COORDINATING THE PRODUCT DEVELOPMENT, INVESTMENT AND FINANCIAL REPORTING FUNCTIONS

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o   Developing an investment strategy for new products
o   Inconsistencies between pricing and financial reporting models
o   Total return on the investment portfolio versus total return to the company

MR. MICHAEL R. WINN: We are going to approach this rather broad topic from three separate viewpoints: (1) the viewpoint of the chief officer of a corporate actuarial department at a major New York life insurance company; (2) the viewpoint of a consultant to life and health insurance companies in the areas of product development, financial reporting and investment; and (3) the viewpoint of an individual who is renowned for both his practical and theoretical approaches to risk management.

Our first speaker this afternoon is Sam Goldfinger who is a Vice President and Actuary at New York Life Insurance Company. Sam is also Chief Actuary of New York Life Insurance and Annuity Corporation, a subsidiary company which New York Life formed to sell nonparticipating products. Sam is the chief officer of the corporate actuarial department at New York Life where his responsibilities include determining payable dividends and valuations for individual product lines, including actuarial reserve certifications.

Our second speaker is Jeff Miller. Jeff is a Vice President and Principal of the Tillinghast Division of TPF&C. He has overall responsibilities for the firm's Kansas City office and direct responsibility for life and health consulting in the

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Kansas City unit. Prior to joining Tillinghast in 1983, he practiced as a consulting actuary for six years in two other firms. Jeff's experience in consulting has been rather broad, but his primary areas of expertise have been individual life and health insurance, group health insurance and financial reporting. His clients have included direct companies as well as reinsurance companies, third-party administrators and preferred provider organizations.

Our last speaker is Irwin Vanderhoof who is Senior Vice President at Equitable Life Assurance Company in New York. Prior to joining Equitable's staff, Irwin was Vice President and Actuary for many years at Standard Security. He is a frequent speaker at our programs on a multitude of subjects, and just this past year finished a three-year term on the Board of Governors of the Society.

MR. SOLOMON GOLDFINGER: Communication and coordination among the profit centers and investment and financial reporting areas are necessary elements in the success of most insurance companies. It is useful to begin by contrasting the problems and tasks of five years ago in several areas relating to asset/liability coordination versus the problems and tasks in those areas today.

If the problems of five years ago had to be summed up in one word, that word would be "education." In the area of functional development within a large company, there was a real educational need to understand what different departments did and how they did it. In the area of managing asset portfolios, the job was to understand how to segment asset portfolios and how to proceed in making the transition. In the area of asset/liability models, the need once again was to understand what they were, how they worked and how one might go about developing or obtaining such a model. In terms of reserve certification, the notion that reserves were more than just the sum of a series of rates was just starting to take hold, and it was important to understand how a better certification, of the adequacy of reserves could be achieved. In terms of dealing with top management, the challenge five years ago was to educate and expose them to a new problem that should have been of their concern.

Many different problems face companies today, but many of them can be summed up by the word *communication*. With respect to departmental segmentation, the task is to perform an effective job of sharing information among all the interested departments. In terms of asset portfolios, many companies have already

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implemented segmentation and their challenge now is to use it to their best advantage. In the area of asset/liability models, many large companies have them in place and are faced with the challenge of using them effectively and maintaining up-to-date assumptions. In terms of reserve certification, the task is not so much to understand the concept of cash flow testing for reserve purposes, but to be certain that the consequences of such testing are understood before problems arise. Finally, in dealing with top management, the emphasis has changed from educating them to anticipating their many questions.

What do communication and coordination mean? They can best be defined by looking at the questions that should be asked, and that typically are asked, in a communicative environment. Some questions that might be addressed to the investment department are:

1.   What is the average duration of the assets that were purchased for the universal life segment?

2.   What kinds of assets have been purchased in the last quarter for the deferred annuity line, as opposed to the average duration of the asset portfolio?

3.   What is the prepayment activity on Government National Mortgage Association (GNMA) securities and how does it compare to what was expected six months ago?

4.   What rates are available for different types of maturities? What is the effect of the present yield curve on the rates that are available?

A number of questions that might be directed to profit centers from the investment department include: (1) what instruments would you like us to invest in? (2) do you have different investment preferences for different product lines? (3) are you developing a new product that will require a different investment strategy from that which we are currently following? (4) do you have any short-term liquidity requirements for your lines of business, and if so, what are they? (5) how sensitive are the lapse and surrender rates of your products to changes in interest rates?

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Some questions asked of the corporate actuarial or financial reporting areas might be:

1. What will the level of our reserves be this year-end?

2. What are your thoughts on the pending bond swap?

3. Are there any problems with taking capital gains on fixed income bonds?

4. Are capital gains just extra surplus or are there further implications?

5. If interest rates were to rise, what would be our best strategy, as deter-- mined by our asset/liability cash flow model?

6. Should profit centers chase interest rates and what are the trade-offs involved in doing this?

Finally, questions asked by top management include: (1) are our assets and liabilities matched? (2) which lines of business will have an unanticipated need for surplus some time in the future?

Questions like these will arise if people are concerned about them and if the environment is such that these questions can be asked freely and answered efficiently. To accomplish this, several requirements must be met. First, communication channels must be open and, related to that, questions of turf must be resolved. In some companies there has been a significant battle in overcoming historical culture and barriers. Overcoming these is a necessary prerequisite in the current environment. Second, another requirement is knowing who has the answers to particular questions or problems. This might sound trivial, but in many companies, this is not always clear. For example, who decides exactly what information gets stored on the company's master record system for its assets? Is it the investment department, the controllers depart- ment or the computer department? Another example of this is, who develops the assumptions that are used in pricing or in running models? Is it the profit centers or the corporate department? These questions are sure to surface at some point and it is imperative to know their answers. Third, another require- ment is to learn as much as possible about the jargon used by other areas of the

company. This is very helpful in understanding and conveying information related to various phases of company operations. If this is not possible, at least know whom to contact for an explanation. This helps ensure that all interested parties are talking the same language. The final requirements is intuitive, though very important: try to speak simply and understandably and stay current.

One specific tool that we use to help accomplish this communication is a quarterly asset/liability duration report for the major individual lines of business in our company. This report is composed of several charts that relay information about our assets and liabilities. The first chart gives the Macaulay duration of our asset portfolio for each line of business, for the current quarter and several prior quarters. Another chart shows the duration of assets purchased in the current quarter and in several prior quarters. These charts indicate which assets have been purchased, their effect on the overall portfolio and the extent to which changes in assumptions or experience have affected the composition of the portfolio. The remaining charts deal with dynamic asset/liability information and use asset/liability models to project cash flows under a wide range of interest scenarios. Specifically, the durations of existing assets and liabilities are graphed side-by-side for several interest rate scenarios along with the comparable numbers from the prior report.

What does this report accomplish? Basically, it provides answers and information on many of the questions I've discussed earlier. This report conveys information about assets purchased and changes caused by these purchases. It also provides information to the investment department regarding the timing of liability cash flow extremes under different scenarios. The report shows how changes in experience or assumptions will affect expected cash flow characteristics and it helps the investment department and others understand how lines of business are different in their cash flow dynamics. Another use of this report is to help detect problems in actuarial reserve certification at an early stage. If doing the reserve certification is an involved job, which is not feasible to do every week or every month, this report will give some clues as to the company's position at year end. Finally, this report presents a complicated subject in a simple, understandable and readable form.

What materials are needed to produce this report? Accurate information on company assets is essential. Ideally, the actual assets of each profit center in your company should be tracked closely. An efficient asset/liability cash flow model is also needed, as well as the resources and ongoing communication to produce these reports and keep them up-to-date.

I'd like to briefly discuss the applicability of the concept of Macaulay duration to interest-sensitive products. There are really two meanings of Macaulay duration. One is the purpose for which it was created, as an index of the sensitivity of the market value of assets and liabilities to changes in interest rates. In this context, Macaulay duration is not very useful for these types of products. One can't assume that since assets and liabilities have the same duration under one scenario that their value will continue to be the same as interest rates change. The second way of understanding Macaulay duration is in terms of its formula, as a weighted average of cash flow timings. In this sense, it is a simple way of conveying important information about the cash flow timings of assets and liabilities. I want to emphasize that doing this report or other reports involving duration does not replace the need for a thorough actuarial certification. However, the results do correlate quite well with those produced by the full actuarial certification process. And if it isn't feasible to do a full study, this report can serve as a periodic communication tool to management or other interested parties.

Finally, I'd like to address the question of whether there is a need to do cash flow testing and asset/liability models for traditional par ordinary life. Most discussions of cash flow testing focus on interest-sensitive products and I'd like to point out some questions that might get you to rethink this issue:

1. Can you really afford to exclude what might be a large portion of your company's business for purposes of asset/liability cash flow testing?

2. If it has ever been feasible for your company to reduce payable dividends as a solution to cash flow or other problems, what was its experience in doing so?

3. How quickly can dividend rates be changed and what is the lead time for the typical change to be implemented?

4.   How much of your dividends are actually taken in cash as opposed to being applied to paid-up additions, dividend deposits or other dividend options? To the extent that dividends are not taken in cash, the primary short-term effect on cash flow of cutting dividends is to increase taxes.

5.   How much dividend deposits and paid-up additions in total does your company have?

6.   Are you sure you can afford not to consider the dynamics of the situation in which people cash in their dividend deposits and paid-up additions?

7.   If your company had a cash flow problem in 1980, was the ordinary life line of business responsible for all or part of the problem?

8.   Has anything changed since that time to prevent the ordinary life business from causing similar problems in the future?

To conclude, every company is different in terms of the way in which various functions are delegated, and in terms of the barriers that exist to effective communication. Regardless of the way in which it may be accomplished, there is a real need to break through these barriers and get everyone involved in achieving the common goals of the company.

MR. JEFFREY D. MILLER: While I can't bring the vast experience with company operations that Sam can offer to our discussion, nor the significant theoretical work that Irwin will contribute, I can offer some observations about the activities of several of my clients in this area.

When coordinating diverse groups of people in any project, two approaches are possible: the carrot or the stick. Under the carrot approach, positive incentives are established for each group which encourage that group to strive for goals consistent with the goals of the entire organization. If such goals are achieved, the members are rewarded accordingly. Under the stick approach, top management sets the goals of the entire organization, and commands the various groups to coordinate toward the achievement of those overall goals. If coordination does not take place and overall goals are not achieved, members are punished accordingly.

Personally, I believe that a carrot approach is more effective if goals for individual departments can be coordinated with overall company goals and are communicated effectively. Also, measurement of progress toward those goals is important to achieving the overall results.

Recently, we have seen many companies establishing return on invested surplus as their overall corporate goal. Such an approach has become extremely popular with life insurance companies owned by nonlife parents. However, the approach also is taking hold in freestanding stock companies and mutual companies, as well.

If return on invested surplus is the key operating objective companywide, then tools are required to establish interdepartmental goals consistent with the company's return on invested surplus goal and to measure the returns achieved through product development, investment, and financial reporting. Expected returns from various alternative actions must be established on a prospective basis, and actual returns must be calculated on a retrospective basis. Presumably, expected returns are compared with company objectives (hurdle rates) to see if they are acceptable, and actual returns are compared with expected returns to measure success or failure.

These remarks will focus on the tools necessary to project expected returns and measure actual returns. The remarks do not represent the actual system of any particular company, but rather the ideal system which has emerged as the consensus opinion of my consulting clients.

THE BASIC TOOL -- CASH FLOW PROJECTIONS
The basic tool underlying all of these functions is a cash flow projection. Such projections include both assets and liabilities. They may include cash flows from an existing block of business, a new block of business, or some combination of the two. They may be based on realistic assumptions, conservative assumptions, or optimistic assumptions. The key point is that a projection of cash flows is required. No longer do factor-driven systems for historical analysis seem to be appropriate.

Cash flow projection is not a trivial process. In fact, we have found that the most visible results of our work come from building a model and selecting

projection assumptions. Frequently our clients discover that the information provided by their data processing systems is not what they thought it was, and that certain segments of their business are obviously not profitable. The initial process of establishing models seems to be one of the most educational processes of the entire project. Thus, after overall objectives of this project are established, subprojects frequently emerge as the projections are completed.

Calculation mechanics involved with these projections are also not trivial. While our traditional methods of projecting liability cash flows are well established, considering alternative economic environments and experience scenarios is more challenging. Further, we have found that the variety of asset arrangements which must be projected is much greater than the variety of liability arrangements. Finally, in coordinating the projections of assets and liabilities, significant new logic is required.

Detailed discussion of modeling techniques and cash flow projection mechanics is beyond the scope of this discussion. However, I do believe that models must be created and cash flow projections prepared before meaningful coordination of product development, investment management, and financial reporting can take place.

PRODUCT DEVELOPMENT

The first step in management of a life insurance company is product development. In the past, this function was called "pricing" and was controlled by actuaries. In the current environment, pricing is a small part of the process and restricted generally to smaller ancillary benefits. In our experience, prices are generally dictated by the marketplace, and product development involves determining if market-priced products can be offered on a profitable basis.

Another activity controlled in the past by actuaries which is undergoing change is assumption setting. We have always known that assumptions could be wrong, but we have never focused on how wrong they might be. Assumptions were set on a deterministic basis, and then sensitivity tests were performed. We now recognize that some critical assumptions, particularly interest rates and default experience, are subject to random fluctuation that must be recognized by stochastic processes.

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Finally, we used to take reserve requirements as given in the product development process and assume that all surplus was distributable. Soon, it is expected that reserve requirements will be a much more subjective process, depending somewhat on the risks assumed by each particular company with respect to their pricing and investments. Further, some level of surplus is required in addition to reserves, if not by regulatory authorities then by the rating agencies. Thus, reserving and surplus requirements are now a dynamic part of the product development process.

These new factors have caused traditional methods of product development and profit testing to be simplistic. New models and techniques are now a requirement in this process. We have found cash flow projections to be the most basic required tool.

The product development process now involves the following steps:

1. Identify a market that might be pursued profitably because of competitive advantages enjoyed by a particular company. (Competitive advantages might include, but not be limited to, an established distribution system, a new product idea, superior service capacity, low-unit expense rates, superior investment ability, etc.)

2. Identify the products and prices necessary to compete in that market, recognizing that the relative competitive posture of prices will have some impact on sales.

3. Model the likely products and sales and project cash flows from those sales.

4. Choose likely investments that can be made from positive liability cash flows and model cash flows from those investments.

5. Calculate the return on investment likely to be achieved (under a variety of scenarios) from the cash flows projected above.

6. Determine if the product is likely to be profitable.

7. Fine tune the product provisions and investment strategies into a final
   product plan.

At its conclusion, this process should generate the following data: (1) projec-
tion of cash flows, including surplus requirements, from the planned products;
(2) calculation of expected return on investment of surplus under a variety of
interest scenarios; (3) initial product specification and a plan for setting non-
guaranteed elements in the future (for example, credited interest rates); and (4)
strategies for investment management, expense and administrative management,
and distribution management. Investment management strategies should include,
for example: type, quality, and duration of investments. The projection of
cash flows and resulting expected return under a variety of experience scenarios
can serve as a guide to management decisions once the product has been
introduced.

PRODUCT MANAGEMENT
Unfortunately, once a product has been introduced and has been on the market
for a while, experience doesn't always follow the expectations of product develop-
ment. Items which might go astray include: (1) market research -- the product
may not be as popular as originally anticipated; (2) competitive environment --
market price levels may decline below a profitable level; (3) economic environ-
ment -- some of the more pessimistic economic scenarios may come true, causing
profit levels to be at the low end of the expected range; and (4) experience
deviations -- persistency, expense, or mortality experience may deteriorate,
causing a change in assumptions to be necessary.

In these instances, new cash flow projections are required under new adjusted
experience scenarios. For in-force blocks of business, plans for setting non-
guaranteed elements may need revision. For new business, all product specifica-
tions may be subject to revision. The important point is that cash flow projec-
tion mechanisms are in place to calculate newly expected returns on investment
which can lead to product management decisions in a timely manner.

INVESTMENT MANAGEMENT
Investment management is really a part of product management, but it is discus-
sed separately because it is so dynamic. During product development, model
investment strategies can be developed which appear to maximize returns on

invested surplus. These strategies state the type of investments, the duration
of investments and the quality of the investments to be pursued. Also, as cash
flow projections are revised, model investment strategies can be revised as well.
There is no way to anticipate all the investment opportunities that will become
available during the product development process. Since new investment oppor-
tunities are constantly arising, investment managers must have the ability to
pursue these opportunities if a company is to maximize its returns on invested
surplus. Investment managers can use cash flow projection models to replace
model investments with actual investment opportunities as they become available.
If these alternative investment strategies produce returns on investment which
are at least as high and at least as stable as those originally projected, the new
investment opportunities should be pursued. Thus, the investment managers can
use cash flow projections to help choose alternative strategies which are consis-
tent with company plans and objectives.

FINANCIAL REPORTING

Since life insurance is a long-term business, a company can't wait to see the
actual results of all past decisions before making new decisions. An ongoing
scorecard is necessary to measure the relative success of alternative product and
investment strategies before new strategies can be developed. Unfortunately,
many companies in the past have tried to "shoe horn" their scorekeeping system
into the established accounting mechanisms used for public financial reporting.
These accounting mechanisms are based on transactional models. Transactional
models identify a single type of transaction which is most important to each
organization and attempt to measure the economic impact of all such transactions
which occur in a specific time period. In the old GAAP days, premium used to
be the primary transaction for a life insurance company. However, this is no
longer necessarily the case.

Increasingly, managers in the life insurance industry and other industries have
found that this transactional model is inappropriate for measuring the economic
success of an organization. Most organizations, and particularly life insurance
companies, are too complex to identify a single type of transaction as determina-
tive of its economic success. Instead, the economic value of a company is depend-
ent upon many types of transactions, all of which will occur in the future.
Thus, if a manager wants to maximize the economic value of this company, he
will try to measure the economic impact of future expected transactions.

Once again, cash flow projections become the basic tool of yet another function, the financial reporting function. Cash flow projections, usually based on the same assumptions and methods as used in product development, product management, and investment management can be used to prepare value-based financial statements. These financial statements can be an ongoing measurement of an organization's economic value. Changes in that economic value over each time period can then be used to calculate the actual returns on investment achieved. Such returns are then a function of: (1) expected returns on products developed and sold; (2) modified expected returns from revised experience expectations reflecting new environmental factors; (3) modified expected returns based on new investment strategies; and (4) deviations of actual experience from expectations.

Internal financial reporting efforts are then focused on: (1) calculating the actual return achieved for a period of time; (2) comparing that actual return with expected return; and (3) identifying reasons for deviations of actual returns from expected returns.

In conclusion, I have stated that the best way to coordinate the activities of product development, investment, and financial reporting is to get everyone moving toward the same goal of maximizing return on invested surplus. The basic tool for that effort is a cash flow projection for new and/or existing business. Cash flow projections can be used in product development as a more sophisticated and realistic profit-testing approach, and can be used in investment management to test alternative investment strategies against company objectives. Cash flow projections can also be used in financial reporting to create a value-based, internal scorekeeping system.

MR. IRWIN T. VANDERHOOF: My presentation will focus on the theory of the term structure of interest rates. There are several theories in existence today, but few of them produce results that can be readily used. A theory of the term structure of interest rates can be used to fit smooth yield curves, to price products from the government bond yield curve, or to understand the concept of immunization. Since immunization was introduced by Redington in 1951, there have been theoretical objections to it, and yet it continues to be widely used. Most of the practitioners and clients are satisfied with its results. This leads to an interesting conclusion about the value of theory and the value of practice. If

the shape of the yield curve or the formula for the shape of the yield curve is known, one could form some reasonable idea as to when immunization would or would not work.

There are a series of classic theories of the yield curve. Segmentation theory argues that there are separate sets of investors for long, intermediate and short maturities and that the rates are set separately by the supply and demand considerations in each segment. More specifically, banks invest in short-term instruments while insurance companies invest in long-term instruments. Therefore, banks set short-term rates and insurance companies set long-term rates based on their particular supply and demand patterns. This theory is not very useful for prediction purposes since investing organizations do not necessarily stick to their particular segment. Expectation theory argues that the two-year rate is the product of two one-year rates. Liquidity premium theory states that expectation is modified by the investor requiring that an additional return be paid to compensate such investor for taking the risk of a longer investment. Finally, various researchers from the University of Chicago and the University of British Columbia have worked to develop the form of the yield curve from stochastic processes determining interest rates and the course of the entire economy.

None of these developments have, thus far, produced a simple mathematical formula that can fit yield curves of varying shapes. That is what I am attempting to do. My argument is that the yield curve is determined by traders sitting in front of CRTs and deciding which bonds are relatively more attractive than others. This choice must be made on the basis of price, maturity, and coupon; for bonds selling at a discount there may be an additional after-tax consideration. Since these are the only independent variables, a choice must be made on the basis of returns and risks of capital. Risk must be linearly related to return because return on a portfolio is linear, and if risk is not so related, investors could improve their returns without increasing their risks. Once all investors have done this, risk will be linearly related to return.

We can accept the traditional approximation that change in capital value is a linear function of duration and speculate, that since convexity (the second moment of duration) is considered desirable, it will be an additional term in the formula. This leads to a formula for the yield curve composed of a constant,

plus a price for duration times the duration, plus a value for convexity times the convexity of a specific bond. In these equations, the Xs represent the variables fitted by linear regression.

$$(1) \qquad I = X_I + X_3 D_1 + X_4 D_2 .$$

Duration and convexity can be calculated using government bonds. While Taylor's theorem requires that derivatives be used rather than durations, tests have shown that they provide no improvement in fit compared to durations.

This formula does not consider the effect that the deferral of tax has on the yields of bonds sold at a discount. Development of the algebra of this impact shows that to exactly determine the importance of this factor one would have to be able to solve for both the average ordinary tax rate and the average capital gains tax rate for the buyers. Since there is only one observable variable, the amount of the discount, this solution cannot be identified. Tests have shown that these functions are lethargic with respect to changes in the tax rates. For this reason a term was added to equation (1) to represent this discount effect.

$$(2) \qquad I = X_1 + X_2 (Dsc) + X_3 D_1 + X_4 D_2 .$$

The discount term can be either positive, if the price of the bond is below par, or zero.

The formula, as it stands, assumes that in assessing risk the bond trader expects interest rates to change by the same amount at all maturities. This is probably not true. If the trader thinks of changes in interest rates as being the product of a series of one-period rates, and that the variations in these rates follows a lognormal process, then the longer term interest rates would be the product of such a process. If the variances in the one-period rates were all the same (how would we argue that they would be different?), then the standard deviations of the long-term spot rates would be inversely proportional to the square root of the duration. Simulations have shown that for coupon paying bonds the reduction can be approximated with the .6 power of the duration. This leads to the more complete version of the formula:

$$(3) \qquad I = X_1 + X_2(Dsc) + X_3(D_1/D_1{}^{.6}) + X_4(D_2/D_1{}^{1.2}) .$$

I have used .6 and 1.2 to adjust for the fact that people perceive short-term rates to vary more than long-term rates.

Tests of these formulas were done using a sample of thirty items each from the CRSP tapes for each January and July from January 1974 thru January 1985 for coupon paying bonds. The average R^2 for formula (1) was 71.2%. For Formula (2) the result was 73.8% which implies that the discount term does capture some of the tax effect of the discount. The result for formula (3) was 78.6%, which indicates that the factors in the denominators make a significant improvement. This seems to generally validate the arguments presented above. I am not aware of any other theory that leads to these results.

Additional tests support the robustness of the general formulation. If .5 is used as an exponent in the denominator rather than .6 there is only a slight loss in fit. If durations and convexity are calculated using 10% interest for all maturities and all periods, there is a slight improvement in fit. An additional higher order term in the regression formula only slightly improves the fit and reductions in "t" statistics lead one to suspect multicollinearity.

A final test was made by using the regression coefficients developed from the .6 runs to calculate the multiperiod spot rates and then using them to value each separate coupon and maturity payment. These were then compared to the actual prices of the bonds to determine if the term structure had actually been captured. The fits were better using this combination of exponents than if the coefficients were the result of regression runs using a .5 exponent. Results were in all cases biased. This may be the result of a series of inconsistencies discovered in the CRSP tapes. I have been informed that these inconsistencies will be corrected.

IMPLICATIONS FOR IMMUNIZATION
The classic form of immunization assumes a flat yield curve. Let this flat interest rate be K. Further let

$$W=1/(1+K) \ .$$

Then the present value of a series of cash payments "C_t" is

$$PV = \sum C_t \, w^t$$

Since the present value of the assets should equal the present value of the liabilities

$$PV_A = PV_L \, .$$

If this equality is to be immune to a change in interest rates, the first derivative should be equal. In addition, if we wish the value of the assets to be greater than that of the liabilities for any change in interest rates, the second derivative of the assets should be greater than that of the liabilities. These are conditions C_1 and C_2. A_t and L_t are the cash flows of the assets and liabilities respectively.

C_1 $$\sum t \, A_t \, w^{t+1} = \sum t \, L_t \, w^{t+1} \, .$$

C_2 $$\sum t(t+1) \, A_t \, w^{t2} > \sum t(t+1) \, L_t \, w^{t+2} \, .$$

This guarantee of profit with any change in interest rate has led to the most basic criticisms of this version of the theory. In addition, tests of the implied portfolio strategy -- a barbell for the assets -- has shown this the least satisfactory strategy.

The form of the spot yield curve developed in this paper is more complex since there are constants present to represent the general level of interest rates, the importance placed on duration and the importance placed on convexity.

$j_t = a + b \, t^{1/2} + c \, t$, and the form for the present value equation is

$$PV = \sum C_t \, v_t^{\,t} \quad \text{where}$$

$$v_t = 1/ \, (1 + j_t) \, .$$

If we denote the first and second order conditions for the guarantee of profit on account of any change in interest rates by combinations of the coefficient letter and number, then the conditions are:

$$a_1 \qquad \sum_t t\, A_t\, v_t^{t+1} = \sum_t t\, L_t\, v_t^{t+1}$$

$$a_2 \qquad \sum_t t(t+1)\, A_t\, v_t^{t+2} \geqslant \sum_t t(t+1)\, L_t\, v_t^{t+2}$$

$$b_1 \qquad \sum_t t^{3/2}\, A_t\, v_t^{t+1} = \sum_t t^{3/2}\, L_t\, v_t^{t+1}$$

$$b_2 \qquad \sum_t t^2(t+1)\, A_t\, v_t^{t+2} \geqslant \sum_t t^2(t+1)\, L_t\, v_t^{t+2}$$

$$c_1 \qquad \sum_t t^2\, A_t\, v_t^{t+1} = \sum_t t^2\, L_t\, v_t^{t+1}$$

$$c_2 \qquad \sum_t t^3(t+1)\, A_t\, v_t^{t+2} \geqslant \sum_t t^3(t+1)\, L_t\, v_t^{t+2}$$

These equations imply that if we maximize our return with respect to a change in the general level of interest rates, we are also maximizing our risk with respect to a change in the shape of the yield curve.

If we compare the various equations we can form some conclusions, always keeping in mind that there is significant noise in all the fits of the interest rate equations:

1. If one present value equation is satisfied the other will be almost perfectly satisfied.

2. Condition a_1 and condition C_1 are substantially the same. Therefore, we would expect immunization with respect to a change in the general level of interest rates to work. This is consistent with investor experience.

3. Condition c_1 and condition C_2 are almost in perfect conflict.

4. Only a very specially constructed portfolio could meet conditions C_2 and b_1.

I do not believe that it would be practical to even attempt to construct a portfolio meeting conditions a_1 thru c_2. They are too similar. Given the noise in the

whole process there is little likelihood that they could be met in practice. Increasing the likelihood of a profit from one type of change would increase the likelihood of a loss under any other.

If we wish to reduce the chance of loss under any change in the shape of the yield curve, we should simply set as many moments of the cash flows equal as practical. If all moments are set equal then we have absolute matching and all changes in the yield curve become irrelevant to the matching process.

In this presentation I have described a mathematical formula for a description of the yield curve and have described some empirical tests of the results. I have also shown how this form leads to immunization criteria that answer the criticisms so often expressed of the Redington formula. This formulation does not require a flat yield curve and is not restricted to parallel shifts. While equilibrium considerations have not been specifically introduced, the requirements for making money without taking risk are impossible to realize in practice. Since there are only four variables in determining yield -- price, coupon, maturity and discount -- and the formula has four terms, there may be no more information possible in the yield curve. It may be helpful to add the importance of convexity to the tools that the actuary uses in assessing investment policies. It may also be useful in determining the ranges in which the yield curve can vary for use in scenario analysis.

MR. WINN: How does the theory of the term structure of interest rates relate to the practical aspect of asset/liability matching? Have you tested this and does it produce relatively good results?

MR. VANDERHOOF: Immunization is really aimed at changes in the general level of interest rates. It works well for most long-term obligations of which we have fewer and fewer every year. Most of our current obligations tend to be much shorter in their horizon. When dealing with shorter term obligations, one must be concerned with how assets will match those with changes in the yield curve. If dealing with guaranteed investment contracts (GICs) or universal life where money is going to turn over in 5 or 10 years, a substantial amount of money can be lost even if the duration is accurate. This can happen if the general level of interest rates does not change but the shape of the yield curve changes several times during the period. In this scenario, it is possible to lose money during

every economic cycle. A better understanding of the possible changes in the shape of the yield curve and the importance, therefore, of the convexity can help one to better organize a portfolio to avoid such problems. Prior to all major equity purchases, I now require that the investment department do an analysis of the returns under various inflationary scenarios. In some cases, it is possible that deals we structured several years ago while in a high interest rate environment probably should not have been made because interest rates have not remained high. And when interest rates drop, the risk of default increases.

MR. G. STEPHEN SILVA: Mr. Goldfinger, in earlier sessions there was use of the term *attitude* and in your presentation I got the sense that you saw a very real need for coordination. If you were the chief executive officer of your company, would you try to foster this cooperation yourself or would you expect the officers that reported to you to develop it on their own? In other words, would you be willing to adjudicate turf disputes or is that something that you would expect them to work out on their own?

MR. GOLDFINGER: Ideally, once people recognize that there is a common goal, the turf disputes should be minimized. Companies must go through an educational phase where, for example, the investment department understands that yield is not the only factor and duration or cash flow timing is part of the objective in their work. This should be done within the investment department itself. A measurement system reflecting goals should be part of the strategy of measuring the success of the investment people. So, the first step is to get the various areas to understand what their piece of the overall problem is. Once you accomplish that, the turf problems are reduced. It is unrealistic to expect people to cooperate with each other simply because top management gives the order. It takes time and communication. Whether this is done through task forces, lunch meetings or placing actuaries in the investment department, it is really a matter of getting people to appreciate that it's in their best interest to work as a team. My personal experience has been that turf problems, while they won't disappear overnight, become a lot less significant once people realize they are all working towards a common goal.

MR. MILLER: Sam, does the investment department in your company embrace the idea of cash flow projections and look at the impact of various alternative

investment decisions on the cash flow projections of the company? If they do, does the valuation area modify reserve requirements or surplus requirements when alternative investment strategies are pursued, and has this been coordinated?

MR. GOLDFINGER: Our investment department has taken to the idea of cash flow projections and they understand that it is their responsibility to use these projections in their investment decisions. It's been said that in the past, investment departments of insurance companies probably did a good job of investing; however, they didn't always do a good job of investing for insurance companies. This has changed. Investment people throughout the industry realize that they are part of insurance companies, and they want to know what actions they should be taking to be as effective as possible.

In response to the second part of your question, our chief executive officer is not particularly interested in holding additional reserves for which we do not obtain a tax credit for. So as a general rule, we do not do much nonstandard investing for lines of business requiring cash flow testing. Since New York Life is a large company, with a fair amount of surplus, any types of investments that might trigger additional reserve requirements are not made to the degree that they would be significant factors in cash flow testing of supporting reserves. We do have venture investments and some less-than-investment-grade securities, but these are all within a range that we feel comfortable with, without strengthening our reserves.

Jeff, what has been the reaction of the companies to which you have proposed this "increase in economic value" financial measurement? And do they have trouble understanding how it works?

MR. MILLER: We have implemented that system for several companies. One is a mutual company which was looking for a mechanism for compensating their top executives. That particular engagement was quite interesting because they established this value-based financial reporting system and have formalized it within their compensation structure requiring independent certification of the assumptions and the projections. So this is probably the most formal adoption of the system. Another company that I have been more directly involved with is a small stock subsidiary of a mutual property/casualty company. In this case, the

chief executive officer of the parent company felt this value-based system was a good idea so the stock life company followed suit. We have had some excellent responses, and have identified a number of problems. This company is now implementing the system on their own and proceeding forward with it. We have a number of other projects in progress in other Tillinghast offices, but I am not aware of the particulars. The major reason that this value-based model is becoming popular is because companies are recognizing the limitations of the transactional model.

MR. MICHAEL P. STRAMAGLIA: We have been hearing much about the calculation and use of return on investment (ROI) statistics. It seems to me they are not particularly useful on their own without some insight into the variability that we can expect to experience. I wonder if Mr. Miller can give some insight into how we might quantify this variability and how it would be taken into account when using ROI statistics?

MR. MILLER: Generally, one can calculate the ROI that is achieved under a number of scenarios and, of course, the most popular element to vary in the scenario is the interest rate curve. We have not yet developed scenarios for various mortality rates with respect to AIDS or other variations. Most of our activity has focused on the C-3 Risk and variation in interest rates. One can calculate the variation in ROI in each of the interest scenarios and call that the variation that is likely to be achieved in ROI.

In one of our engagements, we were asked to develop a surplus allocation where we would calculate the amount of money needed to assure that the company would be statutorily solvent under 95% of the interest scenarios tested. There is where we experienced more activity with respect to measuring variation. We struggled with whether we should allocate surplus as based on the variation in the present value of profits on the value-based model or whether we should allocate statutory surplus as that portion of the surplus necessary to give some confidence level where the company would always be solvent. We decided to keep the value calculation constant and consider the variations when we were allocating surplus. The reason for this was that the value calculation is quite frequently used to identify fluctuations of actual experience from expected experience. Therefore, focusing on a value calculation that is fluctuating in and of itself causes the whole process to become too complicated.