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**ASSET/LIABILITY MODELING (AND MATCHING)
FOR PENSION PLANS**

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Techniques and considerations in beginning an investment strategy to develop a cash flow pattern appropriate for the liabilities being funded.

- o Role of the Actuary
- o Which Liability Should be Covered by Matched or Dedicated Assets
- o Suitable Types of Investments
- o Dedication vs. Annuities
- o Techniques for Asset Selection
- o Valuing Assets and Liabilities to Recognize Their Relationship

MR. MICHAEL J. SENOSKI: One of the things that we often hear talked about is the risk/return trade off. In other words, the objective of the pension fund is to maximize long term investment returns within an acceptable level of risk. I think we as actuaries are particularly qualified to assist clients in the area of risk measurement and evaluation. For example, one of the concerns that a pension fund will have is that it may become necessary to liquidate assets at an unfavorable time in order to pay benefits. This is something that I refer to as liquidity risk. Liquidity risk can be easily ascertained using some relatively simple actuarial techniques. Basically, it involves projecting the cash payout needs of a plan over a period of years. In doing this we find that the contributions that an employer is likely to make over the next several years are, in many cases, likely to substantially exceed the cash flow requirements of the plan. Now in cases such as this, the plan's liquidity risk is obviously minimal and the risk tolerance in this area is particularly great. On the other hand, there may be situations where there is a mature plan or a plan of a company in a declining industry where the cash flow needs of the plan will be greater than the cash coming in via employer contributions. In any event, relatively simple cash flow projections of the needs of the plan over a period of 5 to 10 years can be very useful in evaluating liquidity risk.

A second type of risk that plan sponsors need to be concerned with is expense volatility risk. This is the concern that plan sponsors have that if the value of the portfolio fluctuates too widely from one year to the next, an unacceptable increase in the company's pension expense will result. There are various techniques that actuaries can employ to measure expense volatility risk.

I would like to point out that the risk tolerance of most plan sponsors, in this area, is probably greater than they realize for several reasons. One is that probably the majority of plans around today use an asset valuation method that tends to smooth market value gains and losses over a period of

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years. Under I.R.S. Regulations up to five years spreading is permitted. Beyond that, once you have cushioned the impact through the asset valuation method there is also the employer's policy for amortizing actuarial gains and losses. Under current I.R.S. funding regulations, employers can elect to spread losses out over a period of up to 15 years. So when you study the double cushioning you get from the asset valuation method, and the employer's policy for amortizing unfunded actuarial liabilities, you find that the impact on pension expense of short term fluctuations in the value of a portfolio is not, in many cases, terribly great. I recently completed an exercise in this area for one of my own clients and observed that a \$100 decline in the value of this company's fund in year X would result in only a \$2 increase in the company's pension expense in year X + 1.

A third type of risk that plan sponsors need to be concerned with is balance sheet risk: the perception that is created in the minds of analysts and the investing public about the financial soundness of a company. Currently disclosure of a company's pension assets and liabilities occurs in the footnotes of the financial statements. I am sure most of you are aware that there are proposals being put forth by the Financial Accounting Standards Board to raise that to the balance sheet. But nonetheless, information on the value of accumulated benefits and the market value of plan assets currently appears in the footnotes to the financial statements of plan sponsors. And this information does not go unnoticed by securities analysts and the investing public. As a matter of fact, there have been articles written by people from Moody's. I recall one particular article on what they do with the information on pensions that is contained in the footnotes; how they convert it to some kind of a balance sheet debt equivalent. We know that security analysts and others are looking at this information. If a pension fund is going from year X to year X + 1 incurs a substantial decline in the value of assets on a market value basis, so that the gap between pension liabilities and assets increases significantly, it is difficult to say precisely that that will result in an increase in the cost of debt or equity financing to the plan sponsor. But logic tells us that, at some point in time, it has to be unhealthy for the gap between actuarial liabilities and plan assets to widen continuously. So, from an investment standpoint, there is this balance sheet risk. Again, I do not know how you would quantify it, but there has to be a concern in the minds of management with that issue.

A fourth type of risk is the risk that, over the long term, pension expense will rise to unacceptable levels. This kind of a risk is the opposite of the volatility issue which tends to suggest more conservative stable type investments. If the concern is that, over the long term, costs will rise to unacceptably high levels, then the appropriate investment strategy would be one that seeks to maximize long term returns.

The final comment I would like to make on risk is that you could go through an analysis for a client and evaluate his exposure to the various types of risk, but in the final analysis, after you have presented your case, probably the overriding factor in the client's decision as to how aggressive or risk oriented he wants to be, is something I would call risk temperament. I think it is a simple fact of life that you could take the identical situation and present it to two different managements and they could very likely come to different conclusions about the level of risk that they feel is appropriate for their pension fund. I can not explain why this occurs, but this seems to be, based on my experience, a universal truth. It may reflect the degree of conservatism or aggressiveness in the company's overall financial

goals and objectives. It may reflect biases in the individuals who are making the investment decisions for the pension plan, or at least recommending them to a Committee of the Board of Directors. Or it may be that, after you have done all your analysis and presented the results, the people you are dealing with do not fully comprehend or believe everything you have presented and they would rather be safe than sorry.

In any event, I find in my experience, that risk temperament, among all the factors I have just cited, is probably the single most important factor or controlling factor that appears in decisions by Investment Committees relative to the level of risk that they are willing to expose pension funds to.

MR. RONALD A. KARP: I thought that was an interesting exposition of some different ways of looking at risk. I think it is often important to keep in mind that while those are all valid, they are really not mutually exclusive or completely exhaustive and they often tend to drive us in very different directions about the way we think about investment decisions. So it is important, as we deal with investments, to try to keep in mind which of those tend to be the most important in the current situation because, I think, they all do have a place. Having said that, in the course of my comments, I will focus on one of them, and maybe bring out a couple of aspects of how other views of risk might play a part.

As Mike mentioned, I would like to try to do a little scene setting for the discussion that we are having today and try to put this question of immunization and dedication and matching in the context of overall investment policy issues. I will be somewhat general. I think the remainder of our panel will tend to be somewhat more specific. I have a few objectives. The first is to try to give some perspective on where dedication and immunization might fit into the overall responsibility of the plan sponsor in terms of his requirement to monitor and supervise investments. Interestingly, this morning Martin Leibowitz was on a panel where he discussed some different approaches to this question, one of which he referred to as "projective" which may, by now, be called the traditional approach. Although I think it is really only in the last 5 to 7 years that people have been using that to focus on pension objective setting. The other was "matched funding" which really relates to some of the potential from immunization. In my remarks, I will be focusing on this projective approach, and then point out a few areas where we can bring in a few ideas of immunized portfolios.

The second idea is to take a very brief look at how a plan sponsor in this projective approach might select an asset mix. That could be a subject in itself, so I do intend to be very brief. But I think it will give us some sense of how immunizing might alter the assumptions and therefore, change the optimal mix and the attainable risk/return characteristics. Finally, if we do ascribe some greater stability of returns to an immunized portfolio, what might that suggest about a new optimal asset mix. Can it give us a new way to think about the fixed income part of our portfolio?

First, a little bit about the place where immunization/dedication fits into the overall responsibilities of a plan sponsor. What we have here (see Exhibit 1) is a very general list of the categories of investment supervision that a plan sponsor must take into account. The first three are those that I regard as relating to investment policy. First is Asset Allocation. By that I mean an asset mix question. The second is Manager Structure.

That is, within the asset classes that are determined, how are the assets to be managed; what style or variety of styles are to be used. The third, the Planning Process, refers to some kind of periodic decision process, usually an annual plan with some mechanism for making observations and controlling it. Then finally, the last two items are in the Implementation stage, (not really what we are aiming at here). They are the selection of managers and the monitoring.

It is in the Manager Structure area where I would consider the decisions about immunization and dedication to be made. Immunization is a style or one approach to fixed income investing. What I wanted to touch on are some ways to think about the Asset Allocation Decision and to see where that takes us regarding immunization. I will point out that there is no right answer in this process, but, as in all actuarial procedures, we have to start out with the making of assumptions.

I want to illustrate some general data that might be a starting point for assumptions about potential returns from the securities markets (see Exhibit 2). We essentially limited it to equities, (the top category) and fixed income (bonds and Treasury bills). Then we also looked at some total fund measures of what pension funds have done during essentially the 12 year period for which some reasonable data exists. The long term numbers, and I am sure it is no surprise to you, suggest that equities have indeed provided a higher return than fixed income. As we will see, that is a driving force toward making them a very significant part of any pension asset mix. On the other hand, part of our whole procedure is to look at the risk components of equities, as well as other categories and to think about the risk of a whole portfolio, and to try to get at some of the reason why given this type of data we do not function with 100% equity portfolios. Clearly that falls in the risk category. But something like this might be the basis for starting to formulate some assumptions about the future. Not that you have to necessarily say that the future will resemble the past, but it is our starting point.

I would like to spend a couple moments on the rationales for and approaches to setting an asset allocation policy. (See Exhibit 3) The first step is to decide what classes you are considering: what asset categories. We have identified equities, bonds and cash, (the traditional three) and a couple of those that are starting to get increasing attention from pension funds. That would be real estate, international equities and small capitalization equities. But there is no reason why this is necessarily the end of the list which could include areas like oil and gas or other natural resource investing, venture capital, and others. Some of these are subcategories. The starting point is to decide what asset classes you are going to utilize.

A second step is to make assumptions. These are basically in the risk/return area. For this purpose, we will be using a measure of volatility for our risk measure. In Mike's terms, that would fall into the category of risk which creates pension expense volatility. We are really concerned in this risk/return trade off with the impact which it has on the whole portfolio. We are not really focusing on whether or not the stocks are volatile or the bonds are volatile but how do all these parts fit together. The key question is how do the different asset classes tend to

behave in relation to each other. To the extent to which they are independent or not completely correlated, you get very strong diversification benefits. The diversification has the effect of reducing the overall risk or volatility of the portfolio. The final item is how to select the best risk/return opportunity. In a few situations one portfolio or mix of asset classes dominates another, in the sense that you can either get a higher return at the same risk or the same return at a lower risk. In that case, it is a very easy decision, almost a non-decision. In most instances, you are looking at portfolios where there is a trade off toward a higher risk or return and there really is no clear answer to that question. It comes back to the fifth of Mike's risk categories, namely the risk tolerance of the deciding group.

Let me show you some sample assumptions. (See Exhibit 4). These were used by us in a particular situation. I think the actual numbers might appear to be a little bit low to you, but we are intending that these be appropriate for a very long period in the future, and that this might be viewed as something like a 5% inflation environment. In that environment we would expect cash to produce about a 5% return. Equities, somewhat in line with the historic real return, we looked for 11.5%, bonds 7%. In the real estate area, we looked for a 10% return, international equities 12.5% and small caps 15%. As a starting point, we have used primarily historical data to set our assumptions. We also have historical standard deviations for these asset categories. The second table is our assumed correlation among the asset categories. This is some fairly key data toward seeing how a whole portfolio will behave which, as I mentioned, is the key factor.

Just briefly, I will mention to you that equities and bonds tend to have a reasonable correlation. They are not perfectly correlated, but the number we selected was .4. Likewise, the subcategories of equities, international and small caps also have very high correlations with the equity market in general. By contrast real estate tends to have low correlations and some of the studies that we have looked at actually show real estate having mildly negative correlations with the securities alternatives. That significantly enhances the diversification benefits that are available from real estate and tends to make it come up with a fairly high representation in most optimized portfolios unless you constrain it somewhat arbitrarily. To see how these look, we have simply put the individual assets on a risk/return graph. (See Exhibit 5). The horizontal axis is the risk measure, the standard deviation. The vertical axis is the return measure, that is the expected annual return in a 5% inflation environment. The main point I would like to illustrate here is that they do indeed seem to follow the relationship that you would expect from different investment categories. There is a reasonable risk/return relationship: the higher the return you expect from a given asset category the greater risk, in this case volatility, that you would expect.

We have begun to look at some portfolios. (See Exhibit 6). What we have attempted to do here is to illustrate how you begin to optimize. In this case we have focused on a three asset portfolio as a starting point, where the three assets are equities, bonds and cash. Essentially, for this initial exercise, we left the cash component at 10% and then alternated the equities and the bonds from a 90/0 to a 0/90. What you can see is that as you go up the spectrum toward higher equities (out to the right side) that

the overall portfolio produces a higher return, as you would expect. What is interesting is, at the lower equity portions, that the slope of the curve turns out to be quite different from the slope at the higher end. I think this says pretty clearly to me that at lower equity representations in a portfolio it is a fairly easy decision to move on to higher ones.

At the left side, it is a very easy decision. I point out most funds that are using equities and fixed income as primary investments are in the FGH range on this graph, which would be from about 50 to 70 percent equities with a small cash component. Also this curve that runs through the portfolios is what you have seen in other literature identified as an efficient frontier. This is what an efficient frontier might look like in a three asset portfolio. In a moment I am going to get to how this might be altered if we consider immunized bonds as a portion or as different type of a bond portfolio.

What we looked at next was to see what happened when we added additional asset categories to those three asset categories that I mentioned earlier. (See Exhibit 7). In this case we added real estate, international and small capitalization equities. Our effort was to see how their being added to a portfolio would impact the risk and the overall return expectation. What we found is that the addition of these portfolios could have some very powerful effects on the three asset portfolio. We found that it could allow you to not only reduce the risk of a portfolio, but simultaneously raise the return. That is something you do not normally associate as a possibility. That opportunity is possible, though, with the use of new asset classes. I would like to show you what that looks like. (See Exhibit 8). With some constraints on the allowable amounts in each of these categories, we determined what some optimal portfolios might look like with the introduction of the new asset categories: real estate, international and small caps. Those are the portfolios that are represented along the line. What is identified as "K" in this graph, is the original portfolio that we began with: the 70% stock, 20% bond and 10% cash portfolio. So by the addition of these new categories you are able to push your potential for investment results from a whole portfolio, up and to the left. That is really the objective of the whole process: to try to obtain the best return results you can at an acceptable level of risk. So these are some approaches to improving both of those; we have moved the efficient frontier up and out.

Question: "How does immunization fit in with this in terms of the way we think about setting our portfolio strategy?" My view is that an immunized fixed income portfolio is really a sub-category of an overall bond portfolio, or maybe the whole bond portfolio. But it is one that has somewhat different characteristics from the way that we have represented bonds, where we have used a market value bond portfolio. What we have tried to do is to first start with what we have seen in the portfolios, the risk return combinations that are available using bonds with a market value assessment. (See Exhibit 9). There are two portfolios on the graph. The A and the F are the two that we selected from the prior chart. The A is the one we had originally started with in the 3 asset mode. That had a return potential of 9.9%. The F, which included some new asset categories, had a return expectation of 10.5% with a lower risk level; that was the multi-asset portfolio. What we then did, (see Exhibit 10), was introduce or substitute

a fixed income component with the same expected return as the market, but with a lower risk element. What that gave us was a shift in the overall risk/return potential using the same mixes as on the previous chart. You can see that portfolio B, which is using just the three asset categories (stocks, bonds, cash), allows the same expected return at a lower risk level. Likewise portfolio G would allow the same expected return at a lower risk level in a multi-asset category.

That is a clearly superior alternative if we will view an immunized portfolio as a stable, or less volatile component of the portfolio.

We then tried to alter our asset classes to come up with a new category, a new portfolio that would bring us back to the original risk level but with a higher return. That is what we attained on the final chart. (See Exhibit 11) A and F, again, are where we started with the old bond characteristics. With the addition of, or with the substitution of, a more stable bond risk parameter, or a negligible risk assumption for bonds, we are able to attain some fairly meaningful increments in the return from a portfolio without any increase in the associated risk.

I would like to close by saying that my view of immunization as a bond management technique is that it allows you to make some different assumptions about your bond portfolio. It reduces the risk of your fixed income component; and perhaps allows you to take a different view of your overall asset mix and again try to move that efficient frontier up and to the left.

MR. ANDREW F. SHEWAN: The theme of these three talks is that the assets of pension plans ought to be invested with regard to the nature of liabilities. Pension plan assets are accumulated to pay benefits and they should be invested to pay benefits. This proposition is one to which tribute is generally paid and often henceforth forgotten.

I want to begin by referring to a survey which was conducted last year of plan sponsors taken from the Fortune 1000 supplemented by 50 Retail, Bank, Utility and Transportation companies. Of the respondents, 78% had changed actuarial investment assumptions in the last 2 years; 62% had changed their salary progression assumption; one-third had changed their funding method or actuarial cost method; one-third had changed the benefit formula and more than one-third had granted cost of living increases to retired employees.

During this period of rather extensive change on the liability side, only 6% of respondents had undertaken a major restructuring of plan assets, and 12% had made "some change in investment policy," leaving over 81% admitting to little or no effect of these liability changes on their investment program.

Now there are a variety of different explanations for this. One is that the plan sponsors in question were operating at an extremely high level of sophistication. It could be that in setting investment policy they have looked beyond today's actuarial methods and assumptions, to the underlying benefits, funding and expensing policies. In other words, the investment policy had anticipated all these changes.

However, some of the answers to other questions in the survey suggest other less happy explanations. For example on the subject of joint meetings between actuaries and investment managers, 54% of the respondents either saw no value in such meetings, or had not considered it, or thought it was "a good idea, but with too many problems." A further 12% were "thinking about it." On another question, almost two-thirds of the respondents saw retirement plans as attracting less management attention than either direct compensation or welfare plans, despite the very large portion of the respondents who stated that they regarded pension expense as being an important item. I think the most likely reason for the absence of changes in investment policy following these substantial changes in funding and benefits policy is that few plan sponsors have actually found a way of making the asset-liability connection other than through a loose statement of intent.

How can we do better than this? Our distinguished guest Martin Leibowitz will talk about some of the practical aspects of immunization, leaving me to talk about the concept of immunization or duration matching from a more theoretical perspective.

The English actuary Frank Reddington has described how during the winter of 1951-52, on a cold Saturday morning, he felt disinclined to get up and dig the garden, so he stayed in bed and invented immunization instead. He added some paragraphs at the last minute to a paper which he presented to the Institute of Actuaries in London in February, 1952. The paper was called "Review of the Principles of Life-office Valuations" and it was as the name would imply, about life insurance company valuation, not about investment. The specific question which was addressed by Reddington, was this: "Is the actuary's certification of the solvency of a life insurance company dependent on a certain level of interest rates being maintained, or can the actuary give a more absolute certification of solvency?" If there is anyone who has lived in a cave for the last 30 years and does not know Reddington's answer, he would surely infer it from the continuing interest in this paper. The answer is that in certain circumstances the actuary's certification can be absolute. The main condition is that the "duration", (or Macaulay duration) of the cash flow out of the company, (which Reddington called the liability out-go) should equal the duration of the interest and dividends and maturity proceeds associated with the assets (known as the asset proceeds). If this condition is met, the values of the liabilities and assets will be equally sensitive to incremental changes in the market rate of interest so the margin of solvency can be maintained.

I have not forgotten that this is a pension meeting, but I hope I can stay with life insurance for a few minutes more to describe why this concept proved so important. The next step will be to see how much, if any, of this can be transferred to the rather different world of the pension actuary.

The first and the original application of immunization theory to life insurance was to asset and liability valuation. Suppose we have a pool of assets and a block of liabilities which will be funded through the receipt of interest and maturity proceeds from those assets, regardless of the future course of interest rates. It would appear to be logical to place

identical values on those assets and those liabilities, at least for most purposes.

This can be brought about either by using market value for the assets coupled with the liability valuation based on current market interest rates, or by discounting future cash flows on the asset side and liability side using the same rate of interest, or through the use of some kind of amortized book value of bonds coupled with a liability discount rate based on the rate for assets, "locked in" or immunized.

The second application of immunization might be in the field of asset management. Since the technique of immunization permits the investment of assets in such a way that liabilities will be funded regardless of the future course of interest rates and security prices, the immunized posture represents a truly risk-free position for the insurance company. It is much more risk-free than the so-called riskless investment, which approximates to T-bills but which is by no means riskless in the context of life insurance (or pension) valuation and investment because the terms on which interest can be reinvested are subject to the vagaries of the market place.

The third application follows naturally from this. If the immunized position is a riskless one, then presumably any other investment posture is adopted with the aim of increasing returns above the immunized rate, but at increased risk. So the immunized position would be a logical base point from which the value added by the investment manager could be measured. This should be weighed against the additional risk introduced, and since the zero risk position is one in which the duration of assets and liabilities are set equal to one another the extent to which the duration of assets departs from that of liabilities would appear to be an important component of the measure of risk.

So, Reddington's theory, at least in relation to life insurance can give insight into three different but related fields:

- (i) the valuation of the assets and liabilities,
- (ii) the management of assets in relation to liabilities, and
- (iii) the measurement of investment performance.

To complete the historical part of my remarks, some recollection of the investment conditions when Reddington wrote his paper may be useful.

For those of you whose memory of the winter of 1951/52 is as hazy as mine, I should reveal that when the paper was presented the yield on long term government bonds (and this was in the United Kingdom) had just risen above 4% for the first time in 20 years. The dividend yield on the common stock index was around 6½%. Thus anyone who had used immunization as an asset management strategy would have paid dearly in terms of opportunity cost as the fundamental reevaluation of stocks and bonds of the 50's and 60's worked itself out. It remains true today that adoption of an immunized approach involves investment judgement. Reddington himself presented immunization in the context of asset and liability valuation.

Now we can transfer some of our thinking to pension plans. I think there are three difficulties in making the translation:

- (i) Many plan sponsors and participants regard the pension plan promise in terms of purchasing power promised, not in terms of a fixed number of dollars of varying value. This introduces the additional variable of inflation into the equations, and if this variable is set at a positive number the effect is to extend the duration of the plan's liabilities significantly.
- (ii) Many plan sponsors see the pension plan as an entity of indefinite longevity, and wish to take future new participants into account when formulating investment policy. That is not to say that life insurance companies are not immortal, but they can admit each generation of contract holders on terms determined by the market at the time, while pension funds may wish to anticipate the conditions which will prevail when future new entrants join the plan. If this philosophical line is followed, this too will extend the duration of the plan's liabilities as they are perceived by the sponsor, if not by IRS.
- (iii) Theories of pension plan asset management should embrace all the investment media extensively used today. Certainly equities are too important to be ignored, and we have to find a way of accommodating them within our duration matching discussion. For those unfamiliar with United Kingdom practice, I should say that in that country there were in Reddington's day few restrictions on the type of assets which could be held by a life insurance company, so long as you could get an accountant to sign off as to their fair market value. Companies invested in common stocks, as much of the actuarial literature on immunization and life insurance company valuation in the United Kingdom addresses the issues raised by common stock investment.

Now, once you introduce the concept of purchasing power and you introduce consideration of future new entrants, the duration of the liabilities appears to be pushed out to the point at which the fundamental equations underlying Reddington's work become insolvable. It is reasonably well known that an irredeemable bond which pays coupons forever, but never matures, will have a duration equal to the reciprocal of the interest rate at which it is valued. So at today's long bond rates of around 13 3/4%, the duration at the long end of the yield curve was about 7½ years. There are techniques for getting longer than this. Zero coupon bonds have a duration equal to their maturity regardless of the interest rates. And there are artificial means of increasing the duration of an asset pool by borrowing short and investing long, or following the same logic by using options and futures.

How can we deal with equities? The simple way is to treat them as irredeemable bonds with an increasing coupon. If we assume the growth rate is constant for an indefinite period and that this growth rate can be inferred from the stock price by setting the current market price of the stock equal to the discounted value of future dividends, then we can show that the duration is equal to 1 plus the reciprocal of the dividend yield. A low yielding stock, by implication a growth stock -- will have long duration.

So if you accept this theoretical approach we find that it is relatively easy to construct an asset portfolio whose duration is anywhere in a predetermined range from zero to 20 or more. How long do we need? Well, if we take an individual age 45 who is going to retire at age 65 and live long enough to draw 15 years of payments, then the duration of that liability at 10% interest is about 25 years. If we build in cost-of-living increases, the duration would be longer. It may, in a lot of cases, be very difficult to find an asset portfolio long enough to match the liabilities of a pension plan.

One practical solution is to segment the liabilities into active, terminated vested and retired. Immunize the inactive liability and invest the rest as aggressively as your risk tolerance permits. This seems to be consistent with the thought that maximizing the asset duration, within limits, is a sensible way to proceed.

Now I am going to present you with a paradox. In a paper submitted to the Institute of Actuaries in 1981, D.E. Fellows, who happens to come from the same insurance company as Reddington, argued that for a pension plan whose obligations are truly considered in purchasing power terms, the duration of the assets should be as close as possible to zero. The basis for this was that the difference between the rate of investment return and the rate of salary inflation is a constant, generally set at a small positive number. If this is so, changes in the nominal rate of interest will be equally reflected in changes in the rate of salary inflation, and will have no major effect on the value of liabilities. In other words, liability values are quite insensitive to changes in nominal interest rates, and if asset values are to be similarly insensitive, they should be invested in instruments of zero duration, or in other words, cash equivalents.

Taking this one step further, suppose the inflation proofing of pensions only applies in the pre-retirement phase, as would be the case in the traditional final pay plan with no cost-of-living increases to retired employees. In that case, any increase in nominal interest rates would result in a reduction in the overall liability for the well known reason that the increased salary scale only operates during the period of deferment. This results in a negative sensitivity of liability values to interest rate changes which could only be matched by assets of negative duration.

Where does that leave us? Well, it leaves me with one minute to summarize what I have said, resolve an apparent paradox and leave you in good shape to hear Martin Leibowitz. So to sum up:

- The usefulness of any valuation technique is expanded enormously through the application of sensitivity analysis.
- This can help us to identify and quantify elements of risk, and it may lead us to strategies for controlling and eliminating these elements of risk.
- In the world of life insurance companies in 1952, the interest rate was by a long way the most interesting variable to use in sensitivity analysis. This work indeed led to a study of duration as a

measure of liability and asset sensitivity to interest rate changes, and strategies were devised for controlling this risk.

- In pension plans in 1984, interest rate sensitivity is still worth studying, no less because other variables have to be considered.
- One of these other variables which affects the relationship between asset and liability values is inflation. There are no doubt other factors which affect the value of common stocks in the pension plan (which may differ from their value in the marketplace).
- Perhaps sensitivity to changes in the real rates of return as well as nominal rates would be worth studying. Personally, I am uncomfortable with a sensitivity analysis which treats the real rate as a constant. One of the hypotheses of Fellows work in 1981 was that the real rate was a constant, which I think is an important flaw in his argument.

MR. MARTIN L. LEIBOWITZ: What I think is really the key matter, and it is one like the professor of economics who gets up there and says "there is one key thing that matters in all of economics, there is one rule you must learn, and that is: you can't have your cake and eat it too." Of course, the professor got it wrong; that does not make any kind of sense at all. The real saying, which no one ever uses is "you can't eat your cake and have it too." I think the key here is that, in some ways, all of modern investment theory has so wrapped us around with a certain way of looking at things, that we have forgotten some of the very early lessons as to why people did things for very basic, almost dumb, certainly naive, reasons. What is happening is that some of those naive reasons are reasserting themselves. We may wrap the concept of immunization into a complex structure, but when you come right back down to it, you take a look at Reddington's paper and you realize that clearly what he did, in terms of inventing immunization, was not a big deal as far as he was concerned. The main message is that we have come to view the investment world in terms of what is called Projective Type Funding as it applies to pension plans. (see Exhibit 12).

Projective Funding is a certain definite set of assumptions as to how the world is going to be. Anyone, when they talk about investments in terms of asset allocations, really becomes forced into this kind of context. You really have no choice. It comes down to saying: "If I take a risk free asset I get a certain return from T-bills. I would expect to get, over the long term, from a investment in say long term treasury bonds, a somewhat higher return on average with a somewhat higher risk and variability associated with that return. If I move further into equities, I would expect, again, higher risk premia giving me a higher return yet and that would also have with it a higher risk and variability return over the short and long term." We tend to take that almost as second nature, but in some ways it is a rather bold concept. It is a concept which is laden with all types of stochastic assumptions about what the world would be like and,

like any stochastic view of the world, it may be vastly different from the characteristics we might guess as defined by the probability parameters.

Matched funding, on the other hand, is a deterministic concept. It is a concept that says: "if you have nominal liabilities in the future and you have an investment which will provide a nominal flow of investment dollars, then you can have a high assurance of securing those pay-outs by using such a matched funding investment." Now fixed income, obviously, is the vehicle which fits a fixed stream of nominal liabilities in a matched funding context. Fixed income, as well as equities, can work in projective funding context and every asset allocation mode that I am aware of does that. Promised Funding is where you have no direct rational linkage between the investments and the liability. Where you say "there's money in the fund, there isn't money in the fund, we're going to make the pay-outs anyhow; don't worry about it." With the advent of ERISA and the new sophistications Promised Funding is becoming rather passe.

What kind of techniques, then, can fit into this matched funding? (See Exhibit 13). A number are obvious. Just having a long bond portfolio to deal with a long set of liabilities is probably the time honored way of matching. It was never viewed as being necessary to be quite so formal. One can formalize that in a more concrete fashion by actually having a target portfolio. One can go into contractual arrangements which put an insurance company in terms of their annuities behind the liabilities. Or one can go into the formal management procedures that we are talking about under the general category of immunization or dedication.

Dedication, in the sense of cash matching, is too trivial to go into any technical details about. You put a bond portfolio in place which will throw off coupons, sinking funds and principal payments in advance of or coincident with the necessary pay-outs. There is all kinds of discussion as to why you do this sort of thing, what the payoffs are and just what color bonds you use. It is worth pointing out, in practice, one does not strive for an "exact match" portfolio. You strive for a "least cost" portfolio that usually will involve some degree of anticipatory funding. There is a great deal to be gained by taking a very conservative reinvestment rate assumption so you will be able to get something more from those anticipatory flows. The motivation for doing this, for a lot of the fund sponsors of the past three or four years, has been to essentially fund liabilities that were on their books in the 6-8% valuation range with portfolios that were purchased at market rates in the 14, 15 and sometimes 16% range. One can achieve savings by taking certain types of measured risk in terms of higher conservative reinvestment rate assumptions or taking somewhat greater credit risks.

Cash matching has been the form of choice for most of the immunized/dedicated portfolios that have been put into place over the past 4 years. It is worth asking why. The answer, I think, is a simple answer, namely "it is simple." It is simple, it is clear cut, it is relatively unmodeled, you have a fair assurance that what you see is pretty much what you are going to get. People in this society have played a role in the acceptance of this sort of procedure. But I think that the simplicity has a great appeal also to the fund sponsors as well.

Cash Matching has certain problems which are troublesome. It seems artificially constrained period by period. You may give up one bond which is a slightly better investment value because it throws off its coupons on February 15th when you have a pay-out which is due on February 13th. That seems somehow a little artificial when you are talking about 20 years from now. It creates certain restrictions in the choice of securities and it requires, despite the surprising degree of ongoing management of cash in matched portfolios, an inflexibility in the cash matched portfolio that limits whatever management can be done. Having portfolio selections made on liability payments that are estimated many, many years in the future, as if they were gospel, is also a problem. (See Exhibits 14 and 15).

Now, contrast this with immunization in the Reddington sense. Instead of matching to the precise cash flows, what you do is you match on an aggregated basis, you match in terms of interest rate sensitivity. (See Exhibit 16). The dotted line is the present value of the liabilities over different interest rates and the solid line is the present value of the assets. You want to get a dominance pattern that looks roughly like this. You want to get the lowest cost portfolio. The straight vertical line indicates where interest rates were when this slide was made. The pattern is what you are seeking. You want to have something which gives the least cost portfolio, that will dominate under certain types of changes in interest rates.

One of the problems with immunization is that there are assumptions about what kinds of changes in interest rates you can have. You can actually make some fairly reasonable assumptions about what the sensitivity of a portfolio is to certain types of changes in interest rates, (although it gets more complicated when you have to take into account yield curve fluctuations and spread fluctuations as well as just level fluctuations). When you deal with a real world where you do not have a uniform discount rate or even a series of clear cut discount rates associated with given maturities, the question of what is the present value of liabilities, in a fulfillment sense, becomes somewhat more complex. It seems that the key thing is a kind of recursive process. This process will take you forward in time and with the passage of time and the changing of interest rates if you peel off the market value of the portfolio just enough to pay your liabilities as they come due, then you will get yourself to the point of reaching that last liability 90 years out.

Immunization in this sense has a fair number of advantages. (See Exhibit 17). Since you are dealing with aggregated measures of the liabilities and aggregated measures of the assets, your selection range of securities is much broader, much more flexible. This should, and usually does, lead to a certain degree of cost saving in terms of the portfolio to immunize versus

the portfolio to cash match. The overall flexibility can be important in terms of greater ongoing management flexibility. But, there are certain disadvantages. (See Exhibit 18). The disadvantages are first of all, you have a complexity in the model. Even the simple model has its complexities. It is hard to explain it to someone who is not the least bit mathematically inclined and who really does not feel that comfortable with the present value concept. There is a real problem in the model: it is not robust across interest rate yield curve changes. There have been a number of modern attempts to try to make it robust but they have been fairly restrictive and have been fairly costly in terms of the bite they take out of the savings one hopes to realize. There is the other aspect which is a little bothersome in that immunization is intrinsically a dynamic process as opposed to cash matching which can literally be a passive process (you just put the portfolio in place, you do not have to manage it). With immunization, you can not do that; you have to do rebalancing and not just when you have payments. You may have to do rebalancing just in response to an interest rate event and that is troublesome for many people.

Looking at the relative advantages, an exact cash match is a very expensive process, but you have zero risk (you are going to get the money exactly when you need it). With the typical cash match (applied using a conservative reinvestment rate and allowing for some earlier throw-offs than the actual out-goes), you get a much lower cost portfolio, but there is some degree of reinvestment risk associated with it. With pure immunization you get a lower cost portfolio yet, but the degree of danger introduced to deal with the various types of short falls is much much larger. (See Exhibit 19).

So, we can sort of lay these advantages and disadvantages of cash matching versus immunization on a chart. (See Exhibit 20) The way it adds up, at least in practice, is that cash matching has, to this point, won the day in terms of practice. One can talk about whether that will so in the future. I think there are problems with immunization, but I think that there is also progress going on in this area.

But, it raises another interesting question - is there not some way of combining the relative benefits of these two techniques? As you might have suspected, the answer is yes. There are number of ways; one way which I would like to suggest to you is the technique called Horizon Matching. Horizon Matching is a very simple idea. The idea is to break up the liabilities into early liabilities and later liabilities. Take five years for illustration. Take a single portfolio, and require it to cash match the early liabilities, giving that great comfortable assurance that those funds are going to be paid out with ease: cash match in a very conservative sense using the full set of assumptions. Then duration match the residual portfolios. So that what could happen, if you are totally passive during the first five years, is that you would arrive at the end of the fifth year having an immunized portfolio to start playing with from that point forward. Note the emphasis on a single integrated portfolio as opposed to two side by side portfolios. Note the emphasis on a conservative cash match as opposed to an immunized portfolio which just happens to be cash matched at the outset. The latter sounds almost equivalent but it can get you into fairly serious trouble.

Such a portfolio would have a pattern which would look like this. (See Exhibit 21). You see that you have the cash matching effect in the early 5 year period with quite a different pattern, and one which is really characteristic of immunized portfolios, a kind of mushed out barbell, in the later years. With immunization, a number of conditions are needed on the end flows to insure that the dominance pattern shown in exhibit 16 is maintained over a sufficient range of rate movements.

A Horizon Matched portfolio has the virtue that one can, like any cash matched portfolio, ride out for five years doing literally nothing. Because there are zero net flows of both liabilities and assets in the early period, the duration really does not change in any significant way in the sense of becoming unmatched. You will reach the fifth year and find yourself in an immunized position where you must go forward and dynamically manage as you would with any immunized portfolio.

An alternative to taking that passive stance is to try to keep that five year cash match frame work in front of you: to roll out after a year has passed from the four year cash match back to a revised 5 year cash match. The work we have done suggests that indeed is feasible, and that it probably can be done without pay-outs under most market conditions. (See Exhibit 22).

The difference between an immunized portfolio and a cash matched portfolio will typically be on the order of 2% on the overall asset value. A horizon matched portfolio will save you relative to a freshly optimized cash matched portfolio, kind of in the pattern that is shown here. (See Exhibit 23). The percentage numbers are shown on the right hand side of the graph. At the fifth year mark, you are usually talking about 1½% or so. It is surprising actually that, even if you go out as far as ten years, there are significant savings. That is, in part, due to not having to worry about when the payments comes due in February 2013. If you go further down to the 2 and 1 year horizon match, you can get more savings but at significant cost in terms of the qualitative advantages of the horizon match.

One of the serendipitous effects of horizon matching in this particular format is that it is easy to explain. This is so, not because it is an intrinsically simpler concept than immunization or cash matching, but because most fund sponsors tend to focus on the cash matched front end, which is simple, clear, secure and also captures most of the present value of the liabilities. However, you get a curious advantage in that one of the real problems of immunization is the yield curve fluctuations (the deviations from a parallel movement to the yield curve.) Those tend to be concentrated in the period prior to the fifth year of maturity so that if you can truncate the immunized portion of the fund to the fifth year and beyond what happens is that you have essentially immunized not only against parallel movements to the yield curve but against yield curve fluctuations. Obviously if you allow the horizon matched portfolio to come in closer and closer you lose that advantage over time but you have gained it for a large part of your liabilities and you do have the option to roll out. What this suggests is that, in some ways, horizon matching gives you:

- simplicity and
- a fair degree of acceptance on the part of actuaries and sponsors,
- the advantages of enhanced security selection.
- initial cost saving and
- better flexibility for ongoing management.

You lose the full extent of disadvantages of both techniques and gain some of the advantages.

In the scheme we showed before, horizon match would fit in between pure immunization and cash match. There is savings, relative to cash match, not as much as with immunization but the risk of short fall is considerably reduced.

A few sentences on contingent procedures. If interest rates are at 15% and I say to you "If I guarantee you 14% and give you some significant degree of active management, would you like that?" A lot of sponsors have said yes, they would. Looking at the present value of liabilities and looking at the types of risk you can take by deviating from a duration matching you find that you can have 300 basis points of cushion in terms of yield moves against going as long as you could with 30 year bonds. That is enough to have some degree of play on active management, to have ample time to be able to guarantee that 14% rate.

One can push this contingent process into a lot of different other areas: contingent dedication, contingent horizon matching and so forth.

But, again, I come back to the main subject of having your cake and eating it too. The key difference between what we have been talking about is a matched funding approach which gives you a deterministic assurance of what the match off against liabilities will be versus the projective technique which talks about broad classes of assets and their allocation.

MR. SENOSKI: At this point in time, I would like to throw the floor open to questions from the audience.

MR. RIAN M. YAFFE: Mr. Leibowitz, what place would equities take in a pension portfolio using the approach of horizon matching?

MR. LEIBOWITZ: It would take a projective place. Matched funding is something which can be applied against well defined liabilities. I was talking primarily in the context of retired lives, although this has been applied to the generations of near retirees as well.

MR. BENTTI O. HOISKA: Marty, have you looked into creating the duration match with the T-bond futures?

MR. LEIBOWITZ: Yes. For a portfolio that is able to use futures, many things that one does with great effort can be done with great simplicity including creating really long duration type portfolios. In fact, one can argue that if CATS had been around or any form of long term zero coupon securities, a lot of the work on immunization would not have been done because it would seem so easy to achieve these things without trying to find mathematical surrogates. Futures fall into the same category.

MR. MALCOLM HAMILTON: Mr. Karp, you showed us a number of graphs where you had a relationship between rates of return and some measure of risk for portfolios. I believe you started with a relatively basic portfolio of treasury bills, bonds and equities and then gradually added other investment classes. One of your classifications was small capitalization companies and for that classification, you had a very high expected return and a relatively high volatility. If your model comes back to you with an answer that pension funds should have a relatively large exposure to these, but if you observe in the market that if all pension funds reach the same conclusion there would not be enough small capitalization stocks to go around. What does it tell you about your model? Do you view that as being just hard to explain, or does that identify a market inefficiency or just what does it mean?

MR. KARP: I think if all pension funds were to reach that conclusion, it may well not be attainable. That suggests that there are investment judgements that are to be exercised also. It has really been in the last couple of years that small cap stocks have been a segregated category of equities; people have looked at them seriously as an asset class, added them and essentially done the analysis that leads to the data we have looked at here. This is not to say that if that is valid that these will not become an increasing part of pension portfolios and in that process have their prices elevated to a point where they are really not attractive and no longer offer the incremental returns that the historic data seems to suggest. When that occurs, we will go through a period of time where they will not produce those results and that will self correct in terms of their representation in portfolios. There is no investment idea that once discovered is always a valid one to employ. We are trying to make assessments about the long term likelihood of relationships in returns among asset classes. It is probably valid that over a long period of time smaller stocks will produce higher returns. A corollary of that might be that I do not think it is likely they will become the predominate part of pension portfolios.

MR. HAMILTON: If I could just have a brief follow-up question. You indicated that your research showed a negative correlation between real estate returns and many of the other returns. I was wondering whether you yourself are confident that that relationship will persist?

MR. KARP: It was not only our research. We looked at about 3 or 4 studies which have been published within the last few years. The quality of data on real estate is not nearly as good as it is with respect to securities. I do not know the answer to that question. I think correlation does not

imply a causation. I believe there are some factors in the real estate building cycles which will tend to make them not coincide exactly with economic cycles. There are some longer lead times in this area that tend to make the real estate cycles somewhat different. All that I can say with some confidence is that, in the past, there has been low correlation and in some studies a negative correlation with some other asset classes. I was not making a prediction about the future.

MR. MURRAY TAYLOR: In the description of our seminar today, one of the sections we were going to address is dedication vs. immunization vs. annuities. We have not talked about annuities. I would like to stage a couple questions on that. In the Canadian environment, our regulatory authorities approve pension valuations and so on. Although they approve and we can work through and write up the assets in one of these approaches, if a client wants to take a lower unfunded liability or a larger surplus from going through one of these things, his only guaranteed way of getting success is by purchasing annuities. In that environment, I have two questions: How should a consultant, or anyone else looking at the client's needs, decide whether in a certain situation buying out the retired lives is better than any of the approaches we have talked about? I would like to identify two issues. One is the risk involved and limit that to the risk of not being matched. The risk of interest volatility goes down to zero, and therefore that must have some relationship on the return that we would expect through this approach. The second is the cost maintenance (follow through of analysis and updating) and again that goes down to zero as well. Could someone, perhaps quantify what the difference then should be between the yield one could obtain on the investments underlying this, opposite what they would be within an annuity purchase which could be determinable by a consultant.

MR. SENOSKI: I would like to respond in a somewhat general fashion. I have a question in my own mind about the role of annuity purchases or setting up an exact match portfolio in a situation where the cash flow coming into a pension plan is likely to exceed the cash flow going out over the foreseeable future. Hypothesize a situation where an employer is considering an annuity purchase but he knows, and his actuary has told him, that it is likely for the foreseeable future that contributions he will be making to the plan will be sufficient to cover the benefit pay-outs. One of the appeals of setting up a dedicated portfolio or buying an annuity has been that the actuaries has been willing to raise the interest assumption on the block of liabilities that is matched by the portfolio. The argument that I have heard actuaries advance in defense of this move is that the reinvestment risk has been eliminated in the case of annuity purchase, and virtually eliminated in the case of a dedicated bond portfolio. The investment return assumption that an actuary employs in doing a pension valuation is an investment return assumption not only on the existing assets and on the cash flow generated by the existing assets. It is an assumption about the rate of return on contributions that are coming into the plan down the road. Now, in a situation where an employer is putting in more than the benefit payments going out, the funding of the benefit payments can come from one or two sources. It can come from the contributions which are coming in or it can come from the cash flow which the portfolio is throwing off. If you set up a dedicated portfolio or buy an annuity, it seems to me that what you have done is eliminated or reduced

the investment risk on one portion of that scenario and that is the portion of the current assets. If the alternative would have been to use current contributions to pay those benefits, then it seems to me that what you have also done is raise the reinvestment risk on future contributions. What I am trying to say is that, in situations where a pension plan has cash flows which are likely to exceed benefit payments over a period of time, I do not think that there is any real reduction in the overall portfolio's reinvestment risk profile. If I missed the boat on this, I would be interested in hearing somebody else's comments on it.

MR. KARP: We start off with one question, we now have two questions on the table.

Let me respond to the first question a little bit. I think that in every case where there has been a dedicated or immunized portfolio put into place, there always was consideration of the insurance alternative, because it is natural that there should be. The pros and cons are sometimes rate, if there is a big gap. Sometimes the rates fluctuate depending on the nature of the quality constraints and so forth; the advantage of sometimes being one way, sometimes being the other, but it is really decided on a rate basis. At least in terms of those portfolios, opting for the immunized route, the decision seems to be made in terms of electing to have flexibility over the long term. That seems to be a very important ingredient. They may want to enter into a matched funding for the time being but they are not necessarily having a clear view as to when they want to come out. This is not necessarily a forever statement. I think that ends up being a very critical ingredient. Some results just recently, in terms of reversion rules, require that annuities be purchased. It is always an alternative and something which has to be considered, and it is considered, I think in almost all cases.

MR. SHEWAN: I was just going to add that there are some other considerations. You implied that we should eliminate questions such as the transfer of mortality risk and the fact that in one case that an employee might get a check from the insurance company and in another case from the pension plan, which has some effect on the relationship between the employee and his former employer. There are other considerations such as the elimination of PBGC premiums on people who have been shunted off to an insurance company. I think the role of the consultant, as always, is just to put down the pros and cons and let Mr. Client make up his own mind, which he usually does on a variety of grounds, some of which, as has been implied, are more emotional than rational.

MR. LEIBOWITZ: Mike, I would like to comment on the question you have raised and maybe thereby raise some more questions. Your point is that if a portfolio is immunized and eliminates the reinvestment risk on it and this is a positive cash flow pension plan then you have really not reduced the reinvestment risk on the overall entity. I think that probably cannot be quarreled with, although I think there may be some ways in which you may indeed have lowered the risk. That is if something is immunized or if there is a dedicated portfolio set aside to meet certain liabilities, that changes the risk perspective of the committee or board or decision making group that is involved with that plan. It tends to perhaps make them think in terms of something which has no fluctuations. Consequently, it lets them

think in terms of being more aggressive with the rest of the portfolio. Now, I believe you could argue, that this is totally artificial and perhaps it is an incorrect perception on the part of this committee and I would agree with you. But it is my view that if something artificial makes them believe that they have a lower risk level it could have a positive accomplishment.

MR. YAFFE: Mike, one other assumption you seem to be making in your statement, both at the beginning and at the end, is that a company is in a position to be making ongoing contributions which are going to provide the cash flow, that the company is just automatically going to be able to that. I think that assumption is a very questionable one in changing, uncertain economic times, even for healthy companies. I think that the move towards some type of dedication or matching helps reduce that risk.

MR. SENOSKI: I think that is a good observation. In discussions I have had with some of my colleagues on this issue, they look at the cash flow stream that is coming in from the employer as a type of fixed income investment, a type of bond, if you will. You get a question of diversification, of spreading of risk. It is like a question of how much of your pension fund do you want invested in just one particular company. In a sense, to rely on the future contributions from an employer to fill a cash flow stream, is saying you are willing to bet very heavily on the existence of this one particular company. On the other hand in setting up investment guidelines for the remainder of the portfolio, you probably have rather strict limitations on how much could be invested in the assets of any one company. So, I agree with your point. I think it is a very valid one.

MR. STANLEY GOLDFARB: You speak of risk/return trade offs, and I am concerned about the measures of risk. From things that I have read, measures of risk are based on what has occurred in the past and the past then has not been a very good judge as to what is going to occur in terms of making these risk/return trade offs: in trading up the scale and getting a higher return for the same risk or a lower risk level for the same return. I wondered if there are any studies that show that these risk measurements really work. Also why did Mr. Karp choose the variability of return as a measure of risk? Are there any others to choose from that really would be good measures of risk?

MR. KARP: I would start off by commenting that any set of assumptions about the future obviously has its uncertainties and risks. In this case, I think the risks the different security classes have, again on an historical basis, seem to exhibit somewhat greater stability over time than the returns. In other words, the risk characteristic has been more constant; however, even that is not a totally true statement. In recent years we have seen fixed income investments become increasingly more volatile. I think we are just trying to make some best assessments about the future. I stand ready to question any of the assumptions that I have used or that may be put forth by someone else. I feel, though, that we have got to use something. We have got to have some frame work for thinking about what the future may hold. I tend to think starting with the past is as good a place as any.

MR. LEIBOWITZ: There is an almost forgotten study now, by the Bank Administration Institute published in 1967 which really first came up with a formalized recommendation that standard deviation of returns be used as a measure of risk. They listed a whole series of potential measures but they uniformly decided that the selection of short term rate of return variance with standard deviation should be opted for because it was felt to be a reasonable, measurable proxy for a long term risk. They had some evidence to educe to that effect; that the long term riskiness of an equity security could be proxied by its variability. A stock which would tend to go bankrupt is one which has a higher risk, higher variance. A stock which would tend to have earnings and dividend problems would be one which would have a higher variance today.

MR. SENOSKI: I think of some of the utilities that may be bankrupt, 3-5 years ago would likely not have exhibited a very high standard deviation of returns.

MR. SHEWAN: There is a distinction between long and short term risk. It seems clear that the Dow at 2000 is riskier on a short term basis than the Dow at 1000. That does not get factored in very heavily. Obviously it has some effect on the standard deviation, but not a lot. On the longer term, it does seem that more volatile classes of investment tend to stay more volatile. There may be some merit in trying to find some kind of select and ultimate measure of risk. I do not know.

MR. KARP: One final thought. I think the pension community, probably encouraged by consultants, has tended to, in my view, overly focus on quarterly results and short term variability as a source of their happiness or discontent, probably to the long term detriment of their plans.

UNIDENTIFIED SPEAKER: In Canada, most large employers have a practice of increasing pensions in payment on an ad hoc basis anywhere from 1 to 3 years. I was wondering if, in the opinion of the panelists, where such a practice existed, it is appropriate to immunize or attempt to match the cash flow for such a plan for the retired lives at least. If it is appropriate, how would you do it?

MR. KARP: With life insurance annuities, that question always comes up. I tend get more involved with those that decide to go ahead with this immunization route. They typically ignore the ad hoc prospects and they do so on a basis that they are not in the set of liabilities that the actuary usually considers. Even though they are there, they are ad hoc. In some cases, there has been an effort to actually formularize it. In other words, to take into some measure of an ad hoc increase which would be granted under some inflation assumption. That has been done a couple of times.

EXHIBIT 1

I N V E S T M E N T S U P E R V I S I O N

- o ASSET ALLOCATION
- o MANAGER STRUCTURE
- o PLANNING PROCESS
- o MANAGER SELECTION
- o MANAGER MONITORING

EXHIBIT 2

HISTORICAL RETURN AND RISK DATA

	<u>Twelve Years (1971-1982)</u>		<u>Fifty Years (1933-1982)</u>	
	<u>Average Annual Compound Return</u>	<u>Standard Deviation</u>	<u>Average Annual Compound Return</u>	<u>Standard Deviation</u>
<u>EQUITIES</u>				
Becker Median	7.1	20.1	-	-
S&P 500	8.3	18.7	11.2%	19.7%
Small Stocks	16.9	28.8	18.5	39.5
<u>FIXED-INCOME</u>				
Becker Median	7.6	8.5	-	-
Long-Term Corporate Bonds	6.6	13.1	4.0	8.0
Treasury Bills	7.7	3.2	3.2	3.4
<u>TOTAL FUND</u>				
Becker Median	7.3	14.5	-	-
CPI	7.8	3.4	4.1	4.2

EXHIBIT 3R A T I O N A L E F O R S E T T I N G
A S S E T A L L O C A T I O N P O L I C Y

o ASSET CLASSES

- EQUITIES
- REAL ESTATE
- BONDS
- INTERNATIONAL EQUITIES
- CASH
- SMALL CAPITALIZATION EQUITIES

o ASSUMPTIONS

- RISK (VOLATILITY - STANDARD DEVIATION)
- RETURN

o RISK/RETURN-PORTFOLIO VS. ASSET CLASSES

- CORRELATION

o HOW TO SELECT "BEST" RISK/RETURN OPPORTUNITY

- DOMINANCE
- JUDGEMENT

EXHIBIT 4ASSUMPTIONS

<u>ASSET CATEGORY</u>	<u>RETURN</u>	<u>STANDARD DEVIATION</u>
Equities	11.5%	19.0%
Bonds	7.0	9.0
Cash	5.0	2.0
Real Estate	10.0	10.0
International Equities	12.5	21.0
Small Cap	15.0	27.0

ASSUMED CORRELATION MATRIX

	<u>Equities</u>	<u>Bonds</u>	<u>Cash</u>	<u>Real Estate</u>	<u>Int'l Eq.</u>	<u>Small Cap.</u>
Equities	1.00					
Bonds	.40	1.00				
Cash	.00	.00	1.00			
Real Estate	.10	-.10	.50	1.00		
Intl. Eq.	.60	.35	.00	.10	1.00	
Small Cap.	.85	.45	.00	.10	.60	1.00

Sources of Historical Data:

Dimensional Fund Advisors, Inc. (All periods ending 1982)

First National Bank of Chicago (1960-1980, and Forecast)

Ibbotson & Fall (1947-1970)

Ibbotson & Siegel (1960-1980)

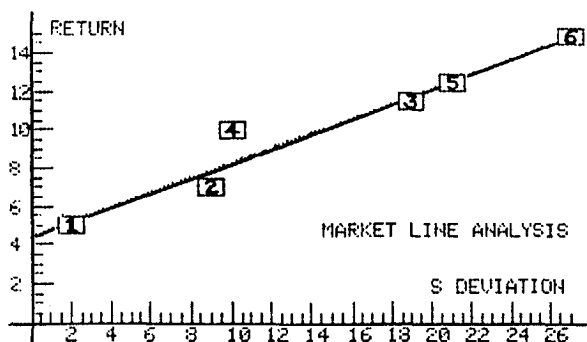
Ibbotson & Sinquefeld (All periods ending 1982)

John McMahan Associates, Inc. (1951-1970)

Prudential Insurance (Forecast)

EXHIBIT 5

RISK/RETURN PROFILE - INDIVIDUAL ASSETS



<u>Asset Number</u>	<u>Asset</u>
1	Cash Equivalents
2	Bonds
3	Equities
4	Real Estate
5	International Equities
6	Small Capitalization Equities

Note:

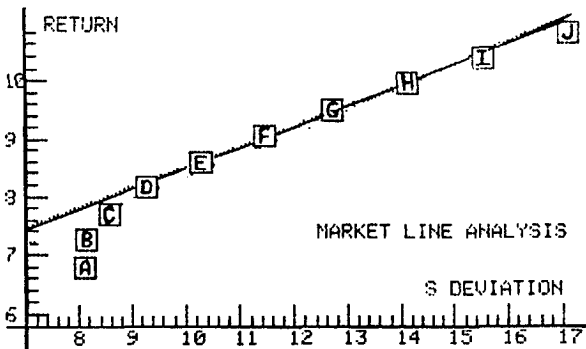
The dashed line in the above graph is the least squares regression line of the individual asset classes.

EXHIBIT 6

3-ASSET OPTIMIZATION
EQUITIES, BONDS AND CASH

	PORTFOLIO									
	A	B	C	D	E	F	G	H	I	J
EQUI	5	15	25	35	45	55	65	75	85	95
BOND	95	85	75	65	55	45	35	25	15	5
CASH	15	15	15	15	15	15	15	15	15	15
R.E.	0	0	0	0	0	0	0	0	0	0
INTL	0	0	0	0	0	0	0	0	0	0
SCAP	0	0	0	0	0	0	0	0	0	0
MEAN	6.8	7.25	7.7	8.15	8.6	9.05	9.5	9.95	10.4	10.85
S DV	8.1	8.15	8.56	9.29	10.27	11.48	12.72	14.12	15.58	17.1
S.R.	.222	.276	.315	.339	.351	.354	.354	.351	.347	.342

Note:
 MEAN = Expected Annual Return
 S DV = Annual Standard Deviation
 S.R. = Sharpe Ratio



$$\text{SHARPE RATIO} = \frac{\text{Expected Portfolio Return} - \text{Risk Free Rate}}{\text{Expected Portfolio Standard Deviation}}$$

EXHIBIT 7

A D D I T I O N O F N E W " F O U R T H "

A S S E T C A T E G O R I E S

o ASSET CATEGORIES

- REAL ESTATE
- INTERNATIONAL EQUITIES
- SMALL CAPITALIZATION EQUITIES

o PORTFOLIO IMPACT

<u>DEGREE</u> <u>OF IMPACT</u>	<u>INCREMENTS TO</u>	
	<u>RETURN</u>	<u>RISK</u>
LEAST	REAL ESTATE	REAL ESTATE*
↓	INTERNATIONAL	INTERNATIONAL
MOST	SMALL CAP	SMALL CAP

*REDUCES RISK

EXHIBIT 8

MOST EFFICIENT PORTFOLIOS - HIGHEST SHARPE RATIOS

The following graph displays the "frontier" (mixes A through J) of the portfolios characterized by the highest Sharpe ratios. Mix K is the traditional 70% equities, 20% fixed-income, 10% cash portfolio. The impact of added diversification is to offer the potential for policies which both increase return and reduce risk.

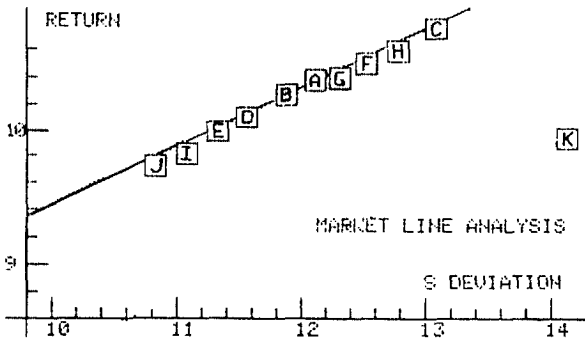


EXHIBIT 9

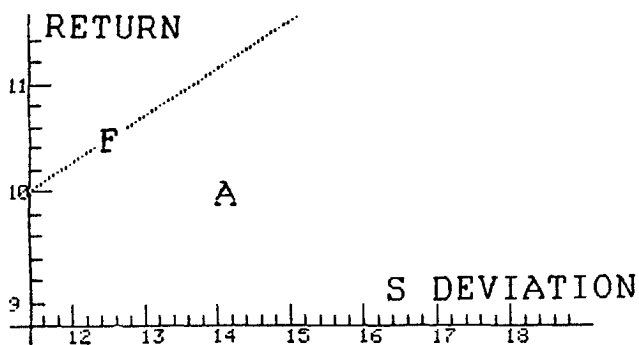


EXHIBIT 10

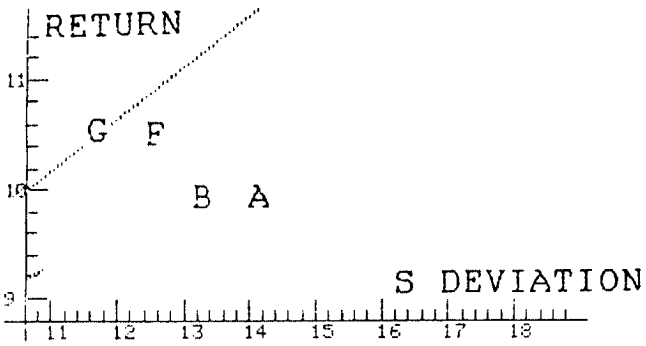
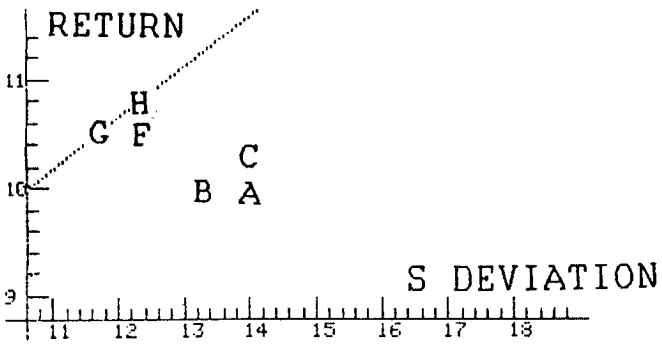


EXHIBIT 11



DIFFERENT INVESTMENT APPROACHES TO FUNDING FUTURE LIABILITIES

	<u>Fixed Income</u>	<u>Equity</u>
• Matched Funding	✓	X
• Projective Funding	✓	✓
• Promised Funding	—	—

MATCHED FUNDING TECHNIQUES

- **Informal Maturity Structuring**
- **Formal Baseline Target**
- **Contractual Arrangements**
- **Formalized Management Procedures**
 - Dedication (Cash Matching)**
 - Immunization**
 - Horizon Matching**
- **Contingent Procedures for Structured Active Management**
 - Contingent Immunization**
 - Contingent Dedication**
 - Contingent Horizon Matching**
 - Dynamic Hedging**

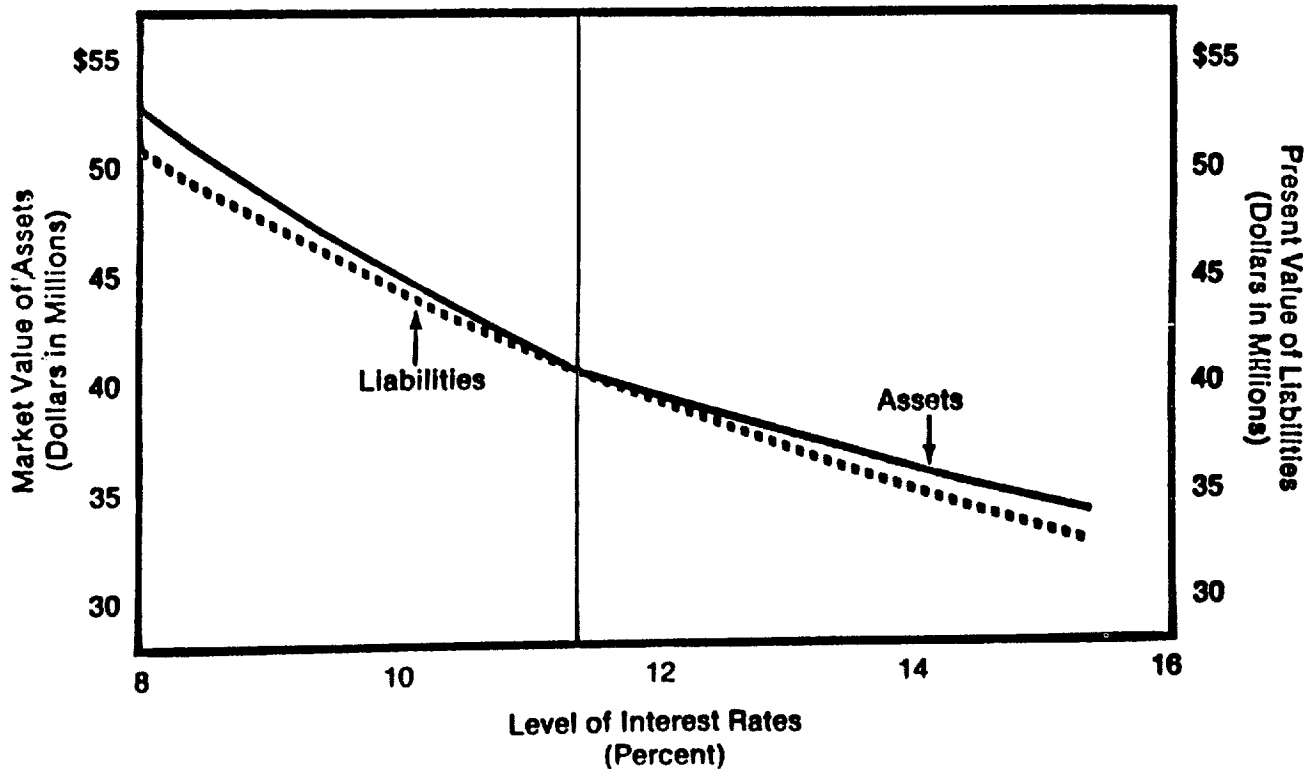
ADVANTAGES OF CASH-MATCHING

- **Assurance of Fulfillment**
- **Simplicity and High Comfort Level**
- **Widespread Actuarial Acceptance**

DISADVANTAGES OF CASH-MATCHING

- **Tight Period-by-Period Constraints**
- **Restrictions on Choice of Securities**
- **Limited Flexibility for Ongoing Management**
- **Potential Overdependence on Payout Estimates
(Especially in Later Years)**

Interest Rate Sensitivity of Assets and Liabilities



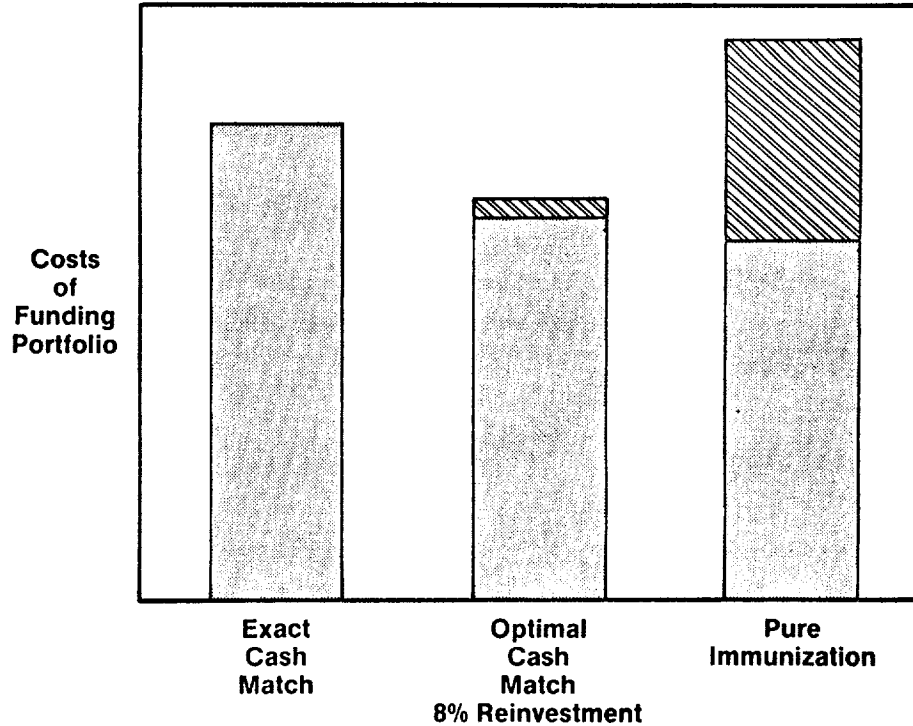
ADVANTAGES OF CLASSICAL IMMUNIZATION

- **Enhanced Range of Acceptable Securities**
- **Relative Cost Savings**
- **Overall Portfolio Flexibility**

DISADVANTAGES OF CLASSICAL IMMUNIZATION

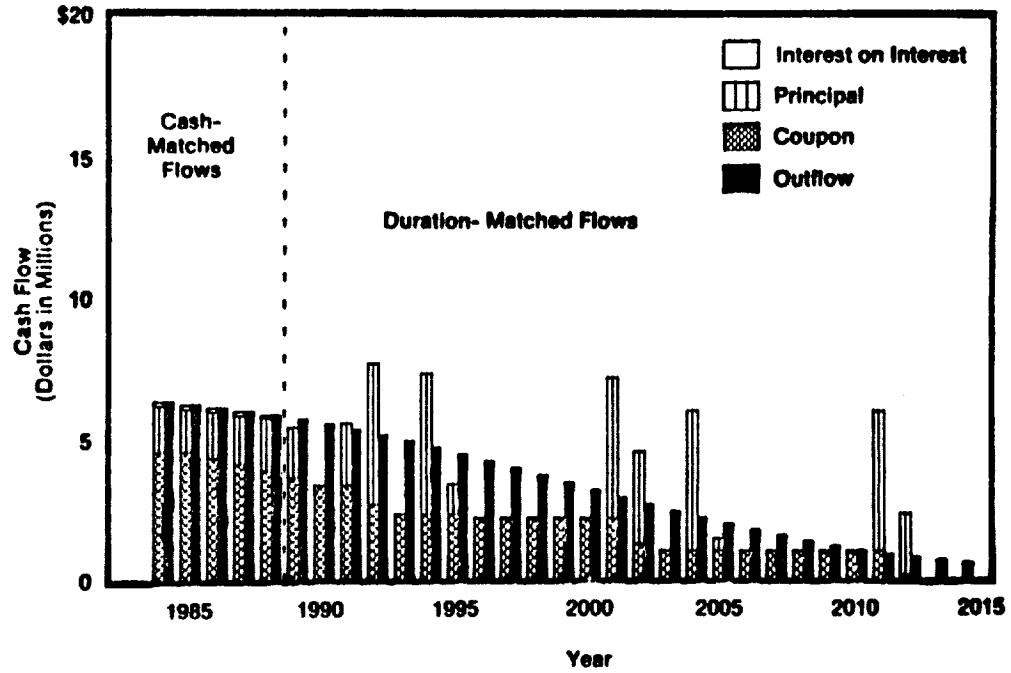
- **Complexity at Outset**
- **Vulnerability to Yield Curve Reshapings**
- **Forced Rebalancings**

PURE IMMUNIZATION RELATIVE COSTS AND RISKS

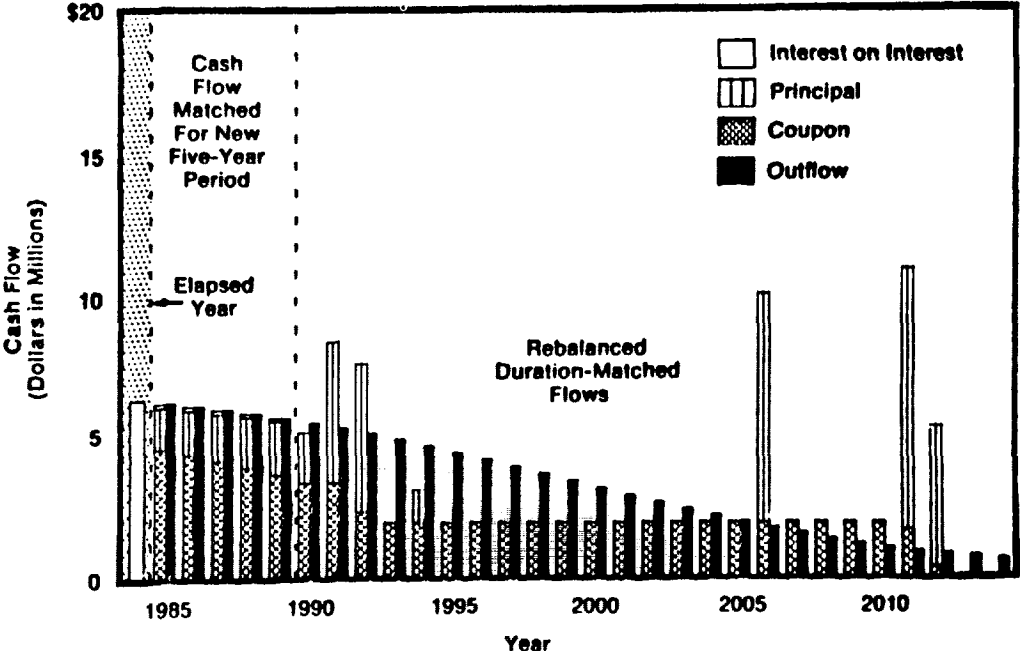


	Cash-Matching	Classical Immunization
Advantages	<ul style="list-style-type: none"> Assurance of Fulfillment Simplicity and High Comfort Level Widespread Actuarial Acceptance 	<ul style="list-style-type: none"> Enhanced Range of Acceptable Securities Relative Cost Savings Overall Portfolio Flexibility
Disadvantages	<ul style="list-style-type: none"> Tight Period-by-Period Constraints Restrictions on Choice of Securities Limited Flexibility for Ongoing Management Potential Overdependence on Payout Estimates (Especially in Later Years) 	<ul style="list-style-type: none"> Complexity at Outset Vulnerability to Yield Curve Reshapings Forced Rebalancings

Horizon-Matched Portfolio



The Roll-Out Procedure for the Horizon-Matched Portfolio



Savings From Horizon Matching

