RECORD, Volume 23, No. 3*

Washington Annual Meeting
October 26–29, 1997

Session 119CS
Case Study for Establishing an Optimal Investment Strategy

Track: Investment
Key words: Investments

Moderator: GREGORY J. ROEMELT
Panelists: TIMOTHY BURTON†
MICHAEL SAMOUCE‡
J. LARRY WHITE§

Summary: Techniques for analyzing and developing investment strategies based on the mathematical approach of linear programming are presented.

Mr. Gregory J. Roemelt: I'm an actuary at Zurich Kemper Life in Long Grove, Illinois. We have three gentlemen from Applied Quantitative Solutions (AQS). They are going to be discussing a methodology for developing investment strategies based on linear optimization models. Tim Burton is the chief marketing officer of AQS. He has a life insurance background and has worked as a registered investment advisor and sold securities for about seven years. Tim will go through an introduction and look at current practices in asset/liability management (ALM). He will be followed by Mike Samouce. Mike is the managing director and founder of AQS. He has worked in the fixed-income industry with an insurance specialization since about 1984. He will set up our case study and give us a preliminary evaluation. Finally, Larry White is the director of product development. Larry has a B.S. in Mechanical Engineering. He will take us through the case

---

†Mr. Burton, not a member of the sponsoring organizations, is Chief Marketing Officer of AQS, LLC, in Austin, TX.

‡Mr. Samouce, not a member of the sponsoring organizations, is Managing Director of AQS, LLC in Austin, TX.

§Mr. White, not a member of the sponsoring organizations, is Vice President of AQS, LLC in Austin, TX.

study and through the model for a look at the methodology for developing the investment strategy.

Mr. Timothy Burton: I'm going to break this up into three distinct parts. I will start with some of the existing ALM techniques that are being used. I'll discuss some of the techniques in this particular case study, and how we have developed some of those techniques into the technology that you are going to see. Then, Mike will then walk through a preliminary evaluation that we did for this specific client in the case study. Then, Larry, once again, will set up the case study for us.

Let's start with the ALM process. I'd like to tell you how we were brought in on this case. We were at an A.M. Best meeting acting as a consultant. Three of us were seated at the table with the A.M. Best group. The actuary walked in and introduced himself to everybody. Then he looked down at the other end of the table and introduced himself to the chief investment officer (CIO) of his company whom he had never met before. We thought that was not a good ALM strategy, and A.M. Best did not find that humorous. The point here is that ALM communications between the asset side and the liability side of your businesses do not occur enough. Second, cash-flow testing is an integral part of the ALM process. It's the driving force for today's case study. Cash-flow testing is your once-a-year guaranteed communication between the asset side and the liability side. We want to make a point in the case study that cash-flow testing is not ALM.

Liability development. The liability cash flows that you will see are an integral part of today's case study. There's PTS Chalke and Tillinghast, as other proprietary systems out there. Those are the liability engines that we're able to work with right now. Covering liabilities with assets is another part of the process. Our thought here is if ALM is the management and measurement of your company's interest rate risk, are you taking a proactive or reactive approach to the problem? What systems do you have in place to deal with effective ALM?

Now I'd like to cover existing practices. There is speculation in forecasting versus risk management; immunization; cash-flow matching; duration matching; key-rate duration matching; efficient frontier analysis; and total return optimization.

First there was speculation in forecasting versus risk management. We're defining speculation as any strategy that is dependant on a particular outcome. Risk management is any strategy that assumes a range of outcomes and seeks to constrain and optimize regardless of the specific outcome. Investment strategies that are part of an ALM program should not be speculative.

There is economic forecasting and speculation. Speculation requires accurate forecasting. A passive strategy of buy and hold may not be robust enough. Here is the *Financial Accounting Standard (FAS) 115* regulation: "An asset cannot be designated as held to maturity unless the asset, viewed in the context of the firm's overall asset/liability match, can, in fact, be held to maturity." Our thought is that a buy-and-hold strategy might not be robust enough in today's marketplace. An active strategy of total return means basically chasing yields. You're giving your investment decision makers the right to move forward and say, "Find me the best yield. Find me the best total return." Many of those managers are evaluated against an arbitrary benchmark—benchmarks are trying to be achieved sometimes with no regard to the liability side of the business.

Let's move on to immunization. We're defining this as the duration of the assets being equal to the duration of the liabilities with the present value of the assets greater than the present value of the liabilities. Dispersion of the assets is greater than the dispersion of the liabilities. Dispersion is defined as the variance of cash flows around the duration date of a bond. Immunization is still duration matching. The concept of immunization and duration matching was developed before we had the computer power available to tumble large amounts of cash flows. That's really the basis of today's case study. We're going to be looking at tumbling large amounts of cash flows and matching those cash flows in a new strategy that varies from immunization to duration matching. Immunization is highly dependant on cash flows. If you're already dealing with cash flows, why not create a solution that deals exclusively with them?

Let's go to cash-flow matching. We believe cash-flow matching is an effective part of the ALM process. When we use the liability cash flows as a constraint, we move closer to an optimal portfolio mix. Cash-flow matching also implies that you can create a minimum cost solution to fund a specific set of liabilities, and a cash-flow match portfolio can be actively managed, which is an advantage. There is a shortfall in cash-flow matching, and Larry is going to touch on this a little more in the case study. When you optimize a portfolio to the cash-flow match, you don't necessarily improve market surplus or your capital position. Those are some of the stated goals that we're going to look at today in the case study: How do we improve our surplus development? How do we get to a minimum cost cash-flow match solution?

Duration matching is one of the most popular forms of ALM today, obviously, because of its simplicity. It is a form of immunization. Once again, I go back to the fact that it's dependant on cash-flow generation. A real important point here is it's applicable to only option-free bonds, which are bonds that don't have call features in them. Much of the modeling that we do of securities includes call features, and

those are really difficult to duration match. The estimates are good only for small yield changes. That speaks to Thomas Ho and the key-rate duration theory that he has put together. Possible residual risk is created with duration matching. I want to define residual risk here. If an asset pays other than at the time the funds are needed to pay a liability, there is a risk that the funds may either have to be reinvested at a lower rate or sold at a loss. This is clearly a suboptimal approach to ALM.

Let's discuss linear programming versus simulation. I think everybody is familiar with the Markowitz theory of the efficient frontier. Most ALM models are a form of simulation. There can be erratic and suboptimal paths like that from a mean variant sampling technique. Our concept comes from Elton and Groover out of the *Journal of Banking and Finance*. They made a statement that for specific liability cash flows, the efficient frontier reduces to a single point. If we're running all these simulations and we're creating the efficient frontier, what is the real time in today's marketplace? Can we reach the best point on the efficient frontier and find an optimal solution with a zero residual risk? We think that those best results can come from linear programming. Larry is going to be discussing that.

Next is total returns optimization. Total returns optimization is closer to a goal of an optimal portfolio. It's important to note that this method is highly dependant on the creation of accurate market-value-pricing matrices. Since such pricing involves significant event risk, the implications that liabilities will always be funded becomes a function of increased residual risk. Nonetheless, total return optimization does deal with the complexities of portfolio management for a complex organization. It implies that liabilities can always be funded under any of the scenarios that you run.

The *Handbook of Fixed Income Securities*, fourth edition, has a wish list for portfolio management, and this is what the handbook says: "Explicitly specify risk/return preferences and build them into the portfolio. Never transact unless there is an opportunity to improve the risk/return profile of the portfolio. [Let's be transaction adverse.] Always fund the liabilities in any specified economic scenario. Most importantly, achieve long-run return objectives within the chosen risk and transaction tolerances."

Mike was instrumental in this preliminary evaluation of the case study. We've done two parts for the client—a preliminary evaluation and a full total optimization.

Mr. Michael Samouce: I will set up the case study for this particular client. You have to really study the client. Look at the situation the client is in now. From that, come up with the optimization. I'm going to introduce a line of business, go over

the preliminary evaluation, and then Larry is going to go into the full-scale optimization model.

We'll look at the portfolio structure and composition they currently have for this line of business and at any relevant financial indices such as duration, convexity, and what's in the portfolio. We will then look at the liabilities created by their actuarial staff, like cash-flow mismatch, surplus development, and various interest-rate scenarios.

Let's discuss a particular client that currently has 65% of their portfolio in marketable corporates, 20% in marketable mortgages, and 15% in private placement, which we consider very illiquid. Their duration is 3.64 years with a negative convexity of –0.05%.

Chart 1 is directly from the client. This is their liability development under the New York Seven interest-rate scenario. We took this right from their actuarial memorandum. It's our starting point.

CHART 1
LIABILITY CASH FLOWS—NEW YORK SEVEN SCENARIOS

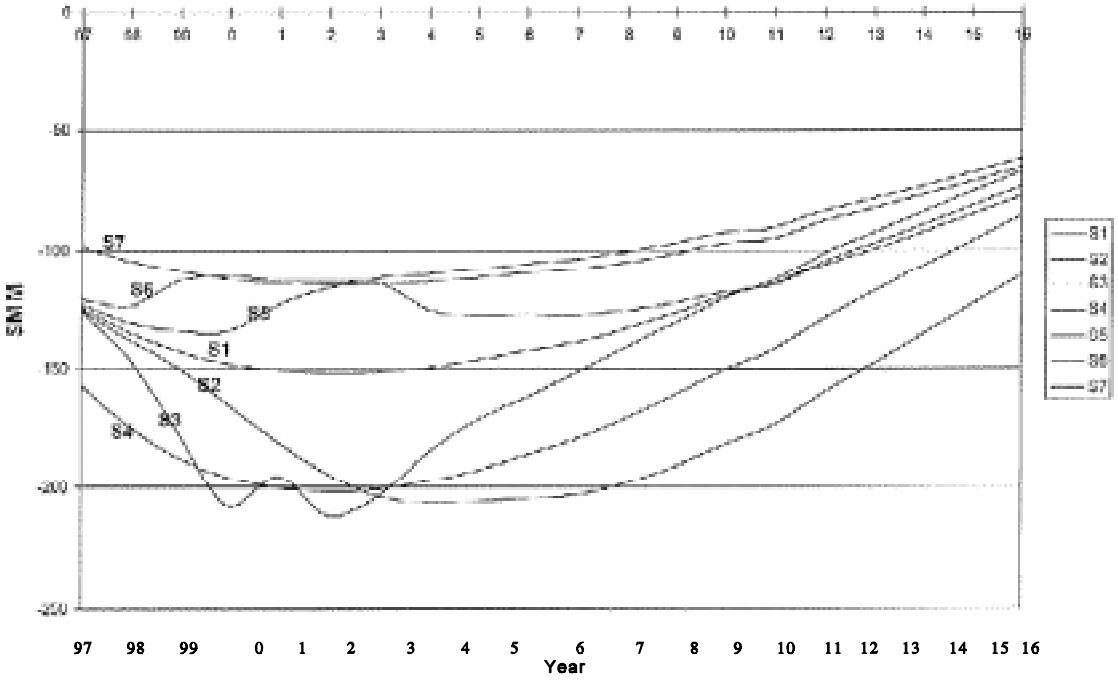
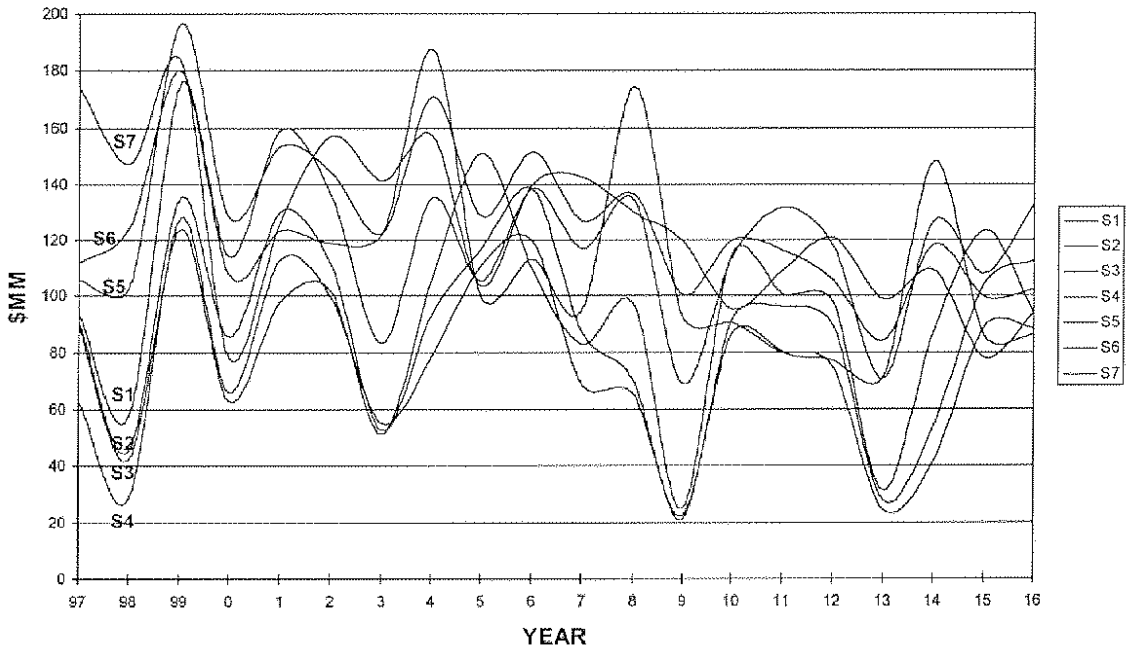


Chart 2 shows the cash-flow mismatch. You can see what's significant about this—by 1999 there is a $200 million mismatch.

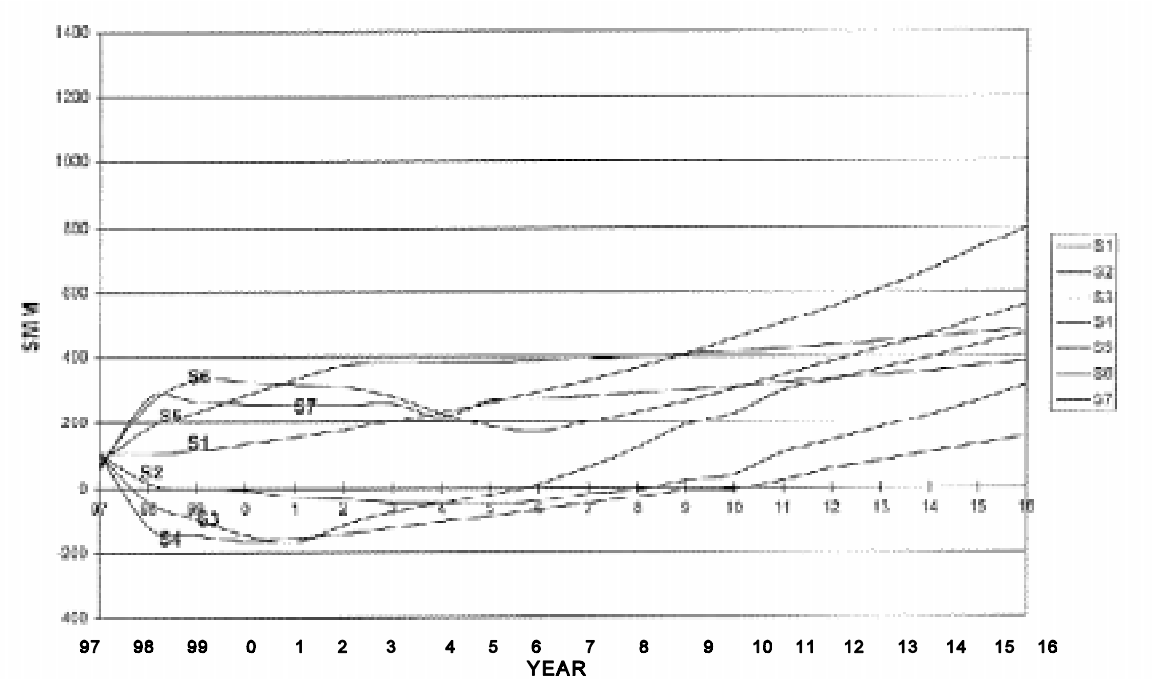
CHART 2
INITIAL CASH FLOW MISMATCH—NEW YORK SEVEN SCENARIOS



We define a cash-flow mismatch as the original portfolio annual interest plus the original portfolio maturing principal minus all annual liabilities. Then we add in the reinvestment of principal and interest. In this reinvestment assumption that this particular client uses, we define excess cash flow as original portfolio interest plus maturing principal minus any liabilities. In this client's case, their reinvestment assumption was a mixture of corporates and mortgage securities.

Chart 3 illustrates surplus development. This is based on their assets minus their liabilities and the surplus over the next 20 years under the New York Seven scenario. There are two important points I want to make about this chart. If you look at these 3 up scenarios, you'll see that this client goes negative in surplus and stays negative in 2 of the scenarios out 10–14 years, so they fail the test. Not many firms would pass this test with those up scenarios. Another significant point is 20 years from now, their surplus development has a low of about $180 million to a high of $800 million. There is a big spread depending on what's going to happen with the interest rate scenarios. That's how they look now.

CHART 3
INITIAL SURPLUS DEVELOPMENT—NEW YORK SCENARIOS



We looked at the surplus development up to this point. Then we started a Treasury curve, which we do with all the clients. The reason we use the Treasury curve is if we can solve or make optimization of their surplus or whatever goal we choose for them better using a Treasury, then we know further optimization is warranted. We also looked at some constraints and reinvestment assumptions. Then we ran a series minimum cost solutions. I'll talk about the results and interpretations.

What about the New York Seven interest-rate scenarios? I would bet that quite a few of you are familiar with them. We use the New York Seven, but we are not limited to using them. We can use any scenario we want with as many paths as you actuaries can dream up. Chart 4 shows a graphical depiction of the New York Seven. We use it because it's more or less universal.

What are the constraints of this client cash-flow mismatch? We didn't want it to be negative; it should be greater than or equal to zero. The maximum investment was variable to this particular account. We kept cash at less than 1%, which is the minimum cost to fund the liabilities. There was this terminal liability in year 20 for this point.

Let’s go back to the reinvestment assumption. Rather than using their corporates and mortgages, we went extremely conservative and used a reinvestment assumption of 50% in a 5-year Treasury and 50% in the 10-year Treasury.

CHART 4
INTEREST RATE SCENARIOS: NEW YORK SEVEN

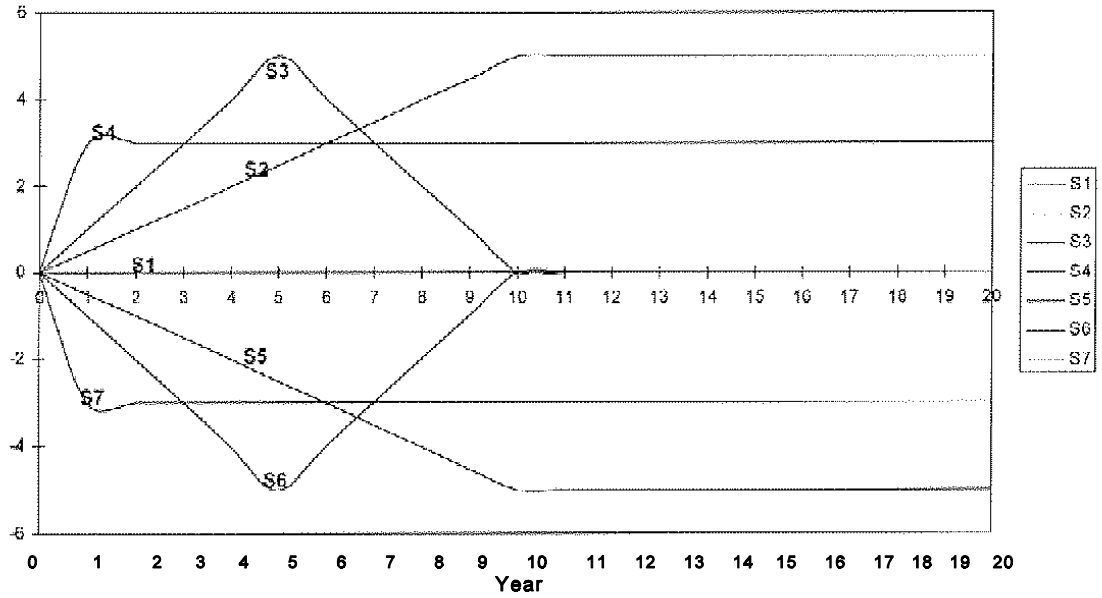


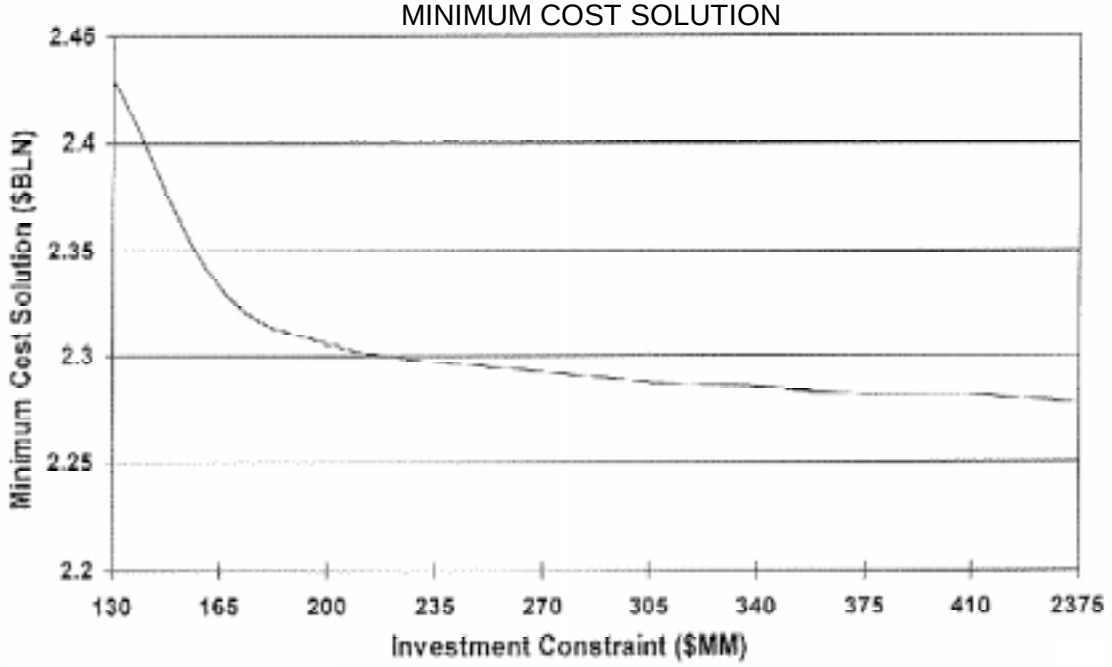
Chart 5 is an extremely interesting graph. This client wanted to know what the minimum cost solution was to match their liability. In doing so, you go all the way over to the right. We ran this model totally unconstrained, meaning the solver picked any amount and any given maturity to achieve this minimum cost solution. The solver loves putting all the money, some $2 billion, in one security. That's great, but that's not prudent. There are not too many accounts out there with one security that can cover the liability. You constrain the model, and if you move to the left, you'll notice that the minimum cost solution goes up, but do we have a convergence between $180 and $200 million where we diversified the portfolio and still attained a minimum cost solution without putting it all into one security?

The cost solution is minimum at the least constrained investment, and the cost solution is maximum at the most constrained investment. The greatest rate of change for this client was between $165 million and $200 million. This assumes one thing, which is that liabilities are 100% accurate. Since we are not 100% accurate when predicting liabilities, this tells us that we do have to diversify, and we have to constrain it in the amount for each one. I set the case study up for this particular client up to this point. We've run a minimum cost solution. We've seen how their surplus looks, and now we can optimize.

Mr. J. Larry White: Most of the portfolios that we have looked at have been interest-rate-sensitive, liability-type portfolios. However, we have noticed similarly robust results with any type of liabilities. That is because there is a great deal of interest rate risk in the asset side of the portfolio already. Because Wall Street seems

to have a knack for creating hot buttons for portfolio managers, and the hot button has been yield and duration, this gives rise to the securities. My favorite is a Fannie Mae that was issued about 6 months ago that was an 8% coupon, 15-year maturity, and callable in 3 months. The yield is substantial. The price is great and it's par. There is no book-value problem. You can account for it. What does that do for the ALM problem? What does that do with the cash-flow mismatch? If you assume a refunding premium of about 25 basis points, that bond is imminently callable. My whole point is that this was an annuity line of business that we began with. You can tell that somewhat from the liabilities. But because of the embedded call risk and the residual risk that's inherent on the asset side of the portfolio, we find that such an optimization works for even interest-rate insensitive liabilities simply because there is so much residual risk built into the asset side of the portfolio.

CHART 5
MINIMUM COST SOLUTION



From the Floor: When you showed the risk and return graph, is it asset return or is it a surplus asset return? I just need some clarification.

Mr. White: The question regards the efficient frontier portfolio and whether the efficient frontier is asset-only or surplus.

From the Floor: Is that the return on the asset or is that the return on the surplus?

Mr. White: Good question. The y-axis shows the main return or the average of return, and the x-axis shows the standard deviation. In other words, we are plotting risk versus return, which is on the asset side of the portfolio. That's consistent with Markowitz's theory. Something we run into frequently is people saying, "We're performing ALM on the basis of the efficient frontier theory. There's nothing wrong with that. That says that we don't want to buy junk bonds, but we'll buy just slightly better credit quality, and we'll achieve a yield so that we can sleep at night." The problem is that even if you do an efficient frontier plot for any number of simulations and achieve this horizon where this efficient frontier exists, the efficient frontier reduces to a single point if you have specific liabilities. That efficient frontier is a line. A line is made up of an infinite number of points and because each one of those points is unique, the question you come to—after you've done about 200 simulations—is, did we achieve an optimal solution or is our computer just tired and our people eager to go home? Second, are we really matching liabilities which may or may not be interest-rate sensitive? While we see the efficient frontier as something that needs to be addressed, on a quantitative basis (i.e., matching asset/liability cash flows), we think that it still has its shortcomings. What's most important is that when we deal with simulation, we still have not achieved a straightforward methodology for achieving an optimum. We've simply determined that we have a solution that is better than the others.

From the Floor: I noticed your reinvestment assumptions are in fives and tens and your duration is 3.64. I was wondering how that fits into maintaining a duration neutral strategy. Also, fives and tens are going to give you, on the margin, a greater duration than 3.64, especially in Treasuries. Those cash flows that you are reinvesting—mortgage back prepayments or maturities—are going to be different from investment income as far as the effect that they have on the write-down and duration of your current portfolio. I'm just wondering where those cash flows are coming from. If you have a dynamic strategy for investing in fives and tens, what proportion do you use, and is that going to create a greater duration for your existing portfolio? That's number one.

I am a portfolio manager at Northwestern Mutual Life (NML). All this modeling is great and we assume that we can go out and buy cookie-cutter corporates and strong triple Bs, and then get the spread off an index like Bloomberg. When you go out and try to find those things, the banks gobble them up. You're then stuck investing in what you would call a suboptimal mortgage-backed or something with negative convexity because that's really the only thing that's going to give you the duration. Could you address why availability in the market for these assets is a constraint?

Mr. White: The first idea that I would like to discuss is the concept of duration. After we performed our analysis and our optimization, we simply backed into the duration numbers just to give everyone a feel for how it stacked up. We don't really care about duration, convexity, or key-rate duration. All these things are great thumbnail sketches of the dynamics embedded in a line of business. The problem is that it has been in use for 40 years. We were using duration matching and immunization back when all we had were slide rules and abacuses to do our work. Now we are taking incredibly dynamic portfolios, and we're trying to boil them down to one number that represents the sum total of all our knowledge of the portfolio. The duration that we calculate is the duration of the initial portfolio, not the reinvestment securities in tandem. We took the duration of the client's portfolio as it exists today, which is 3.6 years, and we did not take the reinvestment securities into account when we calculated that duration. Later I will discuss how the duration was extended from about six months to a year.

The second question was, how do you actually do this optimization and come up with these securities that you want to buy? How do you do this in a fashion that allows you to implement?

From the Floor: Right. There are all these assumptions you make about what you can reinvest in. Now you're talking about Treasuries, which, to me, would be a suboptimal investment, given that we're crediting something by 40 basis points over the Treasury. I will say that duration matching isn't the be-all-and-end-all strategy. I'd say it's necessary, but not sufficient. We do look very closely at our cash flow, especially for payout annuities. To the extent that we can model what's going to happen, we look at single premium deferred annuities (SPDAs), the projected cash flows and the contributions to the bottom line. But as far as what we can actually invest in, we have a negative convex portfolio and an extremely positive convex liability. To the extent that you're paid enough premium for the prepayment risk, you might feel that it is enough to take that extra risk. That is what comes out in your analysis, or it should. Negative convexity is fine if you're paying enough for it. That's hard to quantify without the sufficient frontier methodology. All the models that are used on the street are revamped every three or four years because they don't reflect reality, especially when things other than interest rates affect prepayments. I'm talking about the mortgage side. There's a lot of practical frustration.

Mr. White: I traded fixed incomes for 12 years. You are absolutely correct. Probably the biggest problem I saw in the prepayment modeling was in 1993 when we had new issue securities that were trading at 1,200 policyholder surplus accounts (PSA), but the real company persistency rater (CPR) was only about 0.2%, so the real money coming in to prepay the securities was very low. Because of the

ramp upward on the PSA/CPR conversion curve, you ran into half-year securities. If rates had even stayed the same, the true CPR would have slowed down because it's all in the ramp. You make a good point. How do you optimize if the modeling techniques—the cash-flow modeling techniques in particular—are so highly suspect? I think what you're going to be surprised to find out is that when we get into full-scale optimization, our solver hates mortgage securities and embedded calls in any way, shape or form. What I think that has created is something that I have realized for about the last half dozen years. Portfolio managers are chasing yield and duration, because those are the benchmarks that we all understand and we can explain them. Wall Street can create securities that achieve this yield and this duration benchmark. At the same time, they have so many embedded calls in them that they, in terms of structure, are highly deficient. We have liabilities, but even though we may not have 100% confidence in these liabilities, they are fairly well-structured, and we are confident in how they perform in any given scenario. Wall Street revamped some of its prepayment models. We can run the optimization piece of our actual analysis in seconds. That's more a function of one of your programming techniques than it is anything else. We can generate the cash-flow, path-dependant Seven scenarios (about 1,000 securities) in about 2 hours. If we see a new deal come out and we have to model it and run through all these hoops before we decide we can buy it, we may miss it. As a fixed-income trader, that is what I always impress upon a portfolio manager. If you don't act right now, it's going to be gone, but it will be back. If they blew it out in three hours, they'll price another one and it will be priced just like it.

In terms of the reinvestment assumption that you asked about, we had dumbed that down somewhat because we wanted to see the true performance of the portfolio optimization. We didn't want to take any credit for a reinvestment assumption that we might not be able to implement. This particular client had a rather sophisticated reinvestment routine that wasn't anywhere near what they were actually doing. If we're performing a cash-flow test for the sake of performing a cash-flow test, that's one thing. However, we might want to turn it into a tool that we can actually take to the portfolio manager and say, "Here is a road map. If you follow this step by step, both in structure and in spread, you will achieve these results." Then it is actually something that we can use. We assumed that the reinvestment routine, in the form of treasuries, was easily implementable and conservative in terms of yield. When you see the results that it generated on its own, and the fact that we were able to improve it with the client's reinvestment assumption by about another 15%, I think you'll see what we're talking about on the reinvestment assumption.

From the Floor: My question is about theory. I believe Tim referred to either a theory or an author when he talked about residual risk optimal solution.

Mr. Burton: That's Markowitz.

Mr. R. Thomas Herget: You gave a wish list for portfolio management. Could you elaborate on number three—always fund liabilities in any specified economic scenario?

Mr. White: This was taken verbatim from the *Handbook of Fixed Income Securities*. What they were alluding to was that the duration match is not necessarily a cash-flow match. Immunization, which implies dispersion of asset cash flows around some duration, comes closer to a cash-flow match. What we have embedded in our thinking and in our solver technology is that there are two issues at hand. In total return optimization, we underscore the fact that it implies that liabilities are always funded. The reason for the implication is that total return optimization has a great deal to do with forward pricing matrices. Our collateralized mortgage obligation (CMO) packed bonds that are priced 60 basis points over today's corresponding Treasury will be priced at that spread tomorrow. If you choose option-adjusted spread (OAS), are they going to be priced on that OAS? That is not robust in the volatile markets that we trade in. Case in point, in 1993, right after Orange County imploded, there was a great rush to liquidate anything that looked or smelled like a derivative security. Many CMOs were classified as derivative securities by a number of these clients, so there was a huge rush to sell all these assets. The spreads widened out dramatically, and that's the kind of event risk that we think is a shortcoming of total return optimization because we're looking at a very accurate pricing matrix.

In response to the second part of your question, we recognize that there are deficiencies in pricing. I've priced many portfolios on a monthly basis and, trust me, there are many deficiencies in it. We have developed separately the technology to generate asset cash flows. In other words, will these CMOs pay like this? Will these agency or corporate securities be called given this scenario? If that is developed separately from the pricing matrix that's involved in total return optimization, and if you take the cash flows and call for a cash-flow match as a constraint in your optimization, then you are actually handling the cash-flow matching problem separately from the total return problem, which is one that is involved primarily in pricing, so it's not perfect. That's the true answer to the story. I don't think that given a perfect road map anyone is going to achieve a purely optimal portfolio. AFS, hold-to-maturity, and book value considerations all contribute to suboptimality. If we're not to rely on one side of the modeling problem or the other, then we should feel that, on average, it should work out.

Ms. Cynthia Conrad Morrison: My question is about Chart 5. Could you explain that a bit more?

Mr. White: She's the first one that has been brave enough to say she didn't understand that.

Ms. Morrison: I want to know why I should be focusing on this greatest rate of change between 165 and 200.

Mr. White: The minimum cost solution implies that for a given amount of money, you can also solve for a maximum surplus or a maximum result solution. It's kind of a dual problem. Let's look at the far right-hand side of the chart. Mike said that our solver was unconstrained. That is, of the 20 Treasury securities that we picked across the yield curve, the computer could pick any security that it liked. It picked the shortest maturity and threw all the money in there and that generated the highest terminal surplus for this particular stream of liabilities.

On the left side of Chart 5, you'll notice that it begins to head up rather quickly. What we have on the far right side of the chart is what could be considered a global minimum. It is truly the minimal solution to fund those liabilities. Now that does not imply fiduciary responsibility. It assumes that the liabilities are perfect. If the liabilities are not perfect, then what do we need to do to hedge or diversify against that? We need to buy some other securities. We need to diversify across the yield curve. How do we force a computer, which assumes liabilities are perfect, to diversify across the yield curve? We tell the computer that it can't put everything in one maturity, but the computer wants to know how much it can put into one maturity. You might say, 410, 305, or 235. If you plot each of those particular investment constraints, you'll notice that you have an acceleration in the curve. We know that any time a curve has a great rate of change, it's first derivative is accelerated. That's significant. It's significant in engineering, it's significant in mathematics, and it's significant everywhere.

What does this tell us? We had to ponder that for about a week to figure it out. It told us we wanted a minimum cost solution, but not at the cost of fiduciary responsibility. Where can we achieve a minimum cost solution or a local minimum cost solution that will achieve some sort of diversification? The significance of the acceleration of this chart is that if we constrain investment in any given maturity to about $165–200 million for this particular line of business, we still achieve a local minimum or something very close to the minimum cost solution. We were able to buy securities out as far as ten years in this particular case. What can be taken to this particular client is that with a Treasury solution, we are funding this line of business for less money than you can fund this line of business with given the corporates and mortgages that you are buying.

It also tells us that the portfolio is in need of structure because the portfolio yields more than the Treasuries do. That makes sense, but it doesn't have the same structure as the Treasuries. When we had the conversation with the people, the question came back (and it always does when we have this call with the client), "You mean we've been buying all these callable securities, and we could have outperformed with treasuries?" The answer was, "Yes, that's true, given your own cash-flow test, your own reinvestment assumptions, or your own liabilities." They said, "What have we been missing here?" And they got into my little speech about buying structure versus yield and duration, which you've already heard and I won't repeat. But the whole point and I hope the concise answer to the question, is that the minimum cost solution is, by its implication, a way to determine whether or not further optimization is warranted. Treasury securities are used and are fundamentally model-error free. These are coupons and they are not strips. This brings up another analysis that we had done some time ago where we optimized with strips and we optimized with notes trying to achieve a minimum cost solution. We had liabilities coming due precisely on U.S. Treasury strip maturity dates, and we were still able to achieve a better minimum cost solution with notes than with strips. Take that back to some of the classes, work out the numbers yourselves and you'll see the same thing. Sometimes actual practice boggles the theory of it.

Mr. Jeffrey L. Johnson: Regarding the practicality of implementation, I think you had said that the actual investment strategy they were pursuing was different from what they were putting into their scenario testing. The reinvestment strategy. I guess the question that came to my mind was that maybe as part of a case study looks at what he or she has been doing compared to what you were saying they can do in optimization. What do you bring to their actual investment strategy that they are pursuing? This case study seems to be set up around the Efficient Operating Margin (EOM) testing. Is that the real basis for the conversation?

Mr. White: No. We began with the point that the liabilities are specific to the client. That's probably the limit of the input of the cash-flow test to the optimization. However, the back half of our implementation is that there are a number of optimal solutions in the marketplace today. We have an optimum. They have an optimum. In Microsoft Excel, there is an optimizer or solver. I don't recommend it, but it's there. The whole point is that if you have an optimal solution that you can't put into terms that the people who run the numbers every day can use to make an apples-to-apples comparison, then what good is it? That's probably the key to what we're talking about here. If we generate what we know to be an optimal solution, we only know it because we have internalized some of the numbers. We have done them so many times that we know how they work. The real trick is twofold. First, we need to put it in terms that are consistent with your own internal evaluation and modeling. Second, we need to produce results so that

a portfolio manager can actually look at the quantitative issues and say, "I need to focus on this, this, and this. If I can achieve this, then fine."

We were talking about prepayment modeling every three or four years. However, techniques change. We recommend that this be done at least quarterly. When you have a great deal of volatility like we've had over the last couple of days, our phone starts ringing and people start saying, "We want to reexamine this to see if anything has changed substantially." Fortunately, once it's modeled and it's in the system, it's easy to run the reoptimization. We expect to be able to do this daily. You're not going to like seeing that much paper, but it can be done daily.

What about the full-scale model and its optimization? The first thing I'm going to do is introduce the securities universe that we dealt with, the constraints that we employed, the reinvestment assumption that we applied, the results that we achieved, and how we have implemented such results. The securities universe comes from two places. One is the client portfolio, and the thinking there is that if you already own it, it's much easier to have that security around than it is to go out and buy one that looks just like it.

That brings up another topic that one of our clients raised. We have a number of portfolios dedicated to different lines of business. Could we apply that as a securities universe? If you see greater application for this security with this line of business, couldn't we transfer it over? We never really thought about that. In terms of segmenting assets, it's a great way to go about it because you might already have the securities in one portfolio or another. That leads into being transaction adverse. There is no transaction involved if you transfer securities from one portfolio to another, so the client portfolio represents a good piece of what we do. The amount that we add to our universe is a function of what the client wants to see, and what their investment parameters were. When we set up this optimization, we go to the client's investment policy, and we look at the portfolio that they have had to date. How many do you buy of this? How many do you buy of that? What are your practical limitations in terms of mortgage securities and/or private placements? If left unconstrained, we will generally take the less liquid securities such as commercial mortgages and private placements and cause the model's solving routine not to move them. The reason for that, in the case of private placements and, to a lesser extent, commercial mortgages, is it's very difficult to price. If you have pricing uncertainty, then it's definitely going to be something that may obscure some of the results. Furthermore, if the structure is there, the solver likes the structure, and it's cheaper than anything else, meaning it yields more, then clearly the solver is going to say, "Go buy some of those." However, they might not be available in the market. It's a somewhat illiquid market that we don't like to constrain our portfolio managers with. They cannot go out and find ABC private

placement and snap it up when it comes in two years from now because it's simply a liquidity issue.

The street representation that we pick up involves Treasury notes, Treasury strips, agency notes, mortgage collateral instruments such as Federal National Mortgage Association (FNMA) obligations and CMOs. We pick up the agency notes primarily for a call structure that would emulate some of the corporates that are currently on the market. You'll notice that we don't really mention a great deal about corporate securities. We can, but the reason that we don't is that if our solver chooses to pick up a triple A-rated investment credit that has a specified call maturity structure and the portfolio manager decides that on a qualitative basis it is desirable to go to a lower credit rating, that yields more and as such, costs less, then do it. But this is more a method of attribution analysis where we can say, specifically and quantitatively, these are the things that you need. You need this call structure, this coupon, and this price. If you choose to go out and buy a lower quality security (and clearly if it's lower than an agency note, it's a lower quality security), then you can do that. That becomes attributed to the quality risk that you're taking, and it shouldn't be part of the quantitative issue here. Those are the street representations. I think when we got this portfolio to the optimizer, we had about 700 securities cash flowed and ran in about seven scenarios. Like I said earlier, that is the lengthiest piece of our process. It takes a couple of hours to generate the cash flows. We already have the securities and we see those daily and we update that for a universe. However, this is a great place for the portfolio manager to come in and say, "I've been looking at this sector. I want you to include these for consideration." That's easy to do. We can also do it on a particular security basis.

The constraints that we applied to the full-scale optimization were consistent with the minimum cost solution. We wanted a cash-flow mismatch that was greater than or equal to zero. In other words, we didn't want to have to rely on selling a security in order to fund a liability cash flow.

The maximum investment gets back to the minimum cost solution. We didn't want to pile a bunch of money into one or two securities, which tends to happen. We constrained the maximum investment to $15 million in cash. We did not want to accumulate a lot of cash, so we kept that at under 1%. In order to properly do an evaluation like this, we need a terminal liability or a surrender value in year 20. This particular client did not want mortgage exposure greater than 20% of the total portfolio, so that was another constraint that we threw into the mix.

There are other constraints that we can apply; however, you should know immediately that for every constraint that you add, the minimum cost solution goes up. Therefore, the surplus development that you can achieve goes down.

However, if the constraints are viewed as necessary, such as market versus book value constraints, then it's clearly something that we will apply; however, it was not applied in this case.

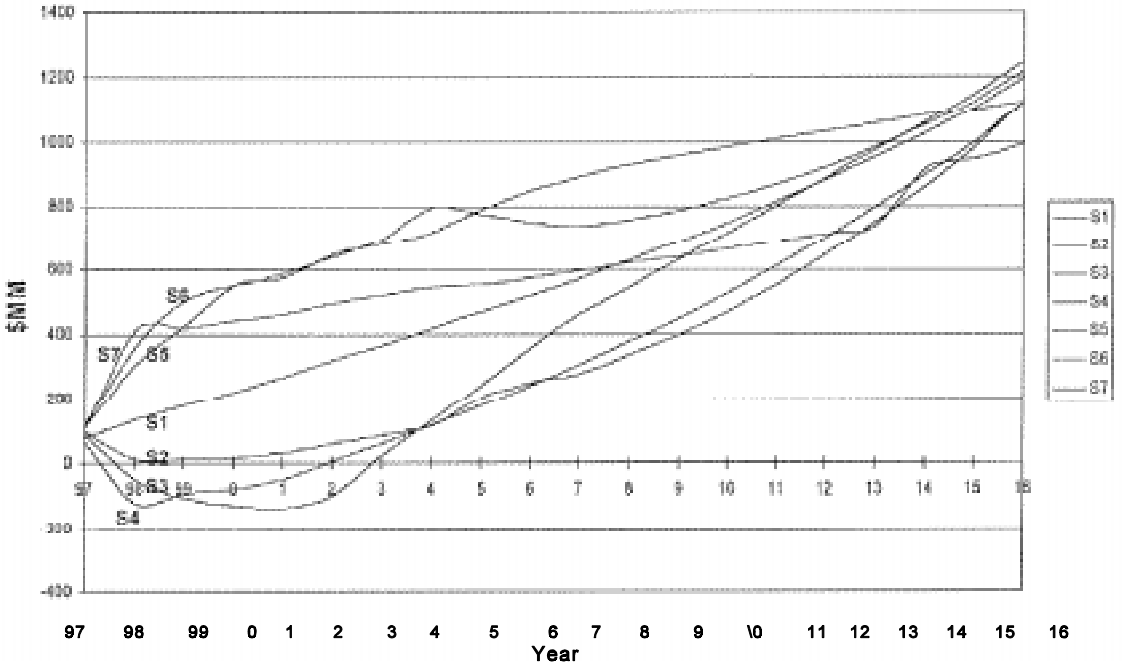
Sometimes we'll see a portfolio that indicates that the client should sell better than half of their total holdings and replace them with something else. While that is optimally desirable, it is not achievable because of authority or government limitations, earnings impact, and book-value impact. We have to constrain the actual transaction limits in some cases. Another constraint is hold-to-maturity versus available for sale. Clearly, we just bound the securities, which must be held to maturity. Risk-based capital (RBC) is another issue that can be added as a constraint, or conversely, as an objective in something like this.

The reinvestment assumption takes the excess cash flow and again reinvests 50% in a 5-year Treasury note and a 10-year Treasury note.

Chart 6 shows the surplus development curve that we generated in our first pass. The significance here is that this is on the same scale as the initial graph. Chart 7 shows a comparison of the two. What needs to be focused on here is how the terminal surplus number in year 20 shows a convergence, and not a divergence, of surplus development. This is different from what the client was initially experiencing. That folds back into the risk management idea that we had discussed a little earlier; that is, for any given outcome, you want to achieve substantially the same results. If you look at the worst case, which was scenario 4 of the New York Seven, which is up 300, our worst case here is better than the client's existing best case. What's also important is that in scenario two, we were negative for about five or ten years initially. We got that to positive. We also got scenarios three and four into positive territory in about half the time that the client did. I hope this goes back to the reinvestment assumption that we were discussing earlier, which is far more conservative than the client was using. Can we apply things other than a five-year and ten-year Treasury? Sure. We can apply anything along the Treasury curve.

Our point is that surplus development should not be a function of reinvestment assumption. It should be a function of having the right portfolio in the first place. What we noticed when we applied the client's reinvestment assumption to these terminal surplus numbers was that they were all increased by about 15%, which was the impact of having some additional yield thrown into it.

CHART 6
PROPOSED SURPLUS DEVELOPMENT—NEW YORK SEVEN SCENARIOS

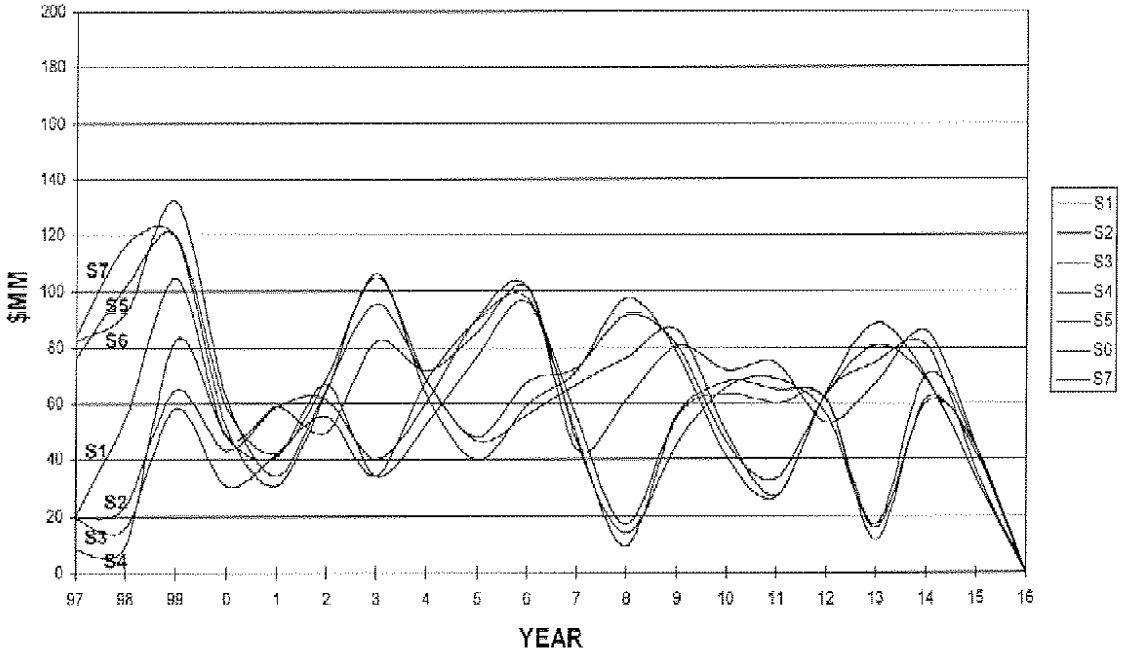


Next let's compare the before and after (before is Chart 3; after is Chart 6). You can see the things I was pointing out. We had negative surplus across the board in scenarios two, three, and four. We also have divergence. The client was experiencing about $800 million in year 20. Our worst case came out to $800 million, and our best case came out to $1.2 billion. Again, this is with a Treasury reinvestment assumption.

Chart 7 is the cash-flow mismatch that was a constraint in our analysis. I hope to make the tie-in to the minimum cost solution here. If you are solving for a minimum cost solution, the cash-flow mismatch becomes an objective, as opposed to simply a constraint. What you'll tend to see is that in one scenario or another there will be absolutely zero cash-flow mismatch. They will be perfectly matched. When we began with surplus, we were going to have cash-flow mismatch. This is the result. The magnitude of the cash-flow mismatch is significant. In the before case, we were up to almost $200 million in 1999. Now we find ourselves down at about $120 million, and that is reducing residual risk.

The next before-and-after graph consists of Chart 2 as before and Chart 7 as after and shows the two again on the same scale where the residual risk was mitigated because of the cash-flow match constraint. That won't happen on every portfolio. It happened to work out very nicely here.

CHART 7
PROPOSED CASH-FLOW MISMATCH—7 SCENARIOS



This is the good part. We had a meeting about two weeks ago. After we showed them all the pictures, the people said, "We can't buy a bunch of CMOs and low-grade corporates." The portfolio composition actually went away from mortgage securities. The portfolio composition before was about 65% of what I'll call bonds—regular old coupon-bearing bonds, Treasuries, agencies, corporates, and some callable versions. Afterward, we had 74% in the more structured securities. Initially, the client had about 20% in marketable mortgages, including one or two commercial mortgages. They were up to their limit thinking that yield was helping them out. When we implemented our optimization, we went away from the negative convex securities like the mortgages. We reduced that exposure to about 10—11%.

As we said earlier, the client had private placements. Again, looking for yield, we constrained that and made no change. That began at 15% and ended at 15%. These are going to be duration matched because we are somewhat cash-flow matched. To do that properly, you would need to take into account the reinvested securities into the future. What we were looking at was the portfolio today versus the optimal one. The duration went from 3.6 years to 4.5 years. We're not exactly sure why the client was this short. We think they felt as if it was helping them in scenarios two, three, and four to possibly fund a large cash-flow mismatch or a large hit to surplus development. That, clearly, was not the answer.

Convexity went from a slight negative to a slight positive. Convexity was simply not an issue in this portfolio. It was structure, which goes back to what I was saying earlier. In our office, we choose not to use terms like duration and convexity. We use it to translate things to clients to help them understand it more, but we don't use the terms because they just don't matter to us. We have brokers call us that want to sell us bonds because we are constantly looking to increase our database. They ask, "Well, what are you looking for?" We say, "We don't know." And we don't. We put the cash flows in, and for any given client, a different security is warranted. More times than not, it is very difficult to say that it needs to have a certain duration and spread. We just don't. We throw many cash flows in the hopper, and what comes out is the optimal solution.

I've mentioned the results in the interpretation. The terminal surplus convergence, regardless of path, is the good thing. Scenario two surplus remains positive. Scenarios three and four achieve positive results in half the time. The terminal surplus range in the initial portfolio had a best case of $800 million, and its worst case was $150 million. The optimal portfolio's best case was $1.2 billion. Its worst case was $1 billion. This is in terminal year 20. The reinvestment assumption is more conservative, i.e., we were using Treasury notes instead of corporates and mortgages. Clearly, if you buy a corporate, you can buy the same cash flow cheaper. It's going to create better results.

So how do you implement this? You have this optimal solution. You can show the craft that you created to the board, and ask, "Do you like that?" They do and say, "Well, do it." The portfolio manager is left wondering what to do. This was a big problem for us. There were 600 or 700 securities in there, so the spreadsheet was substantially larger than the one I created for this presentation.

We showed current and proposed positions and relevant data for the recommended purchase. Recommended new purchases are securities that were picked out of the universe that we offered. We found the solver went to many agency securities. We had put the agency securities, if you recall, into the mix because of their call structure. Our client said, "You mean all of these callable securities we've been buying have been bad?" We said, "No, it's quite the opposite. The right callable security is a great thing, but the wrong one has no impact at best and has bad impact at worst."

We were able to come up with a recommended hit list of securities that you need to buy and or sell, identified by current price, coupon, maturity, spread, duration, convexity, and so on. Suppose a GM security is not available. Maybe Ford has a similar security or maybe Ford is on your recommended list. Or better yet, maybe there is some lower credit quality security out there that has a maturity and call

structure that is very similar. However, you believe that on a qualitative basis it's a buy because it's an improving credit. Clearly, it's going to make sense to buy it if we're using high grade corporates and agencies in our analysis. You find the same structure—plus or minus a 7.5% coupon rate—if that's what happens to be recommended. It doesn't have to be exactly 7.5%. To the extent that the portfolio manager is able to execute these solutions, you are able to achieve closer to the optimal solution.

What is important is that if we're running this on a monthly basis, we simply deploy all the assets that you purchased. Reoptimize all the executions that you've achieved over the last month. It will clearly lean into some of the securities that you did not pick up in that period. That is how we would produce a hit list or a road map.

Let's discuss some considerations and limitations. As I mentioned, I began working with optimization five or six years ago when all we had was a Lotus spreadsheet. Excel was still a bad idea. Actually I calculated accrued interest in Lotus. What we found was that generating results and preparing data was a labor-intensive process. As recently as only a few months ago, we were employing cut-and-paste methods to get our cash flows into a form that would go to the solver in a usable fashion. We figure we had about 56,000 bits of data on one worksheet that needed to be transferred. It took three people two weeks. You end up learning how to do a little C programming after you do that one time. But only by doing these things by hand do you begin to appreciate which are the labor-intensive issues and which are not. Therefore, you find out which way to allocate your programming talent. Do you want to make it graphical and user-friendly before it actually makes sense? No, probably not. We'd like to have the right answer before we have something that is user-friendly.

Access to live capital market information is something that is absolutely relevant. How many people actually sit with the traders? Access to live capital market information is something that is difficult for most of us to acquire. If you only see an old inventory once every week or two, you don't know what's available. If you establish a universe of securities that the street can't produce because the derivative securities that are required to price such a security are not available or they are not priced such that a security like that can be priced, then you are throwing securities in there that hypothetically are a good idea. In practice, it makes no sense if the securities cannot be found in the "live" market.

You also get into hedge issues. This is where some street firms price on an OAS. That's another new buzzword that involves a stochastic path-generation, pricing-type model. The problem is that a trader may buy $5 million worth of a particular

corporate bond, and he or she may sell a five-year Treasury note against it. He thinks, forget OAS and duration matching. I'm going to sell the five year against it and that's how I'll price it. If you have one pricing model, but the traders are pricing the securities in another fashion, then what have you achieved? You have a market that changes, and you think the securities should be priced in a certain way. The trader is only going to sell them if his or her hedge works out right, so you're out of luck.

Processing time limitations are a big issue. We talked to one company that was running simulations. They declared rather proudly that they were doing 200 simulations that were all trial and error. They put about 20 of them each night to run in a batch fashion. It took them about ten days to get the simulations together. They had their efficient frontier, but they still weren't optimal. They had not gone into the elementary row operations necessary to assure optimality. But they had run a lot of simulations.

Another question is, what is optimized and how is it constrained? Again, we must go back to what's commercially available. In an attempt to create a package that is user friendly, and can be shrink-wrapped, many software development companies have to create something that insurance companies, money managers, stock pickers, banks, credit unions, and savings and loans can all use. Clearly, we're not all in the same business. What are we optimizing and does that apply to what we want to do? Our theory from the onset has been that if you can describe mathematically what it is that you'd like to optimize, we can employ it in our code and make it an integral piece of our solution. Surplus is simply used in this case because clearly the client had a surplus development problem.

How is it constrained? Another one that I've seen recently has suggested that you begin your optimization process and gradually add constraints until you have achieved an optimal solution. You don't gradually add constraints. You have to add them all at once because they all matter, and you don't want to have to play with them. About three years ago, I was working with the Excel solver and I thought I had something going. The solver in Excel has a limit of about 600 constraints and about 300 variables. That is not a hard and fast number, but what I found out is when I pushed the solve button, I could get a different answer every time. That's not what we call robust. It's not producing the right answer. Part of that has to do with linear versus quadratic programming. Are you achieving local minima and maxima, or are you achieving global minima and maxima? You have to be careful how you design your program.

Right scenarios. This pertains to binomial and trinomial lattices. What are the rates and how do we want to do this? You generate the rate scenario that you're happiest

with and give us whatever weighting that you're happiest with, and we employ that as a constraint. If these liabilities exist in this interest-rate scenario and are weighted with a 15% confidence level, then we can solve against that.

How are the results presented? Again, it has to be something that's familiar to the people who have to do the implementation, which is why we picked up a cash-flow test and ran with that. We knew that was something that everyone was familiar with to begin with. Let's present our results consistent with that fashion.

Computers make mistakes or the assumptions could be wrong. If you can't verify it, then what good is it? Finally, if it is operationally well defined, then you should be able to hand these rules over to two people with the same background who should be able to implement these results and achieve substantially the same results. What we've focused on the entire time is how we get this information to the portfolio manager and how the portfolio manager can use it to create this optimal solution.

There are some other possible objectives. They are to:

- Maximize surplus
- Minimize residual risk
- Maximize statutory surplus
- Improve reserve efficiency
- Improve reported yield
- Achieve minimum cost cash-flow match
- Improve income
- Improve RBC exposure
- Evaluate new business lines

A minimum cost cash-flow match is a great way to evaluate new lines of business. You begin to look at it not in terms of how much surplus or how much money you can make off it, but the maximum amount of money that you should pay for it. In other words, how much is it going to cost us at a minimum to fund it if it were perfect? It's a good way to look at a new line of business.

From the Floor: A lightbulb went on in my mind as you were going through this presentation. I'd be interested in your experience and perhaps that of the audience as well. The thought that occurred to me is, as valuation actuaries, we are often faced with cash-flow testing to get to the asset adequacy analysis and negative scenarios. We are often limited in what we can do at that point to improve results. It seems to me that there is an opportunity here where you people could be brought in, if those scenarios are identified early enough, and get involved with a proposed restructuring of a client's asset portfolio. I think that would eliminate some of the more troublesome scenarios. Have you been in a situation in which you're not the

asset manager? Would it be a practical possibility, as we get into 1997 activities, to call you in a troublesome situation?

Mr. White: It's like a cavity. If you get to it soon enough, it can be fixed. You'll notice that in this case study in particular where they had negative surplus in 1999, we simply could not do enough to fix that because we didn't have the ability of compounding and forwarding reinvestment to our advantage to fix it. We were able to fix a minor scenario, scenario two, which is up 50 basis points a year. If there is a problem out approximately equal to the duration of the existing portfolio, it has been a rule of thumb that we can begin to have some serious impact. In the case of this client, I think you see that at about the three-year mark or the four-year mark, we began to take the surplus from negative to positive. That's probably a good rule of thumb.

From the Floor: I have a question on your proposed surplus with your reinvestment strategy. Were the liabilities reprojected with this reinvestment strategy? If they were not, and if there is a different strategy, the liability cash flows will change so you will have different cash flows to match.

Mr. White: You mean different like crediting rates where you've already changed those liabilities?

From the Floor: Right.

Mr. White: They were not rerun. What we find is the liability structure changes as a function of portfolio structure changes. What we have found probably 70% or 80% of the time is that with initial optimization applied, even with the new liability cash flows, we're still far better off on a surplus development basis than we were to begin with. The problem that we run into is one of an iterative-type circle where you try this, and then liability cash flows change, which changes the optimal solution. However, what we see in practice is that the optimal portfolio converges on the liability development, such that our first pass is substantially better than the existing portfolio, even with new liability cash flows.

From the Floor: Is the assumption here that you'll be able to invest in assets with similar cash flows to the Treasuries that will support the credited rates that produced the original liability cash flows?

Mr. White: On a reinvestment basis, it was exclusively Treasuries. On an initial basis, we had the universe of agencies, CMOs, private placements, and so forth.

From the Floor: But on the original basis, with Treasuries, your cash flows will change, so I'm wondering if there's any way to retest your proposed portfolio with the new liability cash flows to see if you still have an optimal solution.

Mr. White: This is part of the verification process. This is the part that we're in with this particular client now. OK, we have these wonderful numbers. Now they want to tear into it, apply some different constraints, and look into the restructuring type problem. And to the extent that we need to reoptimize, we can. Again, we don't normally find that's a big issue because the fundamental nature of most of these securities and liabilities is that, if the portfolio gets more speculative in nature, the crediting rate needs to be higher. As we get into better-structured, higher-quality-type securities, there's generally not as much deviation on the liability side. That has been my end of it. Now you're heading over to the liability side of this question, and you're beginning to get a little over my head.

From the Floor: We can go to lower grade corporates and buy some mortgages. If we find that this is a model error or a model bundle that we need to employ to get the credited rate that we want to get, then that's something that we throw into the optimization as a constraint. We can achieve that crediting line because I think that's a humongous constraint.

Based on my view of the mortgage market, mortgages may be rich. You're not getting paid enough for having short convexity. I'm wondering if there is a scenario where mortgage is cheap enough that your model will say, "Those are a pretty good deal." I think you're getting paid enough to have negatively convexed instruments.

Mr. White: That was part of our own verification process. We actually cheapened the cost of some of the mortgage collateral. Suddenly the solver began to pick all of those.

From the Floor: That's refreshing. Taxes are another very important consideration, especially if you're talking about restructuring a current portfolio. Our company is a huge taxpayer, as I'm sure the rest of you are. You probably have a lot of gains in your portfolio because of the bull markets. Any type of rebalancing will imply a tax liability. If you go forward to counter that, you're proposing a less actively managed book, which would imply less tax activity. I'm wondering how much you incorporate taxes into your modeling?

Mr. White: Again, it's a function of the client. There are two ways to handle the tax issue. The tax issue can be handled as a function of a constraint where we can say we want tax impact to be less than a number. We want to apply this rate of taxation. Or what we have seen more success with is, once we apply this

benchmark or this road map to the portfolio, we really leave the portfolio manager alone. We say, "These are the optimal securities that you should purchase, and these are the ones that you should sell." By definition, those have to add up. Then that leaves room for the portfolio manager to be creative on the tax side to say, "If I can buy this one and sell this one individually, there is a tax impact." It's handled that way in much the same fashion that it's currently dealt with.

From the Floor: Last, do you ever consider derivative strategies involving interest-rate derivatives to mitigate some of that negative convexity on mortgages? An example would be caps or put options. I do want to make an editorial comment that Orange County was not a derivatives problem; it was a greed problem where the person was borrowing short and investing long. He could have done it using anything. Derivatives are like a 16-year-old driving a sports car. If your 16-year-old cracks up the sports car, he blames the car.

Mr. White: Your editorial comment is well-received because I was fighting that very same argument all along. The person was borrowing 30 days and investing 30 years. He did happen to have one particular Sally Mae in the portfolio that was a little less than just a bullet bond. The press latched onto that and said it was a "derivative." They looked at the entire transaction as a derivative, and that caused a problem in the derivative market. The answer to your question is, if there are derivative securities or basically any cash flow that you can define and identify in terms of cost, future cash flow, or dollars returned, we don't care what it is. This gets back to how we don't deal in duration or convexity. We don't care about GM or Ford. All we care about is the cost of the cash flow and the performance of the cash flow. If that can be identified, then we can put it in. I will iterate that this is something that, as a natural course of business, we do on portfolios. We originally began with people and said, "You need to look at this. You need to understand it. You need to do this." Then, once we automated the process, as we have now, we simply choose to go to people and say, "Throw out a line of business, and we'll run an analysis and we'll generate the result. If you want to verify it separately, that's fine. If you're interested, we'll talk further." That's a beginning piece. If you like to do such things, please approach us and drop us a card and we'll be happy to work on something like that for you.

From the Floor: I have a quick question on your charts. You had two charts—one was cash-flow mismatch, which was all positive, and the other was a surplus development chart that had negatives for one to ten years or so. With no negatives in your cash-flow mismatch, are those negatives in the surplus caused by expenses or something that I'm missing?

Mr. White: That's a good question. The first time I went through it, it was difficult for me to fathom that. The surplus development is a function of market value of assets minus market value of liability.

From the Floor: So that's a market-value effect?

Mr. White: Yes. That can be done on a statutory basis as well, but market value is more volatile and we thought that was a better representation. The cash-flow mismatch is the cash flow of the liabilities on an annual basis, so they are in two different dimensions.

From the Floor: Are expenses, taxes, and things like that included in the liability cash flows?

Mr. White: Yes, that would be total net liability used. All cash flows are defined by the actuary.

From the Floor: In the systems that you integrate with, the PTS call and the Tillinghast, how do you integrate with other systems? What is required for you to integrate into a system?

Mr. White: It depends. There are so many modules to all of these systems. One of the systems that we use is Bond Edge. We've found that a number of people that use Bond Edge and who interface with Tillinghast and/or PTS save their portfolio and send it to us on a diskette.

From the Floor: Are you basically just entering data into your system?

Mr. White: If it's PTS, it's a function of which module you're using and how you are generating the cash flows. The way we go about our analysis is to take these cash flows and to throw them into our solver. The amount of time required to get from point A to point B is really a function of how quickly we can turn it around. Our interface is 100%, but it's really as much a function of what the utility you're using is doing, as opposed to what it is you need.

From the Floor: I guess I was trying to build ours to suit you. Do you do this type of work with anything other than insurance company liabilities?

Mr. White: We've seen it work with any kind of liability stream out there.

From the Floor: What about pension funds?

Mr. White: Absolutely.

From the Floor: Can I put constraints on it?

Mr. White: You can put as many constraints on it as you want.

From the Floor: Do you actually work with the stock?

Mr. White: Yes, to the extent that you can model a stock accurately. Normally, it is a function of "buy it at this price and hope it goes up." If you choose to consider it a one-year investment with a 10% rate of return, then that is fine. We can tell you that this is how it would be. To the extent that it's going to have a return of 10%, the solver is going to say, "I want all the stocks." To the solver, it looks like a bond with a 10% coupon. How do you get the risk into that equation? That becomes a function of probability distributions, which we'd have to work with you on.

From the Floor: Echoing what the last gentlemen said, I was wondering if there is a natural constraint on being able to sell this type of product. You want it to be competitive. I'd love to go through all the analysis and really dig through it, but I just can't imagine supporting a credited rate that could be competitive; that is investing in predominantly Treasuries or high-grade corporates. In addition, if I take my current portfolio and transform it into such a portfolio, what type of renewal rates will I be able to support? If I can't support something reasonable, I'm going to have lapses.

Mr. White: That question came up in a meeting. What we are suggesting here is the need for more architecture. If we know that the structure of these securities needs to look like this, and if you choose to add crediting rate as a constraint, that can certainly be added. This particular client sees that we need these particular securities, from a structural standpoint, to achieve the optimal.