenario and some of them have values which are themselves determined by independently constructing a model. We will be limited somewhat by computer run time in terms of the sophistication we will be able to have in this model. But we

feel that this kind of approach is going to be necessary because of the complex interaction between the different risk variables and the necessity to really model that on a year-by-year basis.

MR. JOSEPH J. BUFF: Our other speakers have talked about how a company can measure its requirements for surplus over and above reserves. We have heard a bit about the management implications behind the whole idea of contingency surplus, and we have heard a few points of view about how to establish target surplus guidelines for a company.

Why does a company need to think at all about contingency surplus? There is a view shared by many in the life insurance industry, and shared by many actuaries in particular, that the statutory reserves backing a company's liabilities aren't quite "enough money" to do the job. The job we're talking about here is guaranteeing the future strength of the company.

There are many constituencies who are very interested in the future strength of a life company. These constituencies are different groups of people who are dependent on the financial security the insurance industry provides, or alternatively, they are the groups responsible for safeguarding the industry's "dependents." These people include the policyholders, the stockholders (if a stock company), the management of the company, the board of directors of the company, general creditors of the company, insurance regulators, and outside rating agencies (like A. M. Best).

Surplus in addition to the reserves is needed to assure the future solidity and vitality of the company. This is because, if reserves provide for solvency in the face of "reasonable" risks, then more funds need to be earmarked to protect against more adverse "plausible" levels of risk. Here I am following the terminology proposed by Don Cody and other members of the Committee on Valuation and Related Areas (COVARA). By definition, plausible adverse outcomes are less likely to occur than reasonable adverse outcomes. Some of this distinction is semantic, but the basic issue is that reserves alone may not always be enough to ride out tough times. Contingency surplus is held to protect against the contingency that the reserves are exhausted before the liabilities are all discharged.

One approach is to use rules of thumb or benchmark formulas. An example is to hold contingency surplus equal to 3% of the statutory reserve.

The second approach is to establish contingency surplus needs by doing modeling calculations in different scenarios. This approach can go as far as modeling the actual assets and liabilities, and actual management strategies, of the company as of the valuation date. So, I'll call this scenario modeling approach "seriatim valuation."

Let's look at some of the advantages and disadvantages of the two approaches to contingency surplus: rules of thumb and seriatim valuations. Rules of thumb have some important advantages. For one thing, they are comparatively easy to compute. Rules of thumb can be readily standardized, and it's easy for different people to talk to each other about the rules to be used. Another very important fact is that outside rating agencies rely to some degree on rules of thumb in their procedures to assign "quality ratings" to a company's credit worthiness or claim payment ability or general solidity. The rating agencies probably like the ease of communication and computation and the standardization offered by the benchmark formulas.

On the minus side of benchmark rules is that they don't respond directly to many factors that probably have an important effect on a company's real risk exposure.

For instance, risk exposures (C-1, C-2, C-3, and C-4 risks) would tend to vary by product type. Universal life and group major medical don't have the same exposure to C-2 risk. Nor do they have the same exposure to C-3 risk.

Another factor in contingency surplus needs is the mix of business of the company and how that mix changes over time. Shifts from year to year, such as from going into and out of the GIC market or from a Project Update on individual life policies would presumably shift the surplus needs of the company.

Contingency surplus needs would also tend to vary over the life of a particular policy. Consequently, unless the population of policies in the company was close to stable, surplus needs would change over time. Statutory reserve formulas take direct account of shifting demographics of the

in force, and shifts will directly affect the aggregate reserves for Exhibit 8 and Exhibit 9 of the NAIC Blank. Yet, benchmark surplus formulas may not respond directly to these shifts.

Another issue that would affect contingency surplus needs is the set of strategies the company intends to follow to manage its in force. Examples of such strategies are 1) the investment strategies and (2) he credited rate resetting strategies. As you would have seen if you've ever done much sensitivity testing for compliance with New York Regulation 126, changing these management strategies can have a material effect on reserve (and surplus) needs.

To demonstrate the importance of the management strategy to the results of a seriatim valuation of contingency surplus, let's go through a simple example. This will parallel some of the things the other speakers have covered. My main point in introducing this example is to comment on the strengths and weaknesses of the modeling approach. I am making no claim that this approach is generally preferable to the use of benchmark formulas. However, later in this talk I will make the case that seriatim valuations do provide useful information about how different management strategies affect the real underlying risk exposure of a company.

A seriatim valuation of required surplus for one or more life company products needs several building blocks. Without each of these building blocks, I don't think you can do a seriatim valuation. These pieces are as follows:

1. A scenario projection model. This is needed to project cash flows, balance sheets, and income statements in a variety of future risk scenarios. The cash flow model crunches the numbers to show how the company might look in the future depending on what happens along the way.

2. Ruin probabilities. Implicit in the seriatim valuation approach is the targeting of a level of confidence that reserves plus contingency surplus will be enough to survive through bad times. The ruin probability specifies the level of confidence management wants. This is a professional decision -- there are no rules here. However, some people think that a reserve ought to be adequate 99% of the time. But I stress that opinions differ. This point of view is most appropriate to go with stochastic scenarios discussed below. Another point of view about ruin probability is to require survival of the company through a particular worst case scenario. Alternatively, you could require survival in some minimum number out of a chosen set of bad case scenarios -- which brings you back somewhat toward the stochastic view of ruin probabilities. This is also discussed below.

3. Assumptions. Projection assumptions are needed to run the projections through your model. These include assumptions about expenses, policyholder behavior (lapses, loans, etc.), and lots of other factors. Personally, I recommend as a learning tool here the text of New York Regulation 126. That regulation is germane to annuities, GICs, and single premium whole life, but parts of it give a good "how to" about scenario modeling in general.

4. Scenarios. There is some overlap here with assumptions. It might be useful to define a scenario as an assumption about the future environment external to the insurance company itself. Scenarios are needed that pertain to the risks for which contingency surplus is being established. Scenarios might include interest rates, default rates, health claim costs, or AIDS death rates. There are two basic types of scenarios: hand made (or "deterministic") ones and random walk (or "stochastic") ones. The choice of scenarios is by no means a simple process, and I'll touch on some of the difficulties below.

The case study we'll use to develop a discussion of the pros and cons of scenario testing for contingency surplus will be an analysis of C-3 risk for a single block of new issues of a generic single premium deferred annuity product. We used generic projection assumptions which I won't go into here. For scenarios, we used the stochastic approach, using a lognormal interest rate scenario generator. For a discussion of this kind of scenario generator, you can look at "Investment Strategy for Life Insurance Products" *RSA* Vol. 14, No. 2, pp. 821-61. For a general discussion of stochastic scenario generators and a list of further readings, you can read the paper by Merlin Jetton coming out in the *Transactions* soon, along with the Discussions of Merlin's paper.

When you are doing stochastic modeling and looking at ruin probabilities, the question comes up of how many scenarios should you run. This is the way I have come to view this question:

1. You, the user, have chosen a stochastic scenario generator. (See the reading list above for some guidance if you are undecided on this point.) Underlying this scenario generator is a random walk process, a probabilistic mechanism, for generating future scenarios. Each scenario is like the roll of a pair of gambling dice. Implicit in your generator, with the assumptions you've chosen, is a probability distribution. (The analogy to dice is as follows: Counting the number of dots on the upward-facing surfaces of two thrown dice is a scenario generator of sorts. The distribution is the implicit table of probabilities of getting every possible value between two and twelve dots.) The random variable is the track of future experience of the basic risk factor (inherent rates or whatever) that you are studying.

2. Your cash flow model with its asset and liability data, assumptions, and formulas is used to calculate future financial variables. One such variable is the degree of solvency or insolvency of the company along a given input scenario. This cash flow model, plus data and assumptions, creates a mathematical relationship between the input scenario and the output financial results. More generally, it creates a functional relationship between the input scenario distribution and a frequency distribution function for the output variable.

3. The solvency outcome (ending surplus or whatever) becomes a dependent random variable. The independent variable is the scenario with its given stochastic distribution. The functional relationship between the independent risk scenario distribution and the dependent solvency outcome distribution is very complex. It is given by all the details of the projection model.

4. We would like to understand the distribution function for the output. This will help us iterate to surplus required to assure a given probability that the company will be solvent in the future. We will not make any assumptions about the distribution function for the output. Rather, we will measure that distribution empirically by Monte Carlo sampling. Monte Carlo sampling is often used to build up a statistical picture of the probability distribution function of a variable that is too complex to describe in closed form.

5. So, if we run a scenario generator to generate a bunch of scenarios and then feed all the scenarios through our cash flow model, we will end up with a bunch of solvency/insolvency projections. If we target, say, a 1% chance of ruin (99% chance of solvency), what we are looking for is an amount of surplus that produces solvency in 99% of the scenarios we project. But we need to know that the solvency rate is statistically credible. If we run 100 scenarios and only 1 bankrupts the company, we have a sample ruin probability of 1%. But how do we know this is a statistically credible result? Could it just be a fluke, based on the 100 scenarios that happened to come out of our scenario generator? Well, there are statistical methods for addressing this issue.

6. In summary, it is possible to decide how many scenarios are "enough." This is done by figuring out how large a sample is necessary to obtain a tight confidence interval, around the sample ruin probability, for the underlying population ruin probability. Work has shown that about 200 scenarios are needed to be reasonably confident that a sample ruin probability of 10% is statistically reliable, and about 1,000 scenarios are needed for statistically reliable analysis of contingency surplus needs for a 1% ruin probability. Note that these figures are based on calculations that make no assumptions about the distribution of either the input or the output variables. Some judgment was exercised as to how tight a confidence interval was appropriate.

Having highlighted these technical issues, let's get back to our little case study. We've decided to look at a ruin probability of 1%, and we ran 1,000 scenarios. We want to find, by iteration, the amount of surplus, in addition to the statutory reserve, that will assure solvency in 99% of the scenarios we ran. This is done by trial and error. Start with the pure reserve and see what ruin probability results. (If it's less than 1% you can stop!) Then add an amount of additional assets at the start of the projection period -- maybe let yourself be guided by a benchmark formula like 3% of reserves. See what ruin probability you get. I've found that three runs are usually enough to solve this process accurately.

To illustrate the importance of management strategies to actual surplus needs, we consider two strategies for resetting the credited rate on the SPDA business. One strategy is to credit the

current portfolio yield minus a constant spread. The other strategy is to always credit a current competitive new money rate, based on assumptions about future competitive SPDA rates.

In this analysis with the constant margin crediting rate approach, the required surplus for 99% assurance of future solvency was 3% of the single premium. In contrast, with the follow-the-competition-no-matter-what approach, required surplus zooms to 20% of the single premium. (These numbers are purely for discussion purposes only. They depend on the assumptions and methods used. No general conclusions should be drawn about how much surplus is needed for your products without doing your own detailed analysis and sensitivity testing.)

By the way, this was for a 10-year projection period. To keep things simple, we just looked at solvency at the end of this period. Also, I won't go into the details of these calculations because my main goal is to critique the overall process here.

Now that we've built this complicated process for allegedly calculating required surplus in an "exact" manner, you may be having a case of mental indigestion about the whole process. To be fair, this approach is not everyone's cup of tea. Not every company or every product area wants or needs this degree of detail and complexity. However, also to be fair, I want to state that a recent survey of companies that owned one particular cash flow projection scenario model indicated that 80% of the respondent companies did use stochastic scenario testing in one way or another.

Let's pause for a breath and talk about some of the potential drawbacks and pitfalls of the stochastic point of view for risk measurement.

1. The process is complicated and expensive when compared to the benchmark rules of thumb. Is it too complicated and expensive?

2. The results depend on what risk scenarios you use to start the process. Does anyone really know a good way to generate future scenarios?

3. The process depends on all the projection assumptions you need to supply. Is it too difficult to select all these assumptions?

4. As we already said, who knows what ruin probability is the right one to shoot for?

5. A technical detail which isn't as minor as its sounds is the question of how you invest the surplus funds. Do you put them in the assets backing each product and use the same overall investment strategy? Do you invest the money in 90-day Treasury bills? Do you put it all in a separate "corporate surplus" account? What do you do?

The fact is, these decisions and choices are not easy. If things were easy, actuaries probably wouldn't have (according to a recent U.S. Department of Labor survey) the best job around! Or at least there wouldn't be so many jobs for actuaries as there are! Who else gets to ponder almost metaphysical problems, temper them with practical business judgment, play with the latest computer technology, sweat over detail after detail, and help manage billions and billions of dollars of other people's money?

Now, in a slightly more serious vein, let's consider some of the definite advantages of seriatim valuations of solvency requirements. First of all, these methodologies do address directly the particular risk exposures that are specific to the circumstances of individual companies. Also, the techniques use models and procedures that are already in place in a number of companies. Any company that has filed cash flow testing in compliance with New York Regulation 126 is already doing deterministic scenario testing. I think about 75 companies have actually done the testing for New York State. I think that more than 100 companies have at least one scenario projection model that has stochastic modeling capabilities.

The fact that a number of companies are using scenario testing in their internal management decision making is a meaningful endorsement of the current state of the art.

There are decided benefits to scenario modeling for companies that care to go this route. This kind of analysis is a great learning tool for identifying risk exposures and profit opportunities. It

is also a great way to figure out what data you really have and what experience studies might be worth doing. Carrying out these analyses is a fine way to improve communications between the different parts of a company.

It is also worthwhile noting that the modeling of specific surplus requirements is a useful counterpoint to the process of being rated by an outside agency. For one thing, you can gather some ammunition to bring to the table when you meet with the analysts. For another, the modeling can show you ways to manage your business that reduce risk exposure and genuinely improve your chance to get and keep a good rating.

Seriatim valuation of contingency surplus is very useful to guide management in running the company over time. Not only do you know what your surplus requirements "really are," but you also can find out how different management strategies will influence your need for capital and surplus. This ties in things like investment strategies and pricing strategies with the future solidity and solvency of the company. You get to "grab the steering wheel" of your financial statements and drive in the direction you want to go.

Let's take another, more sympathetic, look at the results of our stochastic analysis of contingency surplus. Here we see that one management strategy draws on almost seven times as much as another. This may not be a very precise absolute statement about the precise absolute surplus needs or risk exposures of the two strategies. However, the relative comparison is pretty informative. If a model says one strategy is seven times as risky as another, you can bet that in the real world the first strategy is a lot more risky than the second! We can make very reliable statements about being "a whole lot riskier" without needing to believe that the calculated required surplus figures are exact.

I will end by saying that I have tried to make the case that it is useful, and worth the resources, to compare the contingency surplus needs for different management strategies.

This is because relative comparisons, not absolute statistics, are what you need to choose between different management strategy alternatives. Strategy choices have to be made constantly by senior management, and you should get the best possible advice from your actuaries and their information systems.

Black box models have evolved to the point where they are genuinely helpful to the people who are trying to run an insurance company the best way they can.

MR. JOSEPH H. TAN: We have heard a lot about contingency surplus being enough to protect us with 95% and then 99% confidence against ruin. I would just like to offer an observation about the difference between mortality risk and interest risk that may be helpful. Insurance has been founded on a very basic principle of the law of large numbers; that is, we may not know whether Mr. X will die or not, we don't know whether my neighbor will live or not, but we do know that out of 1,000 policyholders, there are three people who will die in a year and maybe, at most, five people. That's because the risks are relatively independent. If Mr. X dies, his affiliate doesn't really just go die with him. So, when you pool a lot of independent risks, the risk of the total is quite small. That is why we end up with small divisions for a total portfolio. It is quite different though for investment risk. When the interest rate goes down, the economy turns bad, the short-term rate goes down, the long-term rate goes down, common stocks turn bad -- the whole investment area is so efficient that everything moves in the same direction. Take another case. In the 1970s, for instance, who would ever have dreamed of interest rates shooting up to 20%. Probably no one. But just a few years later, things happened. Take another case. Do you think that interest rates will shoot up 30% in the future? We have already seen inflation quite high in several countries -- in Latin America and in China. Who says this won't happen in America? The whole point here is that investment risks might be a completely different ball game. The more I read about investment risk literature, the more I find that the whole risk is quite large. Just like Joe illustrated, if we run a bunch of scenarios, we end up with 20% as required surplus. We can imagine what would happen if we go to management and say, "I need 20% of required surplus in order to make me feel confident that we'll be solvent." My whole point here is that we certainly have to look at all this risk, but maybe our threshold on investment risk might be different from mortality.

MR. BUFF: I think that if you are saying that it's inevitable that the investment risk is going to overwhelm the C-2 risk, I think that is going to depend on what kind of business you are looking at. If you can look at the fluctuations that have occurred in group health coverage and you can look at some of the possibilities of what could occur with AIDS, they are very different risks, certainly; but I don't think that you can argue that among all companies one is going to necessarily overwhelm the other.

MR. ROY GOLDMAN: Joe, considering all the assumptions that go into these models, how do you come up with a number such as 1,000 scenarios as enough for one to get a 1% ruin? What are the assumptions that go into that?

MR. BUFF: That's a very good question. There have been some things that I have seen that haven't been published yet, but I think they are going to be in print soon, that talk about how many scenarios are enough that make some assumptions to simplify the calculations -- things about binomial distributions that become normal when the probability is very close to zero or one, or stuff like that. The results which I cited before about how many scenarios are enough made no assumptions about the assumptions or the distributions. They were based on relatively detailed analysis of the question without any preconceived notions. The work was done by a consultant that my firm hired. It was a classic situation where there was a specific thing which we needed to have done once to get an answer. We knew what the question was. And we knew we didn't have the expertise ourselves, so we actually hired a consulting mathematician who works for a firm that has the expertise, and we gave him a description of the question and some statistics to analyze. He did come back to us with a consultant's report which we used. It doesn't assume things are normal, or binomial, or anything. The answer, therefore, is very robust and is pretty independent of the assumptions. So you can use any scenario generator, any risks, any set of assumptions about lapse rates or expense employed, or whatever. But if what you are looking at is a question of 1% or a 10% ruin probability, it's telling you how much you need to run in order to have a very tight confidence interval between the sample ruin probability and the actual underlying population ruin probability. That is basically what we are talking about -- what does it take to get that confidence interval, 90th percentile, to be very tight? That's how the analysis was done.

MR. BRUCE E. NICKERSON: I happen to be a very real believer in the value of stochastic modeling, but I would like to offer a personal observation about one of the underlying assumptions that I have heard in this session, which is the concern about ruin. We have been talking about the possibility of a company going bankrupt. We talked about having contingency surplus in addition to realistic reserves to keep that under control. Much of the value of stochastic modeling will be better realized by the chief investment officers, investment community, or whatever else you wish to address it to. Long before the company ever gets to the question of is it bankrupt, the CEO has had his career ruined. And long before you worry about that kind of drop in financial situation, the investment rater has taken his profit and left. Knowing and being able to reasonably evaluate the distribution of outcomes is terribly important, but the question of ruin in the statistical sense is, I suggest, far less important than some of the other questions that could be answered with a good stochastic modeling system when properly applied.

MR. JACOBS: Those are good comments, and that, I guess, is what I was trying to get at with my vitality surplus in making the somewhat innocuous statement at the time that vitality surplus of zero was bad even when statutory surplus was positive. That's, I think, the situation that we are trying to analyze, where the company is not in the tank yet but it is getting there real quick. That's when CEOs can lose the job, and that's when we need to start taking notice. In doing the kind of analysis that I think we are all talking about, we can hone in on that vitality surplus and compare that to what the surplus needs of the company are as it moves forward with future growth or acquisitions or whatever it is that it wants to do. And if vitality surplus isn't big enough for future growth or whatever, the CEO is out of a job. So I think that is where you are heading, and that is long before insolvency or ruin hits.

MR. JOHN F. MCBRIDE: I have a question for you Mike. You mentioned that after-tax rates were assumed. I wonder how you came to that conclusion?

MR. ZURCHER: Largely, we were trying to determine what funds we needed to set aside to satisfy the outflows in the future relative to the scenario. We decided it should be on an after-tax basis assuming the company would be earning taxable income throughout the projection period.

MR. MCBRIDE: It just seems to be relatively unconservative to assume that you are going to have projected tax losses. I thought that was implied in what you said. I had the impression that losses were assumed to be tax affected in valuing needed surplus.

MR. ZURCHER: Yes, we did tax-affect the losses assuming that other lines of business would be generating offsetting gains. This may be appropriate for measuring C-3 risks independently, but would not be so for a combination of risks. A company's mix of business would also be an important consideration in making this assumption. Our discounting on an after-tax basis is consistent with using after-tax cash flows.

MR. MICHAEL J. ROSCOE: I have some comments on the use of surplus. I don't think that they were touched on directly, although I think they run underneath the entire topic. They do relate directly to the comment just before about nobody asking for more surplus and also to the 3% versus 20% amount of surplus needed. I would like to think that a big use of this, outside of trying to lower your probability of ruin to 1%, is to determine which course of action to take and to relate it to the return you get between those two. Joe, you said that the new money competitive strategy was seven times more likely for ruin than using the portfolio method. I think really what you mean is not that it is seven times more likely but that it costs seven times as much to have the same probability of ruin because you could have a quite different distribution on those curves. Therefore, what you really want to look at is: will the new money method give you additional profit? Will you bring in more business that will offset the cost of holding seven times as much surplus and that, of course, would mean that you would have to ask for additional surplus, but you would have to do a profit analysis that showed with this additional surplus you can achieve greater returns.

MR. BUFF: I agree with what you said. In doing a brief piece, we obviously didn't touch on a lot of the bigger issues. We sort of talked about the process in the middle. But deciding what to do to run the company best is never ending. If you get your FSA at age 30 and work until you are 65, in 35 years you are going to be trying to figure out how to run an insurance company better.