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INVESTMENT CONSIDERATIONS IN PRODUCT DEVELOPMENT

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Panelists:	JOSEPH J. BUFF
	PETER B. DEAKINS
	SHELDON EPSTEIN
Recorder:	TIMOTHY C. PFEIFER

- o Understanding trends in the investment markets
- o Realism in asset modeling
- o Matching investment strategies to product characteristics
- o Coordinating with the investment department

MR. JOSEPH J. BUFF: I am your moderator and I am associated with Tillinghast, a Towers Perrin company. We will start with Mr. Peter Deakins of Milliman & Robertson and then we will hear from Mr. Sheldon Epstein of Morgan Stanley.

MR. PETER B. DEAKINS: In the last few years the actuarial community has been getting pretty excited about C-3 risk and the valuation actuary concept. I think an area that is maybe more important than the valuation actuary -- one where we need to consider the investment type of questions -- is the pricing area. I think it is good that we're going to start moving in that direction, and I think that we have to go further there than possibly we do on the valuation actuary issue. If we don't as an industry move in that direction, we could bleed to death a lot quicker from inadequate pricing of the options that we are granting to our policyholders than from the risks of a big interest spike or a big drop in interest rates.

I want to start with a few general points. The first is basic economics. Any business enterprise that accepts risk should do so with the idea that they are going to get a gain commensurate with that risk. I really think that this underlies everything that I am going to say.

The second point is that all business enterprises have limited capital and therefore have to manage their risks in a manner that is consistent with the capital available.

The third point, and this is really important, is that actuaries have not been doing too much with investments in our pricing, and we really need to. Historically we have used an expected value, or rather than expected value, I'd say a "most likely value" type of approach. Someone in the pricing department has said, "We're going to get a 150-basis-point spread," and that's it. All the pricing is done assuming you earn 150 basis points more than you credit, with no real thought as to whether or not you are going to be able to do that, what types of risks you have to take to make that likely, and whether that's likely if interest rates move. I think that's an area where we really have to change things.

The fourth point is that investment strategies for interest-sensitive products have rarely been clearly defined. A lot of companies have taken the attitude that they are going to earn their spread regardless, and that's why you see companies buying thirty-year bonds to back single premium deferred annuities. Other companies take the opposite view and say that they are not going to take any risk. They don't really have much concern about whether by not taking any risk they may not be able to make a profit. I think both are short-sighted views. You have to take into account both risk and expected profit in designing liability and asset strategy.

One of the first things that you have to do in any kind of C-3 modeling, especially important in pricing work, is to determine what your lapses are going to look like. For this type of analysis, it is not adequate to say our lapses are going to be 10% in the first year, grading down to 6% over ten years. One of the key variables in what lapses we get are what interest rates do. What we've tried to do is to create an analytical framework for evaluating what kinds of lapses we're going to get when interest rates change.

Here is a sample formula, (see Exhibit 1) and I'm in no way saying that this is the only formula. What we've said is that lapses will be 15% plus 2 times the difference between the market rates and the credit rate squared, minus three times the surrender charge, with a floor of 3%. What we are really saying is that as long as policyholders can get a higher interest rate elsewhere, they are going to have an incentive to lapse their policy and this incentive is going to increase exponentially; so that if you're 2% off the market, you don't have a big impact on your lapses. But if you are 5% off the market, you might get 60 or 70% lapses. Many people look at these kinds of things and say, "that's off the wall." If you say that you have a 5% differential between what you credit and what the policyholder can get in the market, they could easily have a 60% lapse rate. I know that when I first started doing this kind of work, we put together formulas like this that seemed to make sense, and when they produced results like that, we said, "That's crazy," so we put a cap on the lapse formula. It just seemed inconceivable that 60% of the policyholders for a block of business could leave in a year. As we got more involved in this type of work, and we got some experience to look at, we found out that maybe we were wrong. I have run into many people who have told me that their lapse experience on different blocks have been in excess of 50% in the early 1980s. We have concluded that there is no cap.

EXHIBIT 1
SAMPLE DYNAMIC WITHDRAWAL ASSUMPTION

WITHDRAWAL RATE = 15% + 2 x (Market Rate - Credited Rate)^2
- 3 x (Surrender Charge):
But Not Less Than 3%

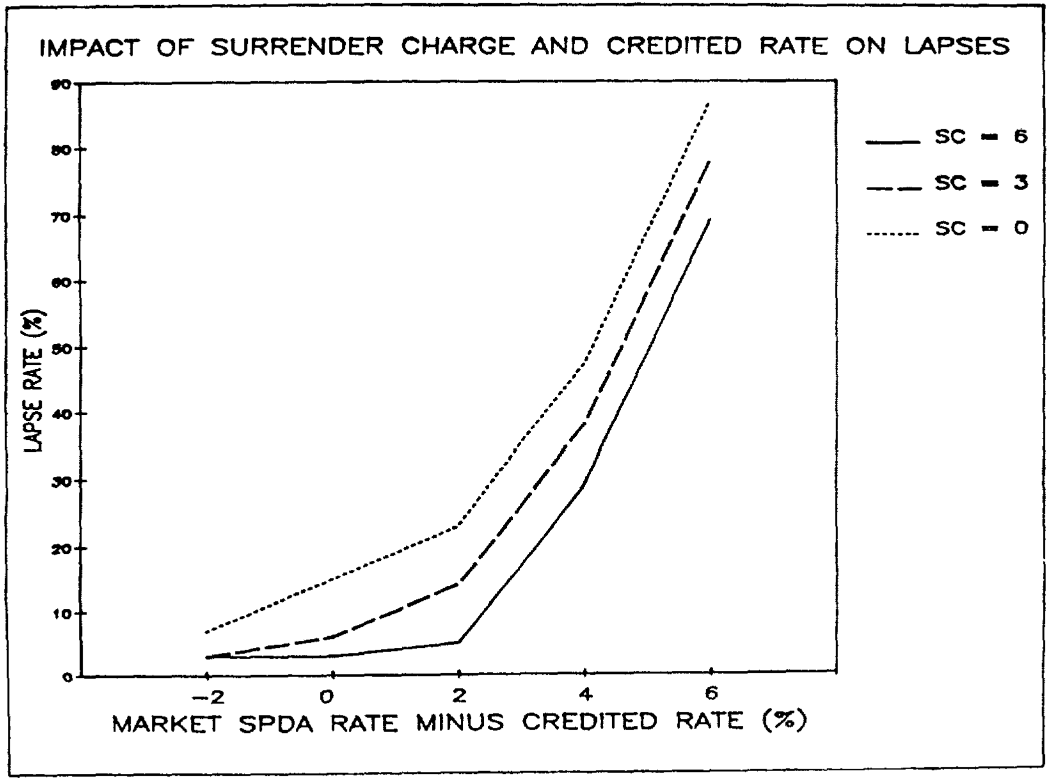
WHERE "MARKET RATE" IS THE GREATEST OF:
(A) 1 to 15 Year Bond Rate Less 1.65%, or
(B) Short-Term Rates Less 1.15%

What I have in Exhibit 2 here are some sample rates that can be produced by a formula like this. They are not particularly interesting, but they show the 65% that I was talking about, in the lower right hand corner. And for those of you like me who don't like numbers, I also have a graph. (See Graph 1.)

EXHIBIT 2
SAMPLE RATES

[MR - CR]	SC	Withdrawal Rate
-1.00%	7.0%	3%
1.00%	7.0%	3%
3.00%	7.0%	12%
5.00%	7.0%	44%
-1.00%	0	13%
1.00%	0	17%
3.00%	0	33%
5.00%	0	65%

GRAPH 1


IMPACT OF SURRENDER CHARGE AND CREDITED RATE ON LAPSES
LAPSE RATE (%)
0
10
20
30
40
50
60
70
80
90
−2
0
2
4
6
MARKET SPDA RATE MINUS CREDITED RATE (%)
SC = 6
SC = 3
SC = 0

Next, I would like to talk a little about investment assumptions, which is another key thing you have to do in any kind of C-3 work. You have to come up with some assumptions about what you can invest in, and saying you are going to earn 150 basis points more than we credit is not adequate. Exhibit 3 is a list of some sample investment assumptions I will use for a series of examples.

EXHIBIT 3

INVESTMENT ASSUMPTION

- Spreads to Treasuries
  - 50 Basis Points for Noncallable Bonds
  - 150 Basis Points for Callable Bonds
- Bonds are called if rates fall 150 basis points
- 7-year callable bonds are callable in 4 years at par
- 10-year callable bonds are callable in 5 years at par
- 20-year callable bonds are callable in 5 years at 106% of par
- 30-year callable bonds are callable in 5 years at 106% of par

What we've said is that you earn 50 basis points more than Treasuries if you bought noncallable bonds, and you would earn 150 basis points more than Treasuries if you bought callable bonds. That's a reasonable assumption, depending on what bonds you are buying -- it might be more or less. We also had some assumptions about callable bonds. We said that if rates fell 150 basis points, a callable bond would be called. We also have assumptions about when they become eligible to be called and at what price they are eligible to be called.

It's important to gather assumptions like this, and one of the key things in pricing is that there is going to have to be a lot of communication between actuaries and the investment department. I don't know about everyone else out there, but I really don't follow the bond market that closely and don't have a good sense for this kind of thing. You have to talk to your investment officer and get his input on this kind of an issue. It may be tough to communicate with him, but I think that we really have to do it.

Another thing that you have to do is generate interest rate scenarios to test. If you are no longer assuming a spread of your credited rates, then you have to look through a whole series of interest scenarios of what you are going to credit, what you are going to earn, and what kind of lapse experience you are going to have. One of the ways that you can generate interest rate scenarios is to develop a yield curve universe. (See Exhibit 4.)

EXHIBIT 4

YIELD CURVE UNIVERSE

Curve Number	1-Year Treasury	5-Year Treasury	10-Year Treasury	20-Year Treasury
1	1.41	2.27	2.38	2.78
3	2.41	3.27	3.38	3.78
7	4.41	5.27	5.38	5.78
11*	6.41	7.27	7.38	7.78
15	10.41	11.27	11.38	11.78
19	15.34	15.27	15.15	15.10
21	18.27	17.27	16.92	16.42

(* Current Curve)

Something like this, where we have developed a fairly wide-ranging universe of rates, could have rates as low as 1% and as high as 18%. We developed a probability distribution to tell how interest rate scenarios would be generated from this universe. You have to have some kind of a process for setting interest scenarios. I happen to like a probabilistic approach. A lot of people like to look at ten or fifteen fixed scenarios and that's an acceptable approach. I think that one of the nice things about using a probabilistic approach is that you can generate a distribution of anticipated results and you can make some statements about what your expected profits are and the level of risk that you are taking and you can do some thinking about whether or not the risk/reward tradeoff is appropriate for the product that you are pricing.

We are going to go into a series of examples. (See Exhibit 5.) This is "Make Your Spread" Life. It's a fairly common situation. This is a company where their actuary said they needed to make 150 basis points more than they credit. (Whatever they earn, they are going to credit 150 basis points less.) That way, they will meet their pricing assumptions. They are going to invest in 20-year callable bonds initially, because that's the only way they can get their spread in the marketplace. They will gradually shorten their portfolio because they are concerned about C-3 risks. You can see that we have other classical actuarial assumptions. We have a lapse rate formula and it is the same one that I showed you earlier. One of the assumptions that you have to make in this kind of analysis is what the market is going to be. That is what the policyholder can get on a competitor's product. In this case, we've said they are going to get the five-year Treasury rate.

EXHIBIT 5

MAKE YOUR SPREAD LIFE
SPDA NEW ISSUES

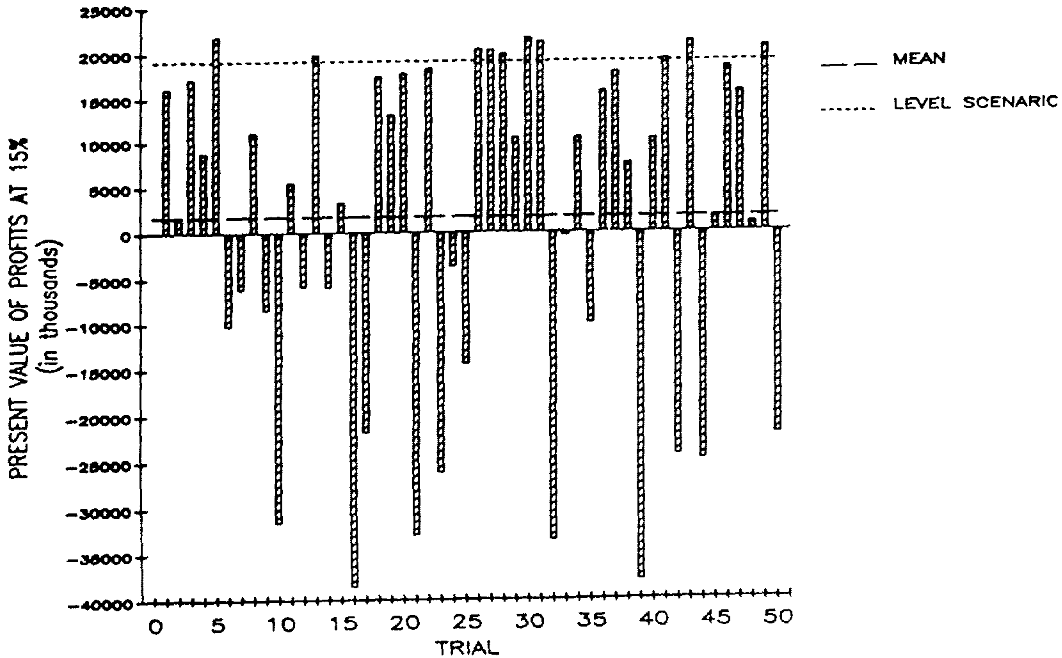
- Premium: \$200 Million
- Average Size: \$25,000
- Surrender Charge: 7, 7, 7, 6, 5, 4, 3, 2, 1, 0%
- Investment Strategy:
  - Twenty-Year Callable Bonds Initially; Thereafter Seven Year Callable Bonds
- Credited Rate: Earned Rate Less 150 Basis Points
- Market Rate: 5 Year Treasury
- Lapse Rate: $15\% + 2 \times (MR-CR)^2 - 3 \times SC$
  Minimum = 3%
- Issue Expense: \$50 Per Policy
- Maintenance Expense: \$25 Per Policy, Inflated at 3%
- Commission: 5%
- Investment Expense: .2% of Fund
- Bailout: 0
- Guaranteed Interest: 4%

Let's see how "Make Your Spread" Life does. (See Graph 2.) We generated 50 interest scenarios from our universe I showed you earlier. You can see that the results vary. One of the things "Make Your Spread" is doing is taking a lot of risk. This is \$200 million of single premium deferred annuity premium. In the worst case of the 50 that we looked at, "Make Your Spread" Life could potentially lose \$38 million on a present value basis. That is quite a bit of risk to take. You'll also notice that, according to the mean of these 50 scenarios, they were expecting to make just over 15% internal rate of return, which is an acceptable profit. (Possibly not acceptable given the level of risk they were taking, but that is really a judgment call.) One of the things I really find interesting in this particular exhibit is that the short dashed line is \$17 million higher than the mean line. The short dashed line is a level interest scenario. That's what happens if interest rates never change, which essentially reproduces what you get when you price by assuming a spread. I found, as we do more and more analyses like this, that 90% of the time the level scenario answer is far better than the random scenarios. In fact, in this particular case, the level scenario is almost as good as the best of the 50 trials.

I really think this points up the pricing risks in assuming a spread. I'm afraid if we, as an industry, don't start pricing on a more realistic basis, we're just going to bleed to death.

GRAPH 2

MAKE YOUR SPREAD LIFE
IMPACT OF INTEREST RATE SWINGS
ON EXPECTED PROFITS



Moving on, I have a second company. (See Exhibit 6.) This is "Never Again Disintermediation" Life. This company has decided they're not going to follow "Make Your Spread." They're not going to take all that risk. They're going to credit 125 basis points less than they earn. But their investment strategy is one and two year bonds, so they're never going to have a real long portfolio, and they're never going to be at any risk for this product. All the rest of these assumptions are pretty much the same as for "Make Your Spread" Life.

EXHIBIT 6

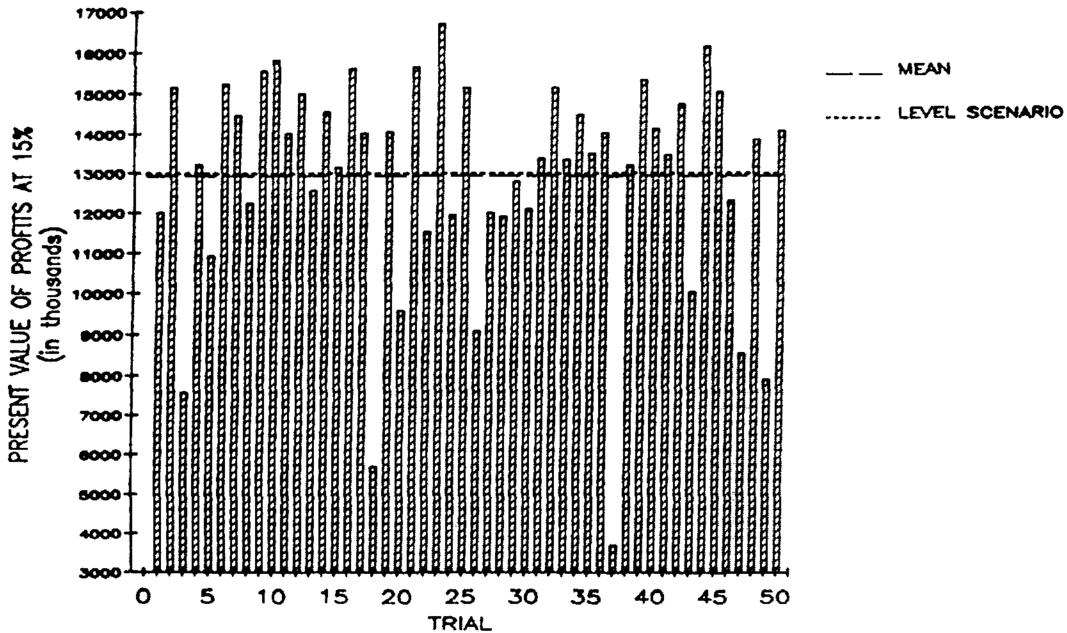
NEVER AGAIN DISINTERMEDIATION LIFE
SPDA NEW ISSUES

- Premium: $200 Million
- Average Size: $25,000
- Surrender Charge: 7, 7, 7, 6, 5, 4, 3, 2, 1, 0%
- Investment Strategy:
  - Initially 50% One and Two-Year Bonds; Thereafter Two-Year Bonds
- Credited Rate: Earned Rate Less 125 Basis Points
- Market Rate: 5-Year Treasury
- Lapse Rate: $15\% + 2 \times (MR-CR)^2 - 3 \times SC$
  Minimum = 3%
- Issue Expense: $50 Per Policy
- Maintenance Expense: $25 Per Policy, Inflated at 3%
- Commission: 5%
- Investment Expense: .2% of Fund
- Bailout: 0
- Guaranteed Interest: 4%

We find that "Never Again Disintermediation" Life has actually done a fantastic job. (See Graph 3.) You'll see that mean and level scenarios are almost the same. There is very little risk associated with this strategy. The only problem with this is that another name for "Never Again Disintermediation" Life might be the "Bait-and-Switch" Life. If you went back to the yield curves I showed you, you might find that by buying one and two-year bonds, this company was going to credit a market rate the first year and then switch over to the earned rate less 125 basis points. If interest rates didn't change, that means their credited rate at the end of the first year would drop by about 250 basis points. That's why I call them the "Bait-and-Switch" Life. If you're willing to live with yourself with that kind of a strategy, it is probably fairly effective. There is also some marketing questions down the road if anybody is going to buy any policies from "Bait-and-Switch" Life. If you are so inclined, it is a potentially viable strategy.

GRAPH 3

NEVER AGAIN DISINTERMEDIATION LIFE
(CREDIT BASED ON EARNED RATE)
IMPACT OF INTEREST RATE SWINGS
ON EXPECTED PROFITS



This is what is probably going to happen in real life -- "Never Again Disintermediation Life" (Part II). Almost every insurance company I've dealt with sells their product through agents or brokers, and that creates some problems. Loyal agents are likely to scream when you drop your credited rates 200 basis points at the end of the first year. What we've looked at here is what happens to "Never Again Disintermediation" Life, if they credit the market rate instead of following their planned, although somewhat dubious strategy, of crediting their earned rate less 125 basis points. (See Graph 4.) As you can see, it is not such a rosy picture. Basically, they have done a good job of eliminating risk by locking in about a $5-6 million dollar loss, but I wouldn't want to take that to senior management. As long as they have a sufficient amount of surplus to throw at this product, there is no question that they will be in business for a long time. At $8 million every 15 years, it takes a long time to eat up surplus.

That illustrates one of the dangers in this kind of work. It's really important that your assumptions be realistic and be something you can execute. I don't know how many times I've gone to clients, looked at their assumptions, come up with projections and at the end concluded that we wasted our time, because they had made some assumptions about what they were going to do with their credited rate that they just wouldn't be willing to do. So if you are not going to want to "Bait-and-Switch" your policyholders, you should not make your projections on that basis, unless you want to fool yourself.

"Follow the Market" Life (Exhibit 7) is another strategy often encountered.

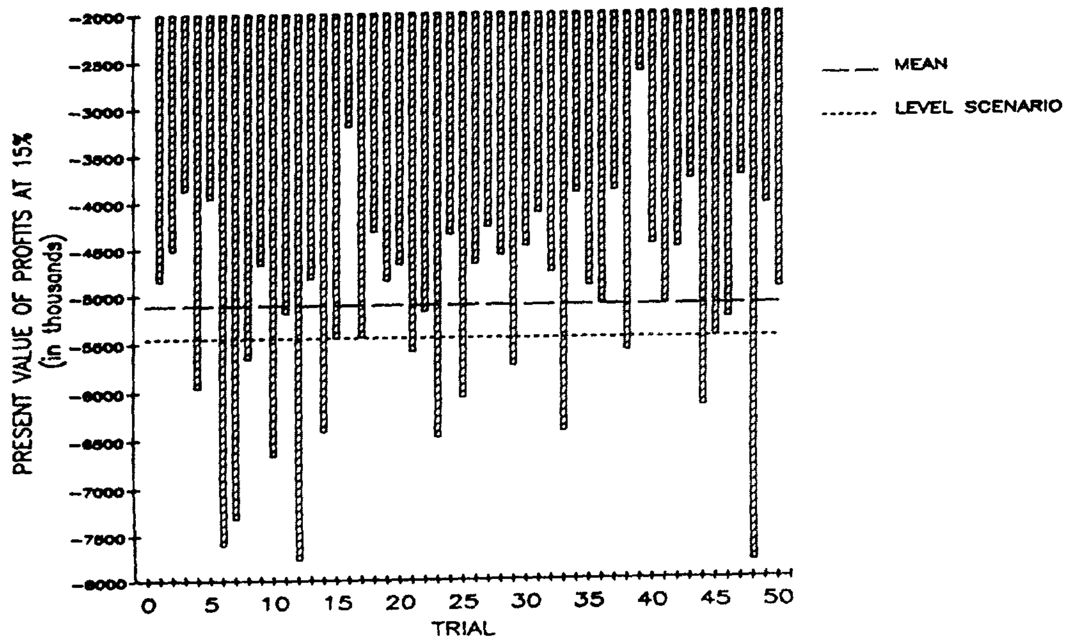
EXHIBIT 7

FOLLOW THE MARKET LIFE
SPDA NEW ISSUES

- o Premium: $200 Million
- o Average Size: $25,000
- o Surrender Charge: 7, 7, 7, 6, 5, 4, 3, 2, 1, 0%
- o Investment Strategy: Buy Whatever Has the Highest Yield
- o Credited Rate: Market
- o Market Rate: 5-Year Treasury
- o Lapse Rate: $15\% + 2 \times (MR-CR)^2 - 3 \times SC$
  Minimum - 3%
- o Issue Expense: $50 Per Policy
- o Maintenance Expense: $25 Per Policy, Inflated at 3%
- o Commission: 5%
- o Investment Expense: .2% of Fund
- o Bailout: 0
- o Guaranteed Interest: 4%

GRAPH 4

NEVER AGAIN DISINTERMEDIATION LIFE
(FOLLOW THE MARKET)
IMPACT OF INTEREST RATE SWINGS
ON EXPECTED PROFITS



This company is just crediting whatever the market is crediting and as for the investment strategy, it is just going to buy whatever has the highest yield. This is a pretty reasonable way to maximize your profit. Unfortunately, it is also a pretty reasonable way to maximize your risk.

You can see they make "Make Your Spread" Life look like a responsible old line company. (See Graph 5.) You can see that we have several scenarios where there are present values of losses in excess of $40 million. They have an acceptable mean present value of profit. The level scenario sticks out like a sore thumb above everything else. This is what happens if they use a level interest scenario or assume a spread type assumption. I can't emphasize enough how important it is to be aware that to assume a spread is fooling yourself.

"Matched Life" is one of my favorites. (See Exhibit 8.) We go into companies and we show them the first four or five companies and they laugh. They'll say, "We're matched, so why are you bothering?" We ask what they are buying. And they'll say, "We're buying seven-year bonds, or five-year bonds, or even ten-year bonds." The reason we're asking is that we are really interested in finding the assets they are buying to match their products (e.g., single premium deferred annuity (SPDA), since the duration of an SPDA varies with interest). "Matched Life" is going to buy medium maturity bonds, essentially matching as they see it. They're going to credit the market rate.

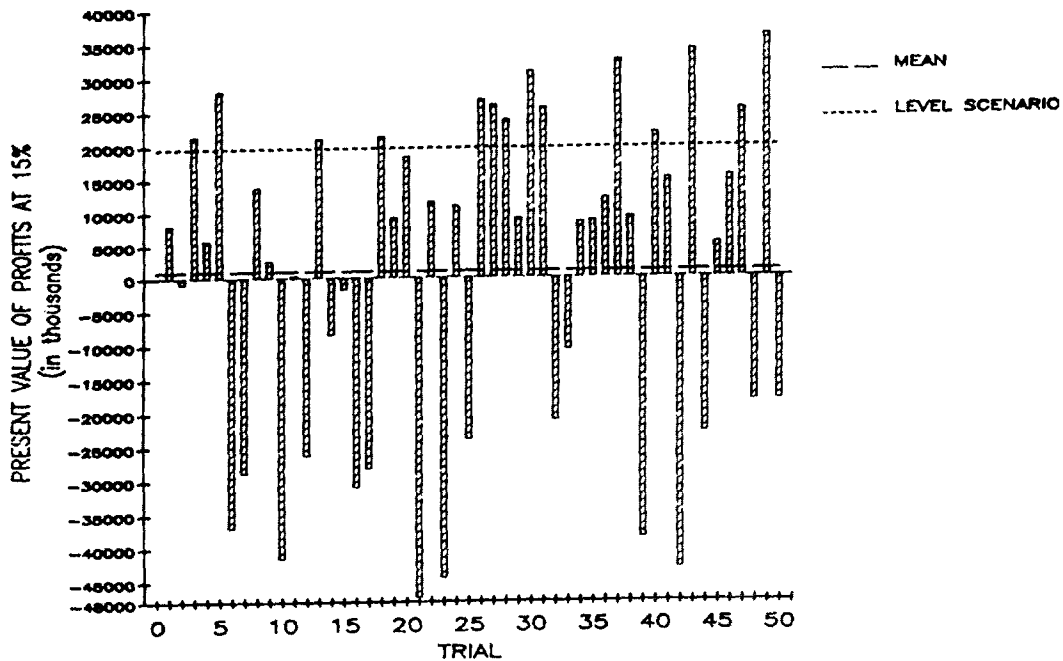
EXHIBIT 8

MATCHED LIFE
SPDA NEW ISSUES

- Premium: $200 Million
- Average Size: $25,000
- Surrender Charge: 7, 7, 7, 6, 5, 4, 3, 2, 1, 0%
- Investment Strategy: Intermediate Bonds;
  Initially 7-Year Callable Bonds
- Credited Rate: Market
- Market Rate: 5-Year Treasury
- Lapse Rate: $15\% + 2 \times (MR-CR)^2 - 3 \times SC$
  Minimum = 3%
- Issue Expense: $50 Per Policy
- Maintenance Expense: $25 Per Policy, Inflated at 3%
- Commission: 5%
- Investment Expense: .2% of Fund
- Bailout: 0
- Guaranteed Interest: 4%

GRAPH 5

FOLLOW THE MARKET LIFE
IMPACT OF INTEREST RATE SWINGS
ON EXPECTED PROFITS



You can see they have considerably reduced their risk from "Make Your Spread" or "Follow the Market" Life (Graph 6), but as you can see from this exhibit, they have by no means eliminated risk. They could be in for a very nasty surprise. You can see by the one scenario they've lost about $23 million on a present value basis.

Now again, these weren't really chosen to be worst cases scenarios -- they are just fifty randomly generated scenarios based on a distribution of what the world might look like.

Here is "Well-Managed" Life (Exhibit 9). One way you might approach this is like this company -- realize that there is no free lunch and that they are in a risk business. They've said they're going to design a strategy that contains losses at an acceptable level. They've set $44 million of losses as acceptable. Within that constraint, they are going to maximize their profits.

EXHIBIT 9

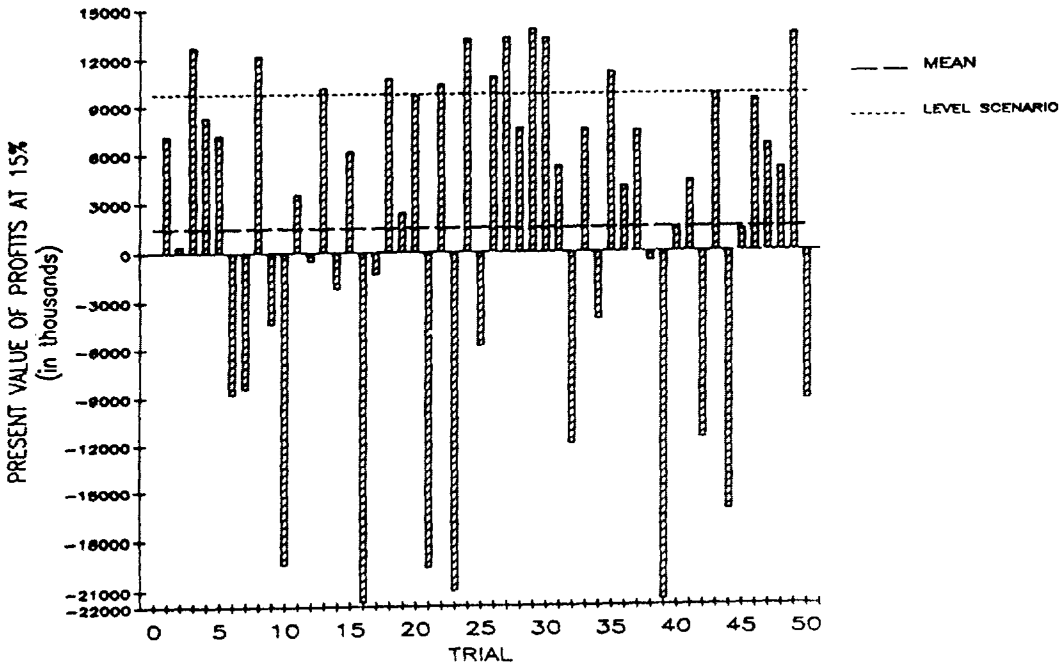
WELL-MANAGED LIFE
SPDA NEW ISSUES

- o Premium: $200 Million
- o Average Size: $25,000
- o Surrender Charge: 7, 7, 7, 6, 5, 4, 3, 2, 1, 0%
- o Investment Strategy: Optimize with a $44 Million Total Loss Constraint and a $11 Million Annual Loss Constraint
- o Credited Rate: Market
- o Market Rate: 5-Year Treasury
- o Lapse Rate: $15\% + 2 \times (MR-CR)^2 - 3 \times SC$
  Minimum = 3%
- o Issue Expense: $50 Per Policy
- o Maintenance Expense: $25 Per Policy, Inflated at 3%
- o Commission: 5%
- o Investment Expense: .2% of Fund
- o Bailout: 0
- o Guaranteed Interest: 4%

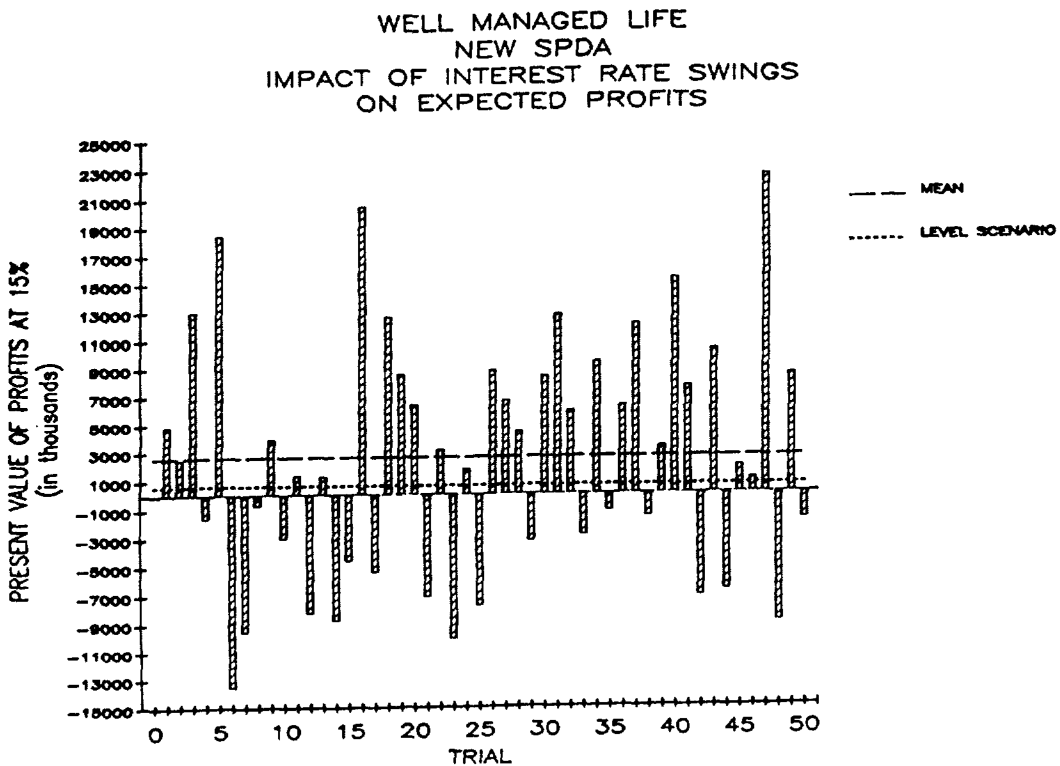
In Graph 7, you can see the kind of results this company receives. Again, in today's competitive market, it is hard to get that mean line very far above zero, (which is the mean present value of profits at 15%, an acceptable level of profit). Depending on management's judgment, this may be an acceptable level of profit for the level of risk they are taking. You can see they control their risk and they are aware. A key thing that differentiates "Well-Managed" Life from

GRAPH 6

MATCHED LIFE
IMPACT OF INTEREST RATE SWINGS
ON EXPECTED PROFITS



GRAPH 7


WELL MANAGED LIFE
NEW SPDA
IMPACT OF INTEREST RATE SWINGS
ON EXPECTED PROFITS
PRESENT VALUE OF PROFITS AT 15%
(in thousands)
25000
23000
21000
19000
17000
15000
13000
11000
9000
7000
5000
3000
1000
-1000
-3000
-5000
-7000
-9000
-11000
-13000
-15000
0
5
10
15
20
25
30
35
40
45
50
TRIAL
MEAN
LEVEL SCENARIO

some of the other companies that we've looked at is that they've done some looking at what happens to them under interest rate scenarios, and they are aware they are taking risks. I think one of the important things is this: Be aware that when you price a product for 15%, you're not locking that in. It may be that you get your 15% internal rate of return, but you may not. It depends on what interest scenarios do.

The key thing is to look at a variety of investment and crediting strategies, and then decide on what one you are most comfortable with, what your mean profits on realistic assumptions are, and also look at the level of risk you are taking. Then compare your options and decide which strategy provides the most acceptable level of return against the level of risk you are taking.

MR. SHELDON EPSTEIN:
Investment Considerations for Product Development: Introduction -- Setting investment assumptions for insurance product pricing can be like shooting blindfolded when the investment and actuarial departments don't coordinate in the product development process. It doesn't necessarily have to be that way, as long as the investment assumptions are consistent with the price and yield behavior of the liabilities, and if those assumptions can be translated into realizable targets for the investment manager.

Setting Realistic Investment Assumptions -- The concepts I will be discussing will help the pricing actuary set realistic investment assumptions, while at the same time almost force coordination with the investment department in a manner that is very natural for investment managers. The main idea that I will develop is that of a baseline index which is based on the interest-sensitivity of the liabilities.

Traditionally, the pricing actuary will make certain assumptions as to the investment return achievable over the life of a product. The investment manager, on the other hand, will usually be evaluated based on his performance versus some independent market index, such as Shearson-Lehman's indices, or the Standard and Poor 500 index. Thus the investment manager will tend to manage his funds towards the duration and yield characteristics of these market indices. If the actual and expected returns of the index and of the liabilities are similar, it will have been coincidental, as most of the usual indices that are benchmarks usually have very little in common with the insurance company liabilities, especially if asset and liability matching is an issue.

However, it is possible to construct an index -- which we at Morgan Stanley have dubbed the Baseline Index -- that will match the duration and yield requirements of the underlying liabilities. At pricing time it will be much easier for the investment department to assess the reasonableness of the index, as it will be something they have to manage towards. The baseline index will represent the return that must be earned based on an asset mix that has a duration similar to liability duration. The investment manager will have more freedom to choose assets for his portfolio, as he won't be tied to the assets that are used to set interest crediting rates. Further, whereas one of the usual indices might show a total return of, say, Treasuries plus 150 basis points, the baseline index might indicate a return of Treasuries plus 250 basis points as the target. The difference lies in the fact that the baseline index is constructed using durations that are typically shorter than those of most indices. Short duration assets typically have lower yields, thus a higher spread is usually required. By having the investment department manage towards the baseline index, they will only take mismatch risks intentionally and not as a part of a desire to match the market index.

I will briefly explain the logic behind the construction of a baseline index. When an insurance contract is issued there is an implicit purchase of a stream of uncertain cash flows by the policyholder. These cash flows are the death, disability, loan or withdrawal benefits that are part of the contractual guarantees. The fact is that the purchase of an uncertain stream of cash flows in an insurance contract is not all that different than the purchase of a government national mortgage association security (GNMA) or a callable bond which also have uncertain cash flows. In the event of single premium insurance, the analogy is almost complete as the purchase price is determined by the single premium. In the case of the continuing premium products such as universal life, the purchase price is itself a stream of uncertain cash flows to the insurance company. Further, the purchase stream can affect the liability stream, but it is still possible to identify the two streams separately.

The point of the analogy is that just as a callable bond or a GNMA has distinctive price and yield characteristics, so do insurance company liabilities.

Insurance premium flows also have separate price and yield characteristics. When I refer to price characteristics, I am really referring to the price-sensitivity to interest rate changes, or duration, as it is commonly known. Without understanding the behavior of the liabilities, and possibly the behavior of the premiums (with respect to interest rate changes) it is very difficult to set investment assumptions which are both realistic and achievable.

What Is a Baseline Index? -- We call the price and yield characteristics of a defined cash flow its baseline index. If all other assumptions are acceptable to the actuary and to the company, and if the assets can at least perform as well as the baseline index, then the product will be supported from an investment point of view. The question becomes one of whether the investment department feels that the index is achievable, and to what extent it can deviate from the index by adopting various strategies in order to enhance the total return, which is a concept that is often forgotten in investment asset/liability matching.

Baseline Index Characteristics -- The major characteristics of the baseline index are the price, for pricing purposes this is the net single premium or the first premium; the duration and convexity of the liability; and finally, the yield. The yield is best described as a beginning term structure spread over the Treasury yield curve, such as U.S. Government Bonds.

Most insurance company liabilities are interest-sensitive, both in the sense that benefits are related to interest rates, and in the sense that withdrawals and deposits depend on interest rates. Thus, it is important to be able to price interest-sensitive cash flow streams in order to determine the baseline index characteristics of the liabilities. At Morgan Stanley, we use option pricing models to determine the characteristics of the liabilities we study.

The underlying model is the same one that is used for pricing interest-sensitive assets such as mortgage backed securities or callable bonds.

With the ability to price interest-sensitive cash flows, it is possible to determine how prices change with respect to interest rate changes, and it becomes apparent that there is one very important investment assumption which is often not dealt with explicitly, and that's the volatility of interest rates. The volatility of interest rates can basically be thought of as the average deviation of rates over a certain time horizon such as one year. Given an explicit volatility assumption, and an initial yield spread over risk-free interest rates, it is possible to determine the price of an interest-sensitive cash flow stream.

The baseline index can be constructed given an initial price for the cash flow stream. The result is the initial yield spreads for the term structure that must be initially achieved. And remember, the yield spread is the spread over the Treasury curve. Obviously, the investment department should be consulted for the reasonableness of such a target. If the beginning term structure is deemed not achievable by the investment department, then the product must be modified, such as by lowering the credited rate, lowering the minimum interest rate guarantee, or by making the product less interest-sensitive.

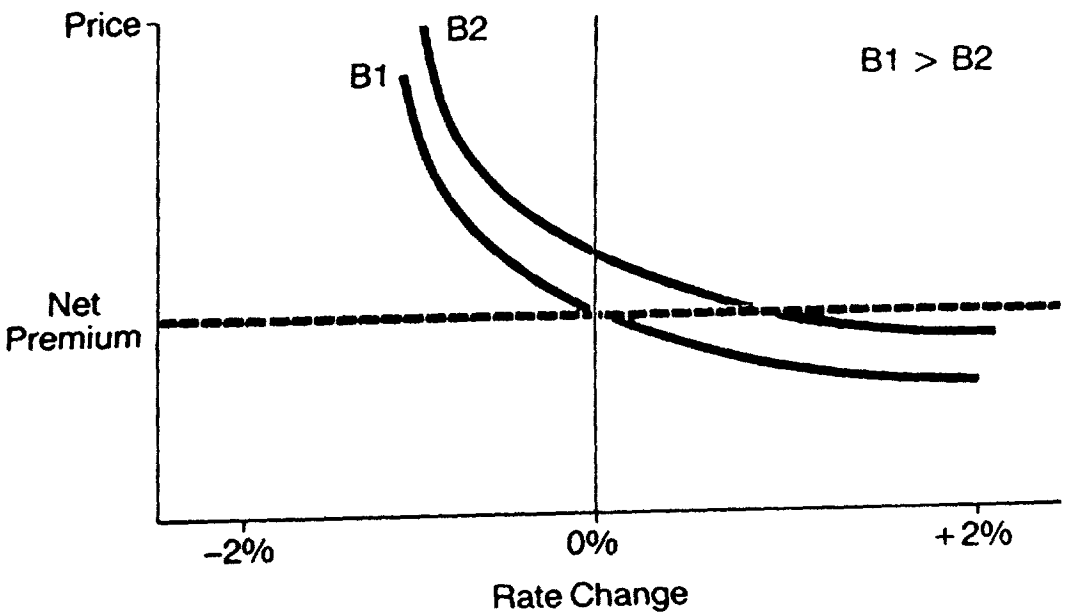
It should be noted that while the particular assets that the policy interest rates are based on need to be specified, (such as if you were crediting Treasuries plus 25 basis points), the calculation of the baseline index does not make any assumptions as to particular investment strategies. As an example, if we consider an SPDA which credits five-year Treasury rates plus 25 basis points, or even if you will use this as the basis for your recrediting strategy, then the investment department could invest in anything it felt would give it the required yield based on the duration and convexity requirements of the liabilities, such as collateralized mortgage obligations (CMOs), callable bonds, etc.

The baseline index can be graphically represented (as in Graph 8) by plotting the price of the liabilities versus an instantaneous change in the interest rate environment. The graph shows that if (1) you can invest at an initial spread of Treasuries that will allow the price of the liability flows to equal the price of the premium plus asset flows in today's interest environment, and (2) you are comfortable with your interest rate volatility assumption, then the value of your liabilities will change according to the price curve representation of the baseline index.

In Graph 8, B1 and B2 represent two possible baseline indices, where B1 is based on a higher yield spread, and thus a higher total yield than B2. The horizontal axis refers to a change in the interest rate environment, relative to the rates on the day of valuation, which can be thought of as a change in the Treasury yield curve. It could be a parallel shift up or down or a nonparallel

GRAPH 8

Level of Baseline and Price



shift up or down. The vertical axis represents the price of the liability flow at each level of the base Treasury curve. The price has to be evaluated using some type of option-pricing model.

Note that in the graph baseline index B1 implies that a higher yield is necessary than for baseline index B2. That is, the higher the yield is, the lower the price of the liabilities. Also, note that if the investment department manages toward B2, the only way they will meet the yield requirements of the contract is if they intentionally mismatch. One possible mismatch would be to anticipate an increase in interest rates. The mismatch would require purchasing shorter duration assets so that the asset values do not fall as quickly as the liability values when rates increase.

How to Use Baseline Indices -- At this stage, it is vital to coordinate the baseline index information with what your investment department feels are realistic yield spreads over today's risk-free yield curve. Also, it is important that the investment department buys into interest rate volatility assumption. In Exhibit 10 the product baseline index is one that has a yield of Treasuries plus 175 points in order to have the net premium equal to the liabilities. If the investment department feels that it can only manage Treasuries plus incentive stock option (ISO) basis points consistently, than either the product will have to be modified to allow for this, or structured risks will have to be taken.

Traditional Investment Risks -- Insurance companies have traditionally relied on their credit analysis abilities and on interest rate projections in order to provide extra returns. While not intentionally, they have also tended to mismatch. Usually, the direction of the mismatch is for asset durations to be longer than liability durations, due to the fact that the put options attached to insurance contracts are usually not accounted for. Fortunately, this has worked out rather well in the last few years as interest rates have fallen. However, even if a portfolio is duration matched, there is still potential for other arbitrage profits due to superior asset selection, and for what is known as convexity profit, which occurs whenever interest rates move.

Structured Risk Management -- Using a baseline index, the investment department will know at the time that the pricing of a contract is done whether structured risks will have to be taken and can thus communicate this information to

EXHIBIT 10

Baseline Index

(Net Premium: $50,000)

	Yield Spread	Duration	Liability Price
B1:	175 b.p.	5.3	$50,000
B2:	150 b.p.	4.3	$55,000

Either: 1) Need to earn B1
2) Assume B2 but take Structured Risks
(Credit, Mismatch, etc.)

the pricing actuary. The baseline index will provide the investment department with all the information it needs with respect to duration matching. Thus, it can take structured risks, which are based on being well informed as to the level of risk, as they will be fully aware of the riskless matched situation. The risk taking will tend to be more effective on account of this.

In any case, the investment department will have a clear objective for structuring it's investment philosophy so as to support the liabilities. The beauty of this approach is that an investment strategy can be tailored to the structure of the liabilities and the risk taking abilities of the investment department. It is important to keep in mind that the baseline index is constructed independently of the investment strategy and thus is an excellent unbiased performance measure.

The baseline index can be recalculated periodically based on the current price of the liabilities, as well as on the proposed prices for new additions to the liability flows, i.e., new sales. As long as the investment portfolio out-performs the baseline index, within a predetermined duration match tolerance, it can be safely assumed that the investment department is providing enough yield to support the liabilities.

Future Premiums as Assets -- I would like to just briefly touch upon a concept that helps one understand the term structure risks that are inherent in premium paying insurance contracts. Traditionally, option pricing models have been applied to single premium products but they can be applied to premium paying products using these ideas. Premiums are a stream of uncertain cash flows that the insurer accepts in return for the liabilities that it issues. The insurer accepts other types of uncertain cash flows such as when it buys callable bonds. The premium flows are in fact just a special type of asset that the insurer owns in his investment portfolio. The fact that the level of liabilities can be closely tied to the level of future premiums is important but does not invalidate the view.

In Exhibit 11 resents the surplus -- or the present value of profits due to the assets and liabilities associated with a particular insurance contract. "S" is equal to the value of the assets (A), over the value of the liabilities (V). But the value of the liabilities is equal to the excess of the present value of future benefits (PVFB), over the present value of future premiums (PVFP). If

EXHIBIT 11

Future Premiums as Assets

$$S = A - V$$

$$\rightarrow S = A - (PVFB - PVFP)$$

$$\rightarrow S = (A + PVFP) - PVFB$$

- Duration of PVFP > Duration of PVFB
  Assets must be short to match
- Duration of PVFP < Duration of PVFB
  Assets must be long to match

we group all of the positive terms together in the surplus equation, it becomes obvious that the future premiums belong with the assets.

If the investment department is using durations in order to match assets and liabilities, it is clear that the duration of the combination of assets plus future premiums must equal the duration of the liabilities. At issue, assets are equal to the first year's premiums which, before they are invested, have a duration of zero as long as they are held in cash. It has been our experience at Morgan Stanley that it is very rare for the duration of the future premiums to equal the duration of the liabilities, due to the different types of options attached to each flow. Hopefully, at the time of issuance, the market values are at least equal.

What this implies is that the correct investment for the first and subsequent premiums is highly leveraged on the degree of duration mismatch between future premiums and future liabilities. I bring this point up as it is important to structure the premium paying options at product design time, such as stop and go features in universal life, so that the premium and asset durations are more manageable with respect to the liability durations.

Conclusion -- I would just like to say that not only must investment considerations be taken into account at product development time, but an effort must be made to understand the management of the assets that emerge within the framework of traditional portfolio management.

MR. BUFF: What I am going to talk about is C-1 risk. I hope that you will come away from this panel with the feeling that you've heard about the two important aspects of investment risk.

Introduction -- I would like to start my comments by building on something Peter said in the beginning of his talk. He made two very important points. In all these investment strategy discussions, you really have to look at alternatives and ask yourself whether the gain, the reward that you're getting, is really proportionate to the risk you are taking. We've now seen a number of excellent methodologies for getting at the C-3 risk. I think you know that a number of companies now make consulting studies available on software. Information has been in the literature for the last five or six years about C-3 risk. Interestingly, going back a few years, there was a New York Society meeting which was on the subject of investment problems. There was a lot of talk about defining the problems. At that time there was not much discussion about the solutions, because I don't think that many of the solutions really existed. We face a similar problem today in the area of C-1 risk.

Let me, for review, really define what C-1 risk is meant to be. This is the risk of loss of surplus because of asset defaults, particularly on bonds, or the reduction in asset values of equity investments as a result of the deterioration of the underlying credit worthiness of the person who's issued the investment instrument. Now, associated with the loss in value of the stock or the default of the bond, is a loss of interest income beyond the date of default, which was included in the original promise. In fact, right there you are talking something about a C-3 risk, as well as a C-1 risk. I would suggest that it is in fact soon going to be time to take a look at the combination of C-1 and C-3 risks. It was with that in mind that I developed over the last four or five months a method to approach the C-1 risk. We are just getting the results out of the program that implemented this method. The results will be made available to the membership as part of the whole effort to develop cash flow methodologies for the various risks for valuation actuaries. That collection of suggested methodologies will probably end up in the *Valuation Actuary Handbook* published by the Society.

We've defined C-1 risk basically as asset defaults and loss of market value of common stocks and related reductions of investment income. I'm going to concentrate here on bond defaults.

The Problem of C-1 Risk -- I think that before we can talk about developing a model, we really have to decide what the problem is, and try to define that as completely and realistically as possible. I would say that there are several points that need to be made in defining the problem of C-1 risk.

Default rates in a given period vary because of the different characteristics of assets. At a minimum, there are obvious characteristics that are going to affect default experience. For instance, quality (investment grade or high yield), industry (oil, gas, airlines), and coupon and time-to-maturity can all influence the default experience.

A major problem is that future default rates are very difficult to predict. They almost surely will vary over time. (Please remember I said that, because I'm soon going to make some parallels with C-3 risk methodologies.)

The extent of diversification of an asset portfolio definitely affects its exposure to C-1 risk. This is intuitively evident. Holding a few big bonds is not the same as holding a lot of little bonds. Consequently, any decent model that's appropriate for insurance companies in C-1 risk will have to take into account the diversification of the portfolios.

Bonds in default are seldom completely worthless. They have a salvage value because some payments by the debtor will probably be made eventually. It's possible that you could commute the payments of the bonds in default by selling the bond. It will have a market value and several studies have suggested that a salvage value of forty cents per dollar of par is a reasonable average.

Investment managers can plan to select bonds which are good buys relative to their credit ratings, and they can plan to sell off bonds quickly if the issuer's financial standing begins to deteriorate. However, it is very difficult to "beat the odds" or outperform the market with any consistency. If you are to sell a bond that has deteriorated in credit standing, then someone else must buy it. Since the life insurance industry owns more than one third of outstanding bonds, some life companies will own bonds when they default. Widespread use of early warning tests like Zeta(tm) may make the problem of unloading a deteriorating credit more difficult.

C-1 risk cannot be completely mastered in isolation from C-3 risk. Economic conditions affect both default rates and interest rates. Default rates and salvage values depend in part on interest rate levels. Cash flow matching is affected when assets go into default.

The spreads between the yields promised on investment grade and junk bonds definitely vary over time. This is kind of an inseparable problem of C-1 and C-3 risk at the same time.

What Should a C-1 Model Do?

If a C-1 risk model is to be really useful for valuation actuaries, it probably should be consistent with scenario testing cash flow simulation methods that have already been developed for C-3 risks. Let's take a page from the story of C-3 risk, because if you consider a problem phrased in a certain way, C-1 risk and C-3 risk are almost the same. C-3 risk could be defined as follows: We need to understand the impact of future interest rate changes on the surplus of our companies, for either valuation purposes or pricing purposes. However, we don't know what future interest rates are going to be. What are we going to do? The answer, embodied in the regulations in New York, and beginning to be endorsed by a lot of professional practices now, is to look at future interest rate environments and run a simulation cash flow model across that set of environments, and get a range of results. Then we need to think about that range; what is its mean, its highest, lowest, standard deviation, etc.? The model should be as realistic as possible, avoid overly theoretical concepts or abstract points of view, and not be too expensive to develop and operate.

A good C-1 risk model should be able to handle existing portfolios of insurance product liabilities and accompanying assets. In other words, you should take your actual in-force files, your actual assets with their maturity dates and call provisions, and feed them into a model and get results. These results, along with the assumptions that you specify, are specific to your particular product situation. The model really should reflect the effects of recurring premiums, on C-1 risk exposure, open blocks of business, and timing of default events over the projection period. This really becomes critical to the valuation and pricing actuaries.

The output of the model should directly answer questions about risk charges (pricing) and reserve and surplus requirements (valuation).

The model should accept different assumptions about yield spreads, asset allocations by quality grade, and diversification rules, and then be able to calculate the distribution of profit or loss across a universe of default rate scenarios. This will permit effective quantification of the risk/return position created by different asset portfolio strategies.

A Way to Study C-1 Risk

I've been leading an effort to design such a C-1 model. A model has now been developed which:

1. Uses scenarios of nonconstant future default rates. These can be varied by asset type (bonds, mortgages, etc.), by quality grade (AAA, B, etc.) and by industry (oil, gas, airlines, etc.).

2. Uses Monte Carlo sampling to quantify the statistical effects on profit variance of different approaches to diversifying the portfolio. This applies to the starting asset portfolio and to the reinvestment strategy.

3. Models default events by selling a bond when it defaults, for a salvage value which is a user-specified percentage of par.

4. Projects asset and liability cash flows for a user-specified data base of existing assets and in-force policies. It permits inclusion of new business and can combine different products.

5. Summarizes key financial input such as annual cash flows, book profits, and accumulated surplus, reflecting the impact of C-1 experience.

6. Uses a flat constant yield curve to have a "pure" C-1 risk model. In a sense the interest rate doesn't matter. However, the computer programming that was utilized to run off the samples I will describe, really came straight out of a C-3 scenario cash flow model. In fact, once the specifications for the model were developed, the actual programming that led to an executable software package took comparatively little time. I think that is one of the strengths of this approach. On the premise that all of us have some sort of access to a good C-3 risk model, and if one is able to augment it so that it can do C-1 this way, then you could augment a model without that much difficulty. Then we have something that might be acceptable to valuation actuaries. This would pass a couple of tests that I think are critical, and you can decide for yourself after you see the rest of the results, and hear the rest of what I have to say, if it, in fact, passes tests of practicality, realism, avoidance of theoretical points of view, and input requirements which do not require too much "crystal balling" by the users.

7. Uses computer programming similar to that of a C-3 scenario testing model, so as to allow eventual combination of C-1 and C-3 risks into an "asset adequacy model." This model would use multirisk scenarios, specifying interest rates and default rates together.

This model in part draws on, or parallels, research into C-1 and C-3 risk by Donald D. Cody, Michael E. Mateja, James A. Geyer, Richard L. Sega, James A. Tilley, and Robert D. Shapiro and W. James MacGinnitie. My approach is consistent with the cash flow techniques required by New York Regulation 126.

Monte Carlo Sampling

Monte Carlo statistical sampling techniques are an empirical way to derive the probability distribution of a complicated financial variable. These methods are covered on Part 5 Risk Theory. Rick Sega applied them to study C-1 risk in his recent *Transactions* Vol. 38 article, "A Practical C-1". I use them somewhat differently, to follow Jim Tilley's approach to C-3 risk of projecting profit along a "worst case" scenario, then measuring the surplus needed at the beginning to assure solvency at the end.

Professors Elton and Gruber of the New York University Business School, in a report to the Life Insurance Council of New York (LICONY), which they co-authored with Professors Altman and Sametz, provide tables of one-period default distributions for portfolios with different numbers of bonds. These tables were derived using closed-form combinatorial formulas. Since a really effective C-1 model needs to project wealth to the end of a multiyear period for bonds of heterogeneous sizes, with varying year-by-year default rates, and with cash inflows and outflows, I decided to use Monte Carlo methods in my model.

The problem is that any one individual bond either defaults or doesn't default in entirety in a given period. If we assume an overall default rate of 2%, the individual bonds all exposed to the 2% rate must be separately tested for actual default, one by one.

Were we to apply an aggregate 2% decrement to the investment yield or to the par on all the bonds, the situation is oversimplified. A good valuation system should produce reserves that are responsive to the real level of risk exposure.

A good model of C-1 risk needs a way to reflect the effects on risk exposure of portfolio diversification.

There will also be period-by-period statistical noise in the actual experience, according to the number of bonds in the portfolio, just like for a portfolio of life insurance risks. In fact, because the entire market of bonds has just a few thousand issues, and default rates in the aggregate are usually rather low, the entire market's annual default rate is subject to sampling variance. Monte Carlo testing within a cash flow projection model takes all of this into account. In fact, we need to take several Monte Carlo samples through each default rate scenario to get a good feel for the gain and loss distribution.

Monte Carlo sampling assumes independence of the trials (defaults of each bond). However, in some environments we might expect a correlation between defaults of separate bonds (contagion); for instance, because of a depression in our industry. This is meant to be taken account of by the default scenario, not by the Monte Carlo sampling within a scenario. If we wanted to examine the effects of a depression, we could use high default rates in a scenario. The Monte Carlo sampling then quantifies some of the inherent uncertainty of actual future experience. In general, I think a probabilistic approach to the future is useful for valuation actuaries, as opposed to a credit analyst's concern with "industry fundamentals," which are short-term and rather hard to forecast effectively. Finally, I would note that some industries (such as airlines, entertainment, food, etc.) may have only a dozen or fewer major junk bond issuers, in which case a 2% average annual default rate (or whatever you assume in a scenario) only seems to be meaningful in the context of Monte Carlo sampling.

Some Points of Elaboration

If we want to examine reserving for 90% likelihood of solvency, and holding additional surplus for, say 99% likelihood of solvency, then we really need to look hard at the end of the loss tail for investment risk. Scenario/Monte Carlo testing is a way to get at this information for C-1 risk.

Some actuaries may want to study situations where bonds are sold before they enter default. This could be done by specifying a rule about when such a sale is triggered; for instance when a bond is trading at say 80% of what otherwise similar bonds in good standing are selling for. We can make up scenarios showing rates of credit deterioration to this level of price depreciation and combine this with a salvage value assumption of 80% of market value. (Here market value has to mean market value based on pure C-3, ignoring C-1.)

The C-1 model's investment diversification rules can include two components. How much of the portfolio goes into junk, and how much money is allowed to be put into any individual bond? This can increase the model's computer running time because the diversification rule can lead to the creation of a large number of separate bonds. The diversification rule could try to buy more separate bonds, if a lot of assets accumulate, than actually exist in the market. This kind of market saturation can be handled by switching to other classes of assets (there are more investment grade bonds than junk bonds now outstanding), or by increasing the holdings of bonds the model already owns (i.e., adding to their par). This can be done under computer control, including a projection of the future size of the junk bond markets used to trigger the switching of asset purchase rules.

Some investment grade bonds do default now and then. They may undergo a gradual downgrading of their credit rating before default, but this doesn't always happen first. Such downgraded bonds are called "fallen angels." Noting that bond quality ratings sometimes are upgraded, I call such upgraded bonds "risen devils." A C-1 model could take account of these quality class transfers through the Monte Carlo sampling process. Even with a small default rate, some defaults sometimes occur because of the sampling process. These defaults are fallen angels. We could consider upgrades to be encompassed within those lower quality bonds which, during the Monte Carlo sampling through the default rate scenario, don't default.

I now draw your attention to the accompanying Appendix, which lists the methods, assumptions, and conclusions of our C-1 risk model. Also shown are enhancements which may help analyze C-1 risk further.

The Appendix shows plots of distributions of wealth for a couple of simple projections. I projected a starting portfolio of $100,000,000 for twenty years. I assumed two default rate scenarios, 2% per year constant and 4% per year constant. I tested three diversification rules, namely $1 million per bond (start with 100 bonds), $5 million per bond (start with twenty bonds), and $10 million per bond (start with ten bonds). The diversification rules also applied to the reinvestment of cash flows during twenty years. It is interesting to see what we can conclude by plotting the distributions. I suggest you turn to the *Conclusions* section of the appendix. One additional observation I will offer is that, because of the statistical uncertainty of actual default experience over twenty years for portfolios with a limited number of bonds, a few times out of one hundred, the ending wealth under the 2% scenario is very near the mean of the 4% scenario, and vice versa. Since the valuation actuaries are concerned about events with low probabilities of occurrence, these interesting results can't be ignored. They say C-1 risk is not adequately quantified by deterministic default rate assumptions. Furthermore, the substantial difference between the 2% mean and the 4% mean (which is no surprise) proves the importance of looking at a number of scenarios of default experience before making any conclusions about pricing, reserves and surplus for C-1.

I would like to make an observation about the C-1 Scenario/Monte Carlo Model's conclusion that diversification reduces the loss tail more than the gain tail, for a case study accumulating wealth over a holding period. Rick Bookstaber and Dave Jacob wrote a paper (Morgan Stanley, January, 1986) in which they studied total return over five years for different junk bond portfolios, using actual historical data. They concluded "the drop in variation of return comes more from a truncation in the risk of substantial underperformance than it does from a diminished opportunity for extraordinary gains" as diversification increases. This is a useful, independent confirmation of this C-1 model. Furthermore, it suggests that strategy decisions derived from using the C-1 model ex ante might be borne out by actual results ex post.

We can briefly illustrate how this sort of information can help us to calculate reserves and surplus requirements. Look at the 4% default rate/$5 MM per bond diversification case. Imagine that solvency requires ending wealth equal to the mean of about $260 million. What reserve is needed to assure 90% probability of solvency? Looking at Graph 9 we see that ending wealth fell below about $245 million eleven times out of one hundred. If we held $100 x 260/245 million at the start, then we should have ending wealth of about $260 million about 89% of the time. This suggests that variance about the mean increases required starting assets by about 6%. Note than in practice, changes at the start do not get

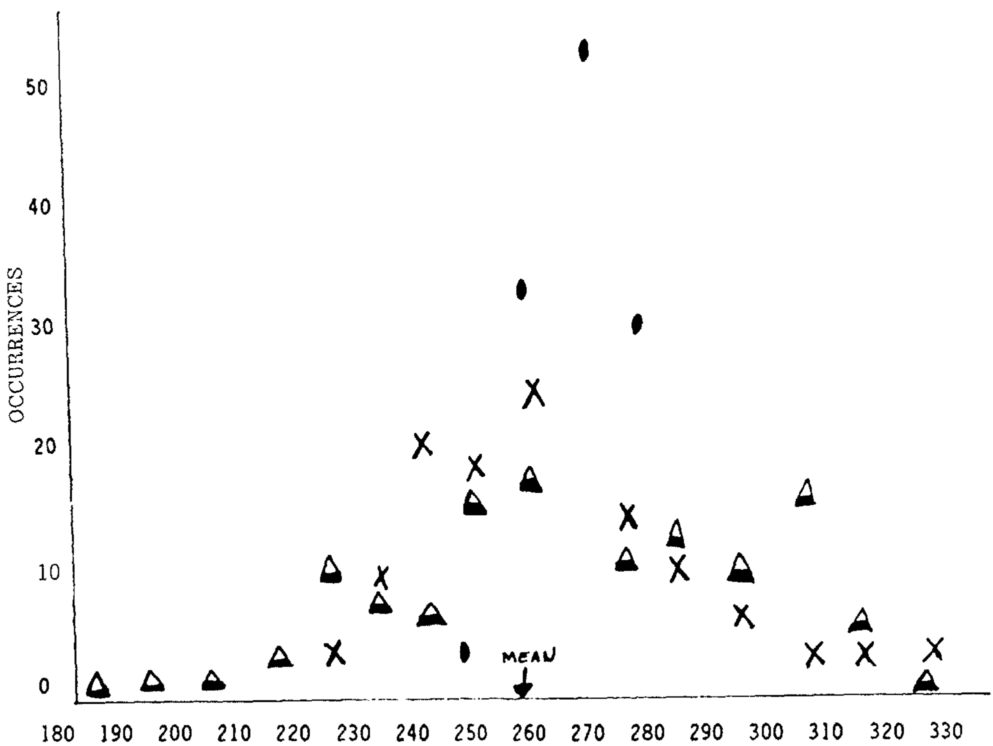
GRAPH 9

.DISTRIBUTION OF 100 MONTE CARLO
SAMPLE RUNS

WEALTH AFTER 20 YEARS, STARTING WITH $100MM

4% Default Rate, 40% Salvage, 7½% Interest

● $1 MM per bond diversification
X $5 MM per bond diversification
▲ $10 MM per bond diversification



$000.000's at 20 Years

reflected so simply at the end. In general, to solve for starting surplus needed to achieve ending solvency, iteration may have to be used.

C-1 Risk for a Universal Life Example

In just the last few days I've been reviewing the results applying my C-1 model to an in-force block of a generic universal life product with both front and rear loads. This brings in a few modeling elements not in the example detailed in the exhibit. These elements are recurring premium payments, liability cash flows, and reserves at the end of the projection period (so that surplus is not the same as ending assets). I also looked at different combinations of investment grade and junk bond portfolio segments. Finally, I ran a set of six "handmade" junk bond default rate scenarios that represented different future economic environments.

I plan to go through this case study, and others, in greater detail in the next few weeks. I am also preparing a paper for review by the Committee on Valuation and Related Areas, chaired by Robert W. Stein.

The product starts out with $200 million of annual premium and zero surplus. I set it up so that mean ending surplus is roughly zero. After twenty years, policy reserves amount to about $1,750 million. Exhibit 12 shows the distribution of book surplus at the end of twenty years for four different diversification strategies.

EXHIBIT 12

BOOK SURPLUS (in millions)
Percent in Junk Bonds/Millions of Par Amount Per Junk Bond

	100%/25MM	100%/1MM	20%/25MM	20%/1MM
Maximum	255	136	177	7
90th Percentile	150	120	3	(4)
Mean	49	31	(22)	(20)
10th Percentile	(67)	(56)	(48)	(42)
Minimum	(167)	(73)	(76)	(47)

These results are very preliminary and they should not be used to draw any firm conclusions about C-1 Risk for an insurance product. For this reason I won't bother to detail the product assumptions or the default scenarios except to claim they were reasonable. The results combine forty Monte Carlo runs through each of the six default rate scenarios for a total of 240 projections per diversification strategy. These results let us quantify how risk increases as we weigh more towards junk bonds and reduce the diversification of the portfolio.

Exhibit 13 gives the means of the group of forty Monte Carlo samples separately for each of the six scenarios, sorted from best to worst.

EXHIBIT 13

BOOK SURPLUS (in millions)

100%/25MM	100%/1MM	20%/25MM	20%/1MM
131	121	(4)	(5)
141	82	(12)	(6)
75	79	(12)	(6)
16	11	(27)	(25)
13	(49)	(38)	(28)
(57)	(56)	(40)	(43)

How important is portfolio diversification? How important is it to use Monte Carlo sampling in the projections? The above results show that the difference between highest and lowest book surplus results is more than doubled if the forty Monte Carlo numbers are used instead of the mean for each scenario, if the portfolio is relatively undiversified. If the portfolio is relatively diversified, the span from best to worst increases by 20% to 40%, when the statistical effects of diversification are taken into the picture using Monte Carlo sampling. The lowest means are roughly equal to the 10th percentile Monte Carlo samples. I have already stressed that valuation actuaries should carefully review the tails of the surplus distribution, especially the loss tail. This analysis would seem to show that the scenario/Monte Carlo testing method for C-1 risk modeling provides necessary information for valuation actuaries to properly set reserves and surplus requirements.

Topics for Further Discussion

There are a few questions I will research further: How can we develop assumptions about default rate scenarios and salvage values? Presumably, both hand-made and stochastically generated (probabilistic) scenarios would be useful. Irwin T. Vanderhoof has developed a model of default rates based on a beta distribution.

Richard L. Sega and Donald D. Cody have published estimates of risk charges for C-1. What sort of risk charges for C-1 risk does the new model suggest?

James A. Tilley demonstrated how scenario testing can be used to measure reserve and surplus requirements for C-3 risks. What levels of reserves and surplus will the C-1 model suggest are needed for solidity in the face of C-1 risk?

Is mandatory securities valuation reserve (MSVR) the best way to provide for C-1 risk in the annual statement? Are cash flow simulations tailored to an individual company's products, assets, and assumptions a better way to get statement reserves?

Michael E. Mateja and James A. Geyer have done important research into the combination of risks. What else can we learn once we start to do multiple-risk scenario testing to combine C-1 and C-3 risk?

In conclusion, I would like to acknowledge the efforts of Mark I. Brandes and Scott Paul Schleifer, who assisted me in this research.

MR. THOMAS K. GROSS: Mr. Deakins, it was not clear to me what the strategy was of "Well-Managed" Life, to arrive at the favorable results.

MR. DEAKINS: That's not surprising, because I glossed over it pretty quickly. Briefly, linear programming was used to select the assets with the highest expected profits at each point in time given a probability distribution of different interest rate movements within constraints on company risk. In this particular case, we assumed that the company was willing to lose no more than $44 million. We selected the strategy that had the highest expected profits within those constraints.

MR. PAUL T. BOURDEAU: Could you comment on the work being done on the relationship between C-1 and C-3 risk? It seems like we're studying them independently, and there might be some relationship between them.

MR. BUFF: Well, I think there is one. Right now, Mike Mateja and Jim Geyer are preparing a report on their research into the combinations of risk. As I hinted, at some point I will be doing some work on combining C-1 and C-3 with this idea of multirisk scenarios, although we are not really sure what the time-frame for that effort will be. I think that once we get this C-1 approach nailed down, it is naturally the next step for people to try to combine them. In general, I guess that it is a fact that junk bonds have shorter durations than assets that are otherwise the same, partly because they do not respond to interest rate movements one-to-one. They tie more to the value of the stock of the company rather than to the bond itself. So, in that sense, perhaps it's true there's less C-3 risk for junk compared to investment grade bonds.

APPENDIX

A WAY TO STUDY C-1 RISK

Preliminary Results:
Effects of Diversification

Method
A block of assets is projected (no liability side). A market-wide default rate is specified. Monte Carlo simulations are used to test each individual bond for default during each period of the projections. A limit is placed on the amount of par which can be invested in any one bond -- a diversification rule. Defaulted bonds are sold for salvage value. Coupon income, bond maturities, and salvage values are reinvested according to the diversification rule. Wealth is accumulated to the end of the projection period.

Assumptions
Quarterly projection for twenty years. $100,000,000 starting assets in par bonds. Level 7.5% interest rate.

Two default scenarios were tested:
- 2% per year, constant
- 4% per year, constant

Three diversification rules were tested:
- $1 Million per bond (start with 100 bonds)
- $5 Million per bond (start with 20 bonds)
- $10 Million per bond (start with 10 bonds)

Salvage value upon default was 40% of par.

100 Monte Carlo samples were run for each of the six combinations of default scenario and diversification rule.

All bonds were five-year maturities. This wasn't material since the interest rate is constant.

Conclusions
Sample variance of the portfolio's default experience causes significant scattering of results away from the mean.

Diversification measurably reduces uncertainty of final wealth.

The distributions do not appear to be symmetric.

Diversification seems to reduce loss tail more than it reduces gain tail.

Knowledge of the distribution of final wealth permits estimation of starting surplus needed to assure a given probability of solvency at the end, given a target dollar amount of final wealth.

Enhancements Being Tested to Study C-1 Risk
User-specified initial asset portfolios, with arbitrary number of bonds, par per bond, coupons, maturity dates, etc. Flexible reinvestment strategies.

Life insurance liabilities, with recurring premiums and other liability cash flow, in addition to the asset side, to model C-1 risk exposure of complete product line balance sheets.

Scenarios of default rates which vary by year to represent different future economic environments.

Different mixes of asset quality groups with differing default rates.

Analysis of risk charges, and reserve and surplus requirements for the C-1 risk.

Reexamination of the MSVR.

Combination of C-1 and C-3 cash flow effects in multirisk scenario projections, to stochastically model the complete investment risk picture.