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Session 102PD Risk Management Tools

Track: Investment

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Panelists: MR. W. STEVE PRINCE
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Summary: A wide range of tools exists in both the insurance and banking industries to measure and mitigate exposure to risk. For some risks, given their nature and volatility, real-time measurement and monitoring has become a necessity.

MR. CHARLES GILBERT: When the Investment Systems Council originally came up with the idea for this session, the objective was to provide people with some of the risk management tools and techniques currently in use. We found that one of the most topical risks facing both insurance companies and banks was equity market risk and activities of embedded options.

This session focuses on the risk management tools and techniques that measure and mitigate exposure associated with these products. Given the nature and volatility of these risks, real-time measurement in monitoring has become a necessity.

We have two distinguished speakers on the panel, Steve Prince and Dr. K. Ravindran. Steve Prince has been with the consulting firm of Dion, Durrell and Associates since 1997. He does a lot of work on structured reinsurance transactions and the modeling of various non-traditional risk mitigation structures. These structures allow companies to keep the risks they want and pass off the risks they don't want more effectively. The analysis to do this involves the tools Steve will be talking about today.

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Note: The chart(s) referred to in the text can be found at the end of the manuscript.

Steve has served on several committees of the Canadian Institute of Actuaries (CIA) and SOA, including chairing the Life Practice Committee during the overhaul of the Insurance Companies Act. He was an elected member of the CIA Council when the CIA was governed by a single council structure. He has numerous publications in the proceedings of the CIA and also in *The Record* and *Transactions* of the SOA. Steve has also authored an article on reinsurance that appeared in the June 9, 2001 issue of *The Actuary*. Recently, he was one of the advisors to the Office of the Superintendent of Financial Institutions (OSFI), regarding demutualization of Canada's Big Four mutual insurance companies.

Dr. Ravindran is the founding principal of Annuity Systems, Inc., and a leading expert in risk management. Dr. Ravindran has developed a holistic approach to managing risk, and has applied this to managing risk associated with products with investment guarantees. Dr. Ravindran has exotic derivative and portfolio management experience, and has traded in nearly every asset class.

In addition to trading, Dr. Ravindran has substantial hands-on experience in every aspect of executing hedging strategies including building models and systems, as well as putting in place the processes and controls. Dr. Ravindran has worked on several projects that use product development and securitization risk management tools. He recently ran the dynamic hedging program for a large U.S. insurer with over \$40 billion in assets under management.

Dr. Ravindran was also an intern professor at the University of Waterloo and the University of Calgary, and is a well-published author. Dr. Ravindran's writings include the best-selling book, *Customized Derivatives—A Step by Step Guide to Using Exotic Options, Swaps and other Customized Derivatives*. Some of his books and papers have been included as part of the Society of Actuaries exam syllabus.

MR. W. STEVE PRINCE: During the introduction Charles said that we will focus on tools to manage and measure risk, however, I'm not actually going to talk about measuring risk in terms of day-to-day tracking. Also, I am not going to specifically talk about investment risk. The tools and techniques, however, are the same. If you bear with me on the principles, hopefully we'll see the connections.

The two techniques are front-end design and optimized reinsurance. The tools used to do both of them are stochastic simulations and understanding your risk. I'm going to discuss the front-end design because it's often missed.

One of the big lessons from the Canadian seg fund situation over the last couple of years is that people charged into it because there was an analysis that indicated the product has no cost. Later, refinements showed that it often has no cost, which doesn't mean it never has any cost. The world originally said that if this has no cost, then all these enhancements have no cost.

Chart 1 shows the cost of 16 different seg fund guarantees, although the types of guarantees aren't listed. At the CIA/SOA session in 1999, they listed 18 reasonably standard products and asked the world to come up with prices in order to see how different they were. At one point in the evolution of seg funds; a lot of people were saying that these sixteen variations of products basically have no cost, or at least the same cost.

You may notice that very few of these costs are close to zero. Note that the bottom line for product design number two has an average cost of zero. But, at the 99th percentile, it has a cost of 10 percent of the fees people were typically charging. If you look across the board you will see that some had average fees as high as 50 percent of what companies were charging, while others rose to 150 or 100 percent just for the benefits and ignored any friction costs and commissions, etc.

As the true costs started to become apparent (the CIA seminar was certainly a step in that direction) a lot of energy went into finding ways to mitigate or manage this risk. Nobody seemed to ask why we were offering this guarantee in the first place. Once we had it, a lot of energy went into managing it on the back end. Companies were advertising that this product guarantees return of principle. If you paid in \$100 dollars at some point or points in time, you would get back \$100 dollars at some point or points in time. That's all the customer ever seemed to expect, and any customer I talked to couldn't tell the difference between variations and product. If this was all the customer wanted, why was the entire industry knocking itself out proliferating features with extremely different, and in some cases, extremely high costs, which nobody—certainly not the customer—seemed to be asking for?

You should understand the risk and risk drivers and ask yourself why you need to take this risk in the first place. I'm not saying you shouldn't take any risk, but if there's a range of risks that you could take or might take, put some energy into only taking the ones you actually need.

There are a number of stochastic tools. You can build spreadsheets, and there are some built-in features in Excel or other spreadsheet products that let you create some random numbers. There are also a number of third-party spreadsheet add-ins such as Crystal Ball and @Risk.

A number of non-spreadsheet modeling tools are designed from the ground up to let you build stochastic models without too much trouble. Like any good consulting firm, we have our own flavors of in-house software for this, but there are a lot of choices out there.

My point is that it's better to do some analysis with a poor model than to do no analysis at all. At the CIA/SOA session two years ago, we had a lot of debate about the third and fourth decimal place fitting into these curves, whereas analysis, even through the first or second decimal place will indicate a potential for problems. It's easy to get into the trap of think that you have to have a perfect model. In practice

it's better to go with what you have, and if that raises some alarm bells, deal with the alarm bells from the crude models rather than completely ignoring it.

It was entertaining; yet scary to sit through various sessions a couple of years ago and listen to people explain how they can't possibly model this stuff, although they sold \$10 billion of it last year. Something is missing in the process. As I said, some analysis—even if imperfect—forces a little thought on that front.

The first line of attack, and I'll say this about eight million times, is to ask yourself why you're taking this risk or all of this risk in the first place. Is there some lesser risk that you need to take that meets the customer's need? Once you have taken some risk, what's the best way to manage it?

Dr. K. Ravindran will discuss what I call non-reinsurance solutions, and I will discuss reinsurance solutions, although the line between these two is blurring quite a bit. Most major financial institutions have reinsurance arms and financial instrument arms. Whatever risk you wish to transfer can be done either way. You then get into debates about the regulatory treatment of this or that. But the analysis of the risk transfer is the same whether you want to call it reinsurance or something else.

I'm going to take an example from the life insurance world. Traditionally, companies go for proportional reinsurance, which means we will cede 50 percent of everything, or perhaps we will cede everything over \$250,000, which is generally expensive and inefficient because it is necessary to give up a lot of what you'd rather keep to get some of the small protection that you were looking for in the first place.

To optimize reinsurance you need to focus on the issue at hand, know what exactly you are really trying to accomplish, and then pay for only the parts needed. Let's take a simple problem from our elementary actuarial days. What is a safe policy retention limit for your insurance company?

The traditional solution is to do some models, look at some sizes of policies and number of claims, do some volatility analysis or a few stochastic runs, then determine that a particular retention limit seems to be okay. Then you cede everything in excess of that retention limit.

The objective is to try and minimize the risk of serious claims. I don't want claims to get too bad, but the result is that you have ceded a lot of insurance that probably could have been kept, even if things go exactly as or better than expected. Despite doing this, you're still exposed to volatility on a number of claims.

A different solution might be some excess of loss cover. When aggregate claims get above a certain point, then reinsurance kicks in. A lot of people do this poorly. One reason is that you don't get the regulatory or capital relief you wanted. That's certainly a consideration. The second reason is that they try to attach excess cover at such a low point that the price becomes astronomical. In this case, if you attach at points such as 105 –or 110 percent of expected, the reinsurer is actually worried

that you mis-priced it and you're not dealing with volatility. Instead, you're dealing with mis-pricing, and will get a very different cost. But in concept, if you attach at the right point, which requires some care, you remove the downside of serious claims while keeping more of your acceptable risk. This is a one-sided reinsurance solution.

Why stop there? There are actually two sides to the claims curve. Poor results tend to have serious consequences. You can get fired or transferred, and you'll get written up in the press asking why your company did this horrible thing. Good results are quickly forgotten and better will be expected the next time. Some may wonder, why you didn't trade one against the other?

Chart 2 is the total claims curve. You can probably live within any place in this central range. How wide or narrow the range is may be a point of some debate within your company. If claims are bad, you can't live with them being worse than that number. If claims are good, it's just as I said—it raises expectations that you'll do it again next year, which you may or may not be able to do.

A collar contract is a two-sided excess of loss cover. If claims are really bad, the reinsurer pays you. If claims are really good—this part is a little hard to swallow—you pay your reinsurer.

That's an uphill concept to sell with many people. But the advantage of this is that your initial premium is less than it would be under a usual excess of loss cover, and your volatility is reduced since volatility measures look at both sides. If you can reduce both sides, you've reduced the volatility.

I've constructed a hypothetical portfolio for small-to-large life claims, and have run four scenarios. One scenario is with no reinsurance and another is with the traditional solution of reducing our retention limit by 20 percent. Then, I set up an excess cover at the 98th percentile, and a collar contract that kicks in below the second percentile and above the 98th percentile.

Therefore, for this portfolio, my expected claims are about \$500. The retention reinsurance premium for ceding that is 20 percent higher, and the large cases are about \$20. I've ignored any cost of the reinsurer making a profit, doing everything on a net cost basis.

The excess of loss for the insurance premium, if one wants it, is \$1.10, and the collar reinsurance contract trading the second percentile against the 98th percentile is \$0.65. If you're expecting that to be half the cost of the excess it isn't, because your distribution is slightly skewed, so the upper two percent costs more than the lower two percent saves.

There are four contracts that are surprisingly similar (Chart 3). The green line is barely visible because both the collar and the excess contract overwrite it. Basically

there's a tail running off to the side—you can barely see it on the graph because it's so close to zero. If this happens, it can cost a lot of money. Go with the lower retention limit (the red line in the center). Things are more likely to be near the middle. Look at the data behind this chart. The tail still runs quite a bit off to the right. If you simply have a one-sided excess contract, there is a spike when claims get so bad that they can't get any worse.

This would actually be a direct vertical drop, but the charting software makes it appear as a triangle. If you go with a collar contract, the spike is a little bit to the side, because the cost is somewhat less than that of the excess contracts. But with the collar contract, the spike placement indicates that things are really good, and you pay your reinsurer a little more.

What does this do to your situation? In all these cases, you have a mean claim of \$500 because I priced all the reinsurance on a net cost basis (Table 1). Expected claims plus reinsurance cost are \$500.00 for each contract.

Table 1

Example

Net Claims Plus Reinsurance Premiums

	Mean	Std Dev
Gross Claims:	\$500	\$86
Retention Reins:	\$500	\$81
Excess Loss Reins:	\$500	\$83
Collar Reins:	\$500	\$82

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Your standard deviation, which is what a lot of people look at, is \$86 in the gross case, and with the lower retention, it drops to \$81. If you compare that with the standard deviation for the excess of loss reinsurance and with a collar, you'd say that reinsurance excess (the reduced retention limit) produces the least standard deviation, thus it is probably the best solution.

But what was your objective? Your objective was to avoid adverse claims. What were the odds that your claims would be in excess of the mean, plus 40 percent of

the mean? There's a two percent chance of that in a gross scenario. With the reduced retention limit, your probability of having claims that are much worse than expected is still 1.5 percent. Whereas, with the excess treaties or the collar treaty, the odds of claims greater than that is zero percent because anything over that number is picked up by excess reinsurance or the collar contract.

In the 99th percentile of claims you can see it's \$739 for gross claims, \$721 for retention, \$701 for excess reins or \$700 for collar reins (Table 2). If you're driven by value-at-risk (VAR) analysis, economic capital and CTE measures of risk, you'll notice that we dropped the percentile by a significant amount. If you look at the definition, a number of people ought to look at the N percentile minus the mean. The mean was 500. When multiplied by the N percentile, minus the mean, it goes from \$239 down to \$200. You've made a substantial reduction in the bad tail measures a lot of the world looks at despite having a higher standard deviation.

Table 2

Example

	Probability		99%ile
	Claims>		
	<u>Mean+40%</u>	<u>99%ile</u>	<u>CTE</u>
Gross Claims:	2%	\$739	\$789
Retention Reins:	1.5%	\$721	\$764
Excess Reins:	0%	\$701	\$701
Collar Reins:	0%	\$700	\$700

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The 99th percentile conditional tail expectation (CTE) column, which is the average of the things worse than the 99th percentile, has dropped from \$789 to \$700. If your objective was to reduce the tails, these excess or collar type contracts do a better job than traditional solutions. They do it at a much lower premium, which is \$1 or \$2 of reinsurance premium, versus the \$20 in the example I gave. You get the same expected value—they get similar standard deviations. They have very different percentiles in CTE, and if you measure capital on a VAR basis, they have very different capital in VAR.

Modeling complex portfolios is a significant undertaking. You can build simple models in a hurry. They may be significantly flawed. You can add to the process, but it is no small job. We have software that will model an entire company on a fully stochastic basis, but it was not easy to set it up. The potential benefit is in the millions of dollars of capital release, which gives a cost of capital in the single-digit millions. It's well worth the time and effort to set up those models. It doesn't necessarily give regulatory relief, which is an issue, but many companies measure their internal management performance on economic capital. These types of tools give a terrific improvement in economic capital.

The reinsurance and derivatives markets are blurring. As I said at the introduction, if you can model the structure and explain the cash flows, you can usually find somebody who will either take it as a reinsurance contract or as a derivative of some sort.

Stochastic models are the common language. This is why, in our company practice,

we construct these models and explain their workings in some depth without giving away all the trade secrets. Then we take 10,000 sets of stochastic outputs to the market and use them as a pricing tool to negotiate the cost of these contracts.

We do enough of this that there are counter parties on the other side that accept this subject to certain due diligence. However, they accept the concept and they accept us as presenting the results of our modeling, which will be used as a factor in their pricing.

However, they don't always come up with the price we want. Their price is often lower than it would have been on its own because of the stochastic results that we give them. So now there is (A), a tool to manage your business and (B), a lever to lower the cost of managing that business—and that's significant.

In summary, you should do some analysis on the front-end. You should think about why you want this risk in the first place. The fact that the world is going in that direction isn't necessarily a good reason. If you think some customers want it, this doesn't mean all customers want it or that they even expect it. Stochastic tools are useful in quantifying what each risk, or what each sub-component of that risk, costs. If nothing else, it forces some sort of cost-benefit thinking on the front end. On the back end, there are many different forms of reinsurance.

As I have said, the line with derivatives is blurring. Optimal reinsurance is something that does what you want without adding a lot of what you don't want or without costing too much. You can get huge gains in VAR measures or percentiles by remarkably small reinsurance premiums—if they're properly designed.

It takes some creativity to design and price unconventional reinsurance. As good consultants, we all like to think we're brilliant. We go in with clients and show them our "brilliant solution that worked so well last time." They listen politely and say, "That's nice, but it's not the problem we're having today." We then ask, "What is your problem?" And they answer, "You have to design it to fit the situation at hand."

Pricing these unconventional products is, again, no small exercise. However, the potential payoff is in the millions of dollars of reduced capital. You may need some new reinsurers; we find that some of them are more receptive to these things than others, but the reinsurer has the choice of either trying to come along or at least trying to understand what you want to do. It's their choice.

DR. RAVINDRAN: I want to step back from what Steve has done, then give an overview in terms of how all of these things come together and how to package everything. For example, I'm a big believer in common sense and understanding. I think if you can step back and have a better philosophical appreciation of the things you're trying to do, then when you get into the details, at least you have a better appreciation of the amount of work that's involved.

I'm going to talk about the types of risk that you typically would have writing or selling liabilities of this sort. The second issue I will discuss is an overview of what the risk management process is, or what it should be. Then I will talk to you about the processes and instruments of a good risk management system. .

It doesn't matter whether you write unit-linked products, variable annuities, income benefits or segregated funds, but underlying these products you can loosely break the problem into three parts. The first part is what I call the economic risk. By that I mean a risk associated with the guarantees embedded in the products.

Now you can say that you not only want to be able to model this long-term economic risk, but also be able to tie it in with risk-based capital (RBC) or something similar. That's all a matter of definition. Philosophically, if you step back, that's one form of economic risk that simply pertains to the guarantee that you have sold to someone.

The second part is what I call mostly capital volatility and the accounting-related type of risk. In Canada, required capital is a function of the account value. Typically, if you're not doing a good job risk managing, what happens if your account values fluctuate? The capital that's required also fluctuates, right? Many times they don't fluctuate in a one-to-one type of ratio, so you've got to be able to capture that.

Accounting risk is associated with this quite closely. To me, the definition of accounting risk is that it depends on the types of treatment that you get for using certain type of derivative instruments. You know whether they're going to carry them at book value. All of those things are part of the constraints. You have to understand what your objectives are when you try to solve the risk management problem. But once you understand everything, you still have to step back and ask yourself what the constraints are to solving that part of the problem.

Third is earnings volatility. Depending on what kind of revenue they generate it's mostly the profit of the company. Again, these things are all a function of the market value, because, as you well know by now, if the market does not do well, you will take a big hit. That is no surprise. Because of the ways revenues are structured, sales grow and people switch funds. Many factors drive this process. It doesn't matter what the product is, but this is typically how one would think—at least this is the way I think.

Let's discuss the risk management process. Let's say that today we start work at a company that has been selling billions of dollars worth of liabilities. What do we do? If somebody told us to do work and quantify the risk in terms of what's required, the first thing we would need is some in force. Then we would need to understand what kinds of product features are embedded into this liability block.

What do I mean by that? I want to know what kind of roll up I embedded into this

product, what kind of ratchet is embedded into this product, whether or not there are any roll ups, whether or not there are any kinds of currency risks embedded into it, and whether you give any kind of a currency risk, etc. The list goes on and on.

The second question you need to answer is: What are the objectives? This is very important because I find that the companies I've ended up working with many times haven't properly identified what the objectives are and what they want to do. At one moment they may tell you that they want to manage this long-term economic risk, the next moment it becomes related to capital volatility, then somebody else changes his or her mind, then it moves around. It's like a moving target.

One of the key things that you have to do before you start the whole process is sit down with senior management, grill them and get them to tell you the objective. Find out what you are trying to model or manage the volatility on. It could be anything. You have to have an objective.

Next is the model. I have broken out that part from the objectives. Objectives, to me, just define the payoff and payout to the company, as well as the time horizon for managing the payout. They say whether it's quarterly, annual, quarterly averaged into an annual payout, or quarterly and annual managed together. Those have more functions of payout.

Now I will discuss the fourth part—the model. This refers to things relating to the big debate still going on in terms of whether you should be using the trading model, an actual model, or an econometric model. Each has its own merits of cost.

Whether you'd be assuming that the returns are not normally distributed or that there are going to be 10 other people who will say, "In practice this is not what happens in the marketplace. If you look at history it's got this fat tail, thin tail, or no tail." You can dream up and do whatever you want.

The next thing you need is fund and market history, which comes in various aspects. When you start thinking about trying to put a number to the risk, your objectives do not matter.

You have to understand how your funds have performed historically, whether or not there's been a switch of fund managers, and if the objectives have changed.

You have to understand what kind of economic regime a country has gone through. This determines if you should use 50 years worth of data or only use three or five years' worth of data. These are some of the more fundamental questions that you will ask. For that you need the market and fund history.

Depending on how much information you have captured as a company, the fund

history will also give you insights into how your policyholders have behaved over this period of time. That gives you better insight in terms of how to factor other finessing into your whole modeling process.

So with that, altogether, what do you have? You have a dollar value of risk. I use the term "dollar value of risk" very loosely, but what I'm talking about are some risks pertaining to the objectives in which I'm interested. All these things are what I'm going to call a risk quantification process. Today I came in, then my boss told me to take all those things and to go get them done.

I got them done, so this is what I call risk quantification. What's next? I can either be assigned to do something else, or now I have to take this quantification. Well, they're good as of today, but what happens when the market moves? That is what we call a step-two process. Then we think about abating external variables.

What do I mean by external variables? These include whether or not there has been any kind of a records happening in the product, for example, whether or not its inflation increases, your yield curve has gone sideways, or your volatility has just spiked all the way up.

A lot of things drive all this process. You update the mixed set of variables, external variables that you have no control of, which will also include updating in force if you wish. But even if your in force was kept constant, there are a lot of other variables that drive this thing.

You can think of it as another repeat of a risk quantification process. That's what it is, but what are you doing if you're just updating it? If you only do it periodically, then set it aside and not do anything until five years down the road, you're going to be in deep trouble. Once you already set it up, the question is how to actually move the process.

You want to be able to leverage off all the work that has been done to get the first process right. That is what I call the updated dollar value of risk. In my mind, this is very tightly connected to the ability to monitor your risk.

Step one is to quantify your risk. You do all of the groundwork and set it up. Step two is to monitor the risk, because there's no point to quantifying it if you cannot monitor it. Monitoring is going to tell you what kind of a risk you are constantly exposed to and make sure that once all the objective dates arrive, it doesn't matter that it's once every quarter or once a year. At least you have a monitoring process in place in order to revisit your risk again and see if you're comfortable taking it on for the next year, or for the next quarter.

What if you have monitored this thing, and suddenly you see something that you don't like? What do you do? You cannot go back and stop quantifying it and change your variables. Maybe you can if your models are wrong to start with, but you

cannot go back and change your variables and say, "You know what, I was wrong with my inflation numbers. They were actually a lot lower than what I anticipated them to be, so I'm still not at risk right now." I've seen people do it, by the way, so it's not too far-fetched. But the next thing that I think is crucial is the aspect of managing a risk.

What do you need to manage a risk? I started off with this whole concept about the approaches—the models. You will have the internal models, trading models, and econometric models. If you work with a trading model, that's great. It's not too much of a change in mindset, because all of a sudden you are very nicely transferring into your old world of capital markets reinsurance. As Steve pointed out, everything is also tied in closely, and given the fact that sometimes reinsurance is not completely available, you may want to combine both. You may want to keep a certain aspect, or certain parts of it, or you may want to reinsure certain parts of it.

When you're done, you're still managing risk. You start with a trading model that's easy, and you go through a nice transition. But then if the whole problem is an external model, when an econometric model appears, the question becomes, how do you move that across?

The second thing that you have to think about is capital markets. What do I mean by capital markets? The very fact that you may manage part reinsurance and the rest of it indicates that you are exposed to it. Then you may manage yourself or you may not have done any reinsurance, and you want to manage all of it. I do not assume that you've completely reinsured everything, which would be a simpler process.

What do you have to do in capital markets? You have to think about the kinds of instruments you want to use, and what kind of market prices there are. You have to worry about volume and timing. The third one, which is very often overlooked, and a big reason why a lot of people go belly up, is infrastructure. Infrastructure is extremely important. Sometimes people may say, "I'm only managing this one risk and only looking at it once a week or once a month. I don't need an infrastructure."

Wrong—you still need an infrastructure, and one that is customized to what you're trying to do. What do I mean by infrastructure? Are you set up to do margin trading, for example? Are your ISDAs in place? ISDA, incidentally, refers to the international swaps and derivatives association-type agreement. Are your controls in place? Do you know which trades you'll call your brokers to execute? Do they have approval? What is the trading limit that you're going to be exposed to? A lot of details are embedded in all of those questions.

When you start managing a risk you have to be able to monitor it and act on it. I use the term "real time" very loosely, but in the sense that the only reason you're

not acting on something is because you have decided not to act. It is not because you cannot act or don't know how to act. Those are the wrong reasons for not acting.

When I talk about real time, I'm saying that at any time, you need to be able to know what your risks are, and to be able to quantify them. Then you need to be able to know the kinds of things with which you can easily go into the marketplace, so that you can start to manage your risk to a level you're comfortable with. That's what I'm going to call the "managed dollar value" of risk. This is managed because it is what I'm comfortable with in terms of maintaining. This is, of course, called a risk management process. This is step three.

In summary, step one talked about risk quantification. Remember, to do risk quantification you need systems. It doesn't matter whether you built it internally, but if you bought a third party vendor-type system, it doesn't really matter. You will eventually need a system that will enable you to get information, do the modeling for you and give you the answers. Ultimately, you need a system.

You need the systems to not only quantify, but also to be able to monitor. Step three is managing. In managing, it becomes a bit more complex, because not only do you need your systems, but you also need a good process to make sure your controls are in place, and you need to make sure that you know exactly the contracts that you are allowed to do or you should get into to be able to manage a risk. Right now, you have three things to worry about.

I want to step back and philosophically show you how a system actually computerizes or automates a process. That's what a system does. Since you don't want to keep doing something over and over again every day, what do you do? You decide to automate it. That automation part is what you call a system. When you think about systems, you should think about something that allows you to automate a process.

I'm talking about the ability to automate a process that you have to go through. So, in fact, you can reduce this whole thing into one of processes and instruments. But systems will be a component in terms of taking care of all the automated processes that must be considered.

What should a good risk management system have? I will start with a system component. It should be able to bridge models to capital market. What do I mean by that? If you do have a trading model, for the sake of simplicity let's say a lognormal model, when you look at lognormal models and use that to quantify or monitor a risk, when you talk about a 50 percent volatility, go to the capital market, and tell them that you want to buy volatility 20 percent or volatility 50 percent, people understand the language. This is because it is a dollar for a dollar.

In this case, you don't have the problem of trying to convert to how the market

looks at risk. You're speaking the same language, working through the same currency, and moving from quantification to monitoring to merging. It's a very smooth process that doesn't have any extra complications.

You can also talk about what happens if you start with an actuarial model. It is not a smooth transition. Case in point—you may have actuarial models in which inflation is one of the efforts. My first question is, "now that you've done your quantification of inflation question, how are you going to manage your risk on inflation?" What kind of instruments can you buy in the marketplace? Very few. There is no liquidity. Again, the whole concept behind those actuarial economic models does a good job in terms of making your model more sophisticated and more sound, theoretically, at a quantification level; but at the execution level, they become impractical.

This is where the balance comes, as Steve eluded to earlier. You need to have a good balance between searching for this Holy Grail that has everything that allows you to model all sorts of risks, versus the ability to go out in the marketplace and execute what you think needs to be done, if you're managing the risk.

Now keep in mind that the trading part, for example, would be very much less of a problem if you were using their actuarial stuff or you were using the econometric model and reinsured everything completely to a reinsurer. Then you would not have that problem. You start having this problem as soon as you decide that you want to come to the marketplace and start to manage a risk. Then you're immediately exposed to that problem.

However, because you can manage inflation, you have to know how all these equity markets work in tandem with your interest rate market. Also, you have to understand the short-term rates and the long-term rates, then when you look at all the econometric actuarial models, you see a lot of variables running all over.

The only reason, the big reason, why the Black-Sholes model has stood the test of time is because it's very simple to interpret and understand. It's easy to draw pictures and explain how things are when markets are moving, especially in very volatile markets. It's easy for you to start arresting the problem on what's going wrong. Even in extremely volatile markets, you may see volatility at 50 percent, which is quite huge, but I have seen, literally, volatility up to 1000 percent. For example, they have been quite common in the electricity market..

However, people still use the whole idea of Black-Sholes and try to make changes on those things. But again, the reason people do that is because intuitively, it is a lot easier to maneuver, and that's part of the trading model. I use Black-Sholes as an example. There are other trading models that one can decide to use.

The second part is real time. You need to have the ability to actually decide that once you see the risk, you know markets are starting to go down again. What can

you do almost instantaneously? What can you do to start planning your execution or trading strategies?

You need to be able to monitor your risk "real time." I'm fully aware that because your impulse may be large, you may have, for example, 500,000 qualities, and it's going to take time to run all those things. This is why it is all the more important to be able to come up with great proxies that are going to give you an almost instantaneous-type run within a couple of hours, if you wish. It becomes just as important to be able to understand how things can change with your in forces, so that you can actually start quantifying them and working with the parameters that you're comfortable managing.

I want to show what this looks like. So far, I've not been showing too much of a "touch and feel type of picture" in terms of what this is. I'm going to show you an example of a real-time screen and what it looks like (Chart 4). It should have the ability to look at your tickers. That's what you're using. It should be able to tell you what kind of underlying you have. It should be able to use what kind of a current date expired, strike, buy price, sell price, and it doesn't matter whether you're using exchange, traded over the counter. It should be able to give you all of this information at your fingertips. When you decide to get an update, it should be able to be hooked on to any kind of a live feed. That's important.

Now for the next one. You want to be able to quantify, monitor, and manage risk holistically. If you sit back again and start pulling yourself up from the whole problem, this is the whole holistic process. What do I mean by that? Market risk is not the only thing that's involved. People that lapse can affect your market risk. People that die can affect your market risk. Your market risk can also be affected by how your regulations change.

You have to now stop factoring all those things into it. Ultimately, yes, it is only market risk that it can manage with capital markets. That's why you have to start coming up with better ideas such as underlying thought processes, underlying securitization, and product development. How can you start to develop new products in order to start off setting some of the risk that you cannot manage quite so easily in the marketplace? You have to start putting all the pieces together and very soon it can get quite complex.

It is important to be able to quantify, monitor, and manage a risk holistically, not only in one dimension, but in looking at the problem in a bigger dimension. Remember that I mentioned the economic manager who actually talks about the economic risk. Economic risk traditionally tends to be more long-dated. So you have long-dated volatility, long-dated correlation, etc. When you look at more of the capital-type volatilities or those relating to earnings, for example, they are the short-dated type, such as three months, one year, or six months. So the question becomes: how can you start combining a short-term volatility with a long-term one and start managing the risk together? That's where it gets tricky. Therefore, it is

very important for you to be able to make your objectives.

Again, it comes back to the whole idea of objectives. What are your objectives? If your objectives are only to help manage economic risk, then you don't have that problem. But if your objective is to hit the economic risk, then manage your capital volatility at the same time, you have another problem. You have to be able to package everything together.

When all is complete, however, you have to be able to look at your risk holistically and look across different product assumptions to see how all those risks will add up. This gives you another big picture in terms of talking about being a simplified model, which was explained to you before hedging—what kind of a risk you have in terms of your market to market, your delta gamma vegas, then after hedging holistically again, how this risk reduces it. You should be able to see the impact of these things. That's the proper way of doing risk management.

This is actually quite dear to me—the ability to make things illustrative and intuitive. There is nothing like the power of communication, and a picture definitely says a lot more than words in terms of numbers.

When you're managing risk, one of the big problems that I have seen is that many times you have to go to your board and explain what you have done in a way that makes sense. How do you do that? They are not rocket scientists. Don't tell them about all of these econometric models or about inflation going up one way while your long-term interest rates going up that way on the side. You have to find the correlation that has got the GARCH process or ARCH process or they will show you the door. You don't want to get into that kind of stuff.

It is the "keep it simple" principle, in the sense that as long as you have as many pictures as possible to illustrate what you're doing, then you'll accomplish more. It takes less time to communicate, and you may be very in-tune with what you're doing. You may be very comfortable with the numbers. You may know your numbers to the 14th decimal place. Somebody sitting on the board doesn't have the time or desire to figure out the 14th decimal place. Somehow you take that knowledge and package it into something that people can understand and appreciate. You do this through pictures. Pictures are the best form of communication.

For example, look at the in force. I want to be able to tell someone that when I look at my in force, I've broken it down into categories. One pertains to a Canadian equity, one pertains to the fixed income sector, and one pertains to international funds. To me, instead of just looking at the series of numbers, being able to graphically tell a story is worth a lot more. You cut down your time, you cut down on people's misunderstanding of the numbers, and then you get your message across quite easily.

This is one example in which you're illustrating the breakdown of your in force.

Another example could be a basis risk. You want to show what kind of basis risk you are taking in terms of managing your risk underlying these products. Because of the fact that the funds are all actively managed, and that you're actually using liquid hedges, managing a risk clearly is going to be basis risk. How do you quantify them? Pictures. You want numbers too, but pictures are just as important to be able to quantify that to your senior management.

One of the key elements of a good risk management system is that it should allow you to be practical. This means it should allow you to not only look and understand what risk you have, but to go out and do something. Act on what you've seen so you can bring these things back or you can bring your risk back to within the limits that you're happy with. If a system doesn't do that, then it's not a good risk management system.

In this simple example I'm using the Standard & Poor's 500 (S&P) and the National Bureau of Standards (NBS). Let's say this is the exposure that I've identified, the one that I'm exposed to. The next question, before I clearly start to buy or pretend that I'm a big time illustrator, is to be able to understand the likelihood that these indexes are going to be the way they are. Is it likely that the S&P index is going to be as low as 372? How likely is that? Is it likely that the NBS is going to be as low as 1,524? How likely is that? Those are the questions that you have to be able to answer. How do you do that? As long as you can associate a probability or picture that kind of depicts the joint movements, it doesn't matter whether they can be drawn from the implied market or if they could be subjective, from your opinion, because of your feel for how the market behaves.

You should be able to quantify the likelihood of each path of these underlyings, taking in the particular point in time. Once you identify that, you can actually start looking at what kind of hedges you need so you can bring everything back to the level that you want. Once you do that, one of the key things you should be able to look for is what kind of a residual exposure do you have after putting on those hedges?

You have to be able to look at the exposure before and after hedging, and look at the transaction cost incurred in the hedging process. Then you must continue to refine the whole thing. It's a cyclical process. Risk management is not a one-step process. It's not one-way traffic in the sense that you don't decide today, you don't decide on the trades, and you just go and bam-boom—you call, you execute, you're done and then revisit the whole thing one year later. It doesn't work that way.

It's a cyclical process. You start with inflation, you decide what you want to do and what kind of a price you're going to pay, then you come back again. You run it one more time and ask yourself whether it's a premium you're comfortable paying. What is your downside? What is your upside? You ask those questions. It's a cycle for a few iterations, then you have the answer you're looking for.

What about the features of a good process? For any process to be good it has to have well-defined objectives. Again, this is what I started with—the premise that people have to come and tell you exactly what kind of volatility you should manage. For example, should you manage your volatility around your profit statement? Or should it be around your capital? People can define different criteria, but you have to understand what those objectives are before you can start investing any time in terms of trying to do what needs to be done.

The second thing is accountability. Accountability is very important. The last thing you want is for somebody to decide to execute trades today, because the person executing the trades this week is not around. In this situation, there's no proper accountability or proper control in place in terms of: if this person actually goes away who's going to be the replacement? Clearly, you don't want the person who runs the back office to be the one executing the trades. We have heard a lot of stories about this including Barings Bank in Orange County. The list goes on and on.

Many times, if you sit back and look at the reasons, it's all because of bad controls. I have been brought in a few times, to look at some of the forensics associated with things collapsing. You'd be surprised at how simple those controls could have been. Nobody cared about putting them in place, because at that point in time they did not think it was necessary until they started losing money. Then, of course, it's too late.

This comes back to the next part—proper controls. Who has the authority to do all of the trades? Maybe as long as your risk is within a certain tolerance level, for example, a half-million dollars, you don't need any kind of a limit. You can work within that. Then, for anything that exceeds that amount, you have to close a position or get senior management involved to get approval to execute trades because you feel that the market is going to come down. At this point in time, however, your risk has just surpassed the half-million dollar mark, for example. You need those controls to work within the parameters in terms of what needs to be done.

Again, something that I've seen quite frequently in insurance companies is that people tend to think that execution is something that can be regimented. For example, they will tell you that every fourth Wednesday or third Wednesday, or third Friday, the contracts and exchanges expire. However, every third Wednesday—two days prior—we will go to the marketplace and execute those hedges. That's a process. In their mind that means they can do other things they want to do. Monday of that week, they start pulling in all the information, do the work for two days, and then on Wednesday, start executing. This is wrong.

That is never a good way to execute trades because the market is never your friend. You have to learn to understand what the market can do or will do that is going to affect you. The key behind all this execution is to be able to go into the

marketplace and execute trades when conditions are very favorable, then pull yourself away from executing them when conditions are not favorable.

But how can you have this very superfluous process? You can only have that if the process that the people put into place does not hold up the execution. If somebody tells you that only on every third Wednesday of the month you can execute a trade, it defeats the whole thing. This is because, come that third Wednesday of the month, what's going to happen? If, for example, a company has some bad announcements on that day, then what happens? The market suddenly crashes, then you start to buy options on NBS or S&P. You end up paying a lot for the volatility, which easily could be avoided if you do this earlier. These are things from the practical aspect that you need to put into place. With any process you put into place, keep in mind that it should not hold up execution.

What about the features of good instruments? I'm talking about puts, calls, any of the capital market instruments, or even reinsurance. A good feature includes a small transaction cost. The last thing you want is to be able to get into instruments with heavy transaction costs. It takes away a lot of the leverage that you have by managing your own risk. The key thing is to look for instruments that have a very low transaction cost.

The second thing is to look for instruments that have very small basis risks with what you're looking for. If you're looking for an actively managed fund one, for example, try a Templeton growth. I'm just throwing some names out here. For example, you could focus on the S&P 500 index. Do not worry about the NASDAQ for things of this sort. You want to identify the indices that have got very little base risk. Not only that, but you also have to balance it against making sure that you are executing on the indices with very little spread because sometimes a liquid can have a very tight performance with your actively managed fund. But when you start looking at instruments on that particular index, it can be very costly for you to make transactions. In this case you want to decide to keep away from that.

The next thing that you want is very little counter-party risk—as little as possible. This particularly rates to when you start getting into the long-dated or over-the-counter (OTC) options. For example, if you get into a 10-year option contract or a reinsurance contract, do you know your counter-party risk? Do you know what your counter party is doing to manage that risk? Don't be happy just because you've reinsured. If the people who reinsured you are not doing anything about that, then you'll go down with them.

These are the questions that you have to ask yourself. It is okay to ask these questions in order to make sure your board is wonderful in terms of knowing what kind of a risk that you are exposed to.

The next thing comes up to the type of bid-offer spread. This is a related transaction cost. A "tight bid-offer spread" means that the market is pretty liquid.

You can go in and come out any time. Again, this means that you don't want to get into a 10-year or a counter-option and pay a huge premium, then when you decide to unwind a month later because lapses have changed, you pay another huge premium to get out. You want to be able to factor in a lot of those things as much as possible. This ties into high liquidity too.

In conclusion, there's something that I would like to pass on to you. Based on my experience, in terms of what I've seen across all markets, quantification and monitoring is only half the picture. You're never going to get a full appreciation of what needs to be done or what should be done if you stop at quantification and monitoring. As I said, there are many extenuating circumstances in which this argument would work. If you're completely reinsured, that's another story. But as long as you manage risk, quantification and monitoring alone are not enough. You need to be able to manage a risk, then you have the complete picture. Because looking at your picture from merely a half-standpoint is not going to help you with anything.

MR. GILBERT: Steve, could you expand on the stochastic models that are used in looking at the optimized reinsurance?

MR. PRINCE: We have a range of tools, and to date, the model has to be built to the application at hand. We're doing a lot of this in our firm on casualty blocks of business. In these cases, we have to build multi-country models or multi-line models of claims.

A technical situation might be when a large reinsurer has exposures in much of Europe. An example of a situation that you would model would be if there was storm in France and it affected Germany, whereas serious auto claims in Italy aren't likely going to affect your claims in England. But this depends very much on your client's type of situation. From that, we build up the modeling of the terms of the reinsurance contract itself.

If it attaches it at a certain point, you have to model that. Casualty contracts have a lot more variables in them than life insurance contracts do. I discovered this with some surprise. They have limits, and ways you can reinstate once you have hit the limit, as well as costs for this. You have to model in all those features of the reinsurance program, as well as the underlying risk. The process of building a model for one client might take four or five weeks. The payoff is potentially in the millions of dollars, so it's time well spent.

MR. GILBERT: So they're consistent to capital market pricing regarding the terms of the stochastic models, would they be risk neutral, for example?

MR. PRINCE: We tend not to be risk-neutral. Risk-neutral pricing assumes there's another side to whatever risk you're going to take and the nature of the things we're covering means there usually isn't another side of it. We'll build our view of

the world, we'll shop the market and we'll get reinsurers' views of the world and hopefully find a workable solution somewhere in there. By definition, it tends not to be capital markets or risk-neutral.

MR. GILBERT: Right. There is an application for this type of optimized reinsurance when you look at equity risks and products with investment guarantees. Whereas, with part of the total risk management solution, you could use reinsurance to hedge either way—the first layer or the tail exposure.

MR. PRINCE: Yes, our experience is that trying to reinsure the whole risk is quite expensive and I think most of the world has discovered that. We've done some modeling, which suggests that if you simply reinsure that tail, you can keep it within the bounds that you're willing to live with, then your reinsurance cost is much lower. This is because you're only paying to reinsure the tail, and by any kind of capital measure you can show that's optimal, compared with ceding the whole thing.

MR. STEVE COOPERSTEIN: You talked about finding reinsurers once you have evaluated the excess loss. Are you looking for reinsurers who, in turn, hedge their risk, or are you looking for reinsurers who look at your manifestation of the risk and say they have risk tolerance, and they can take this excess risk without hedging it?

MR. PRINCE: We tend to not know what the reinsurer is actually doing, although we have opinions. We will look at, and Dr. Ravindran mentioned, counter-party risk. We'll look at the size of the risk and if we think if somebody is taking a risk on their own account, which is larger than we think they can prudently bear, then we would advise the client not to go that way because of the counter-party risk.

Reinsurers are generally a little sensitive in disclosing how they manage the risk and whether they're taking it themselves. Having said that, we get called in on unrelated transactions where there is clearly a reinsurer. He's lined up some transaction and we get called in to help hedge it out of the back-end. A lot of that goes on although it's not always obvious to the client during the negotiations.

MS. JOSEE DEROY: In terms of reinsurance, can you give us some information on whether or not there are many property and casualty (P&C) reinsurers, life reinsurers, and if they take a 100 percent quota share of that, or like portions of that?

MR. PRINCE: Most of the sophisticated modeling work tends to be on the P&C side. Life reinsurance tends to be aimed at capital relief and, honestly, there is not a lot of stochastic involvement in it. You can model the mortality fluctuation a little bit. Basically, it's so stable and predictable that it's not an issue.

In terms of whether we deal with casualty reinsurers, we tend to deal with financial institutions that are all-encompassing. They will have the casualty arm, a

derivatives desk, and we will go in and print out the problem, they analyze it, and if there is cash flow, we ask if we now write that as an ISDA. Do we write that as a P&C reinsurance contract? They tend to be able to write whichever suits the client best.

MR. GILBERT: Dr. Ravindran, I had a question with respect to your approach to modeling the basis risk. This is a significant issue for a lot of companies that have actively-managed funds in their portfolios, investment guarantees, and try to hedge the embedded options in those guarantees. Could you explain a bit more the process that you use in terms of quantifying the basis risk?

DR. RAVINDRAN: The quantification of the basis risk can actually be done in a couple of ways. But the way that we have set it up right now for some of the clients is based on historical data. Then you're also interested in the time horizon on which you're trying to manage a risk, so it's a function of your time horizon, it's a function of your underlying, and it's also a function of what exactly you are trying to replicate with. This is because, if you typically take a company that writes this kind of a business, they may have, for example, 80 or 100 funds, but you cannot actually try to replicate each fund with an underlying. Instead, you try to solve the problem by first grouping the funds into portfolios.

Again, try to come up with a way of grouping them into portfolios so that you have portfolios that contain funds with similar characteristics. Then, once you're done, the next question becomes, how do you actually tie that in with basis risk in terms of the underlying indices? That part of the basis risk has to be many times history, but then what we do is combine that history, then turn it into a predictive model.

MR. COOPERSTEIN: Dr. Ravindran, you spoke about preparing the hedge manager or the trader for what you're going to do in advance. It scared me a little bit. I've talked to hedge managers who say their experience would save us so much money because they know when to go with which type of instruments. But it still indicates that you depend on a human judgment as to what the market is doing and how the market feels. We know the market can change beyond human anticipation.

DR. RAVINDRAN: Yes, that's an excellent point. Before I answer the question, I will give you a quick anecdote. I had one client who came to look at the systems that we were selling, and he said they were great. He said that they had optimizers working and it was so easy. We could actually run this thing overnight, then come in and look at all the hedges we have to do.

The next question that the client asked me was, "Can this thing be executed directly into any of these exchanges so you can automatically execute a trade?"

I said, "Sure, it can be done." You don't need to come into work anymore. Just stay at home.

The key thing that one has to realize in managing millions of dollars of risk, even in very difficult markets is that there is no substitute for human judgment. I do not want to take that away. The person looking at the markets day in and day out, understanding the nuances that go into it, will end up with a better appreciation of how the markets work and their tendencies. There could also be new instruments that may be more liquid.

I hate to say this, but when it comes down to it, you have to depend on judgment. I assume that it is a very well-qualified judgment. And yes, you have to depend on that—there's no substitute for it. You cannot take that away and computerize everything, because once you start doing that, you lose everything, and all of a sudden you have your process in place. Once you start automating the process, you don't even see what it actually went through.

Keep in mind what you are doing when you're trying to automate any process. You are actually automating the thought process of a human being's top processes. I'm saying that doesn't allow you to quickly react to other situations that you haven't thought about. I think automating is pretty dangerous.

MR. PRINCE: To add more context to that, the trading expertise is definitely an integral part of risk management or the hedging process. However, it's pre-supposed that some guidelines and trading limits would be established within which the trader can act.

MR. ARNOLD GREENSPOON: Getting back to the reinsurance collar, I don't know if there's a market for the low-end claims tail yet. Have you seen any real value in the price break from reinsurers in exchange for giving them back the tail on the lower two percent of claims? How would you account for that?

Again, this is really an economic play, but it doesn't seem to be accountable as a premium because you're not getting anything for the premium. If there is no real price, can you build in other methods of deferring the good news of low claims that you don't want to take today?

MR. PRINCE: The answer to all of the above is yes. We do see a price break. We go to some pains to calculate what we think the price break should be compared to what the reinsurer is telling us the price would be. How do you account for that? We have significant debates with accountants on this point. If your reinsurance contracts say it's a premium, then it's a premium. This sounds trite, but that's the way it works. Are there other ways to defer this good news? Yes, you can write multi-year reinsurance contracts, and this is more common in casualty than in life. But you write a multi-year contract where that money basically stays in some sort of internal smoothing account. The danger you run into there is concerns that it's an income-smoothing device, then the accountants get quite upset. The skill there is in crafting the contract language so that you get the effect you want while complying with the appropriate set of accounting rules. The answer is different for U.S. GAAP

than it is for Canada and parts of Europe. It comes down to the skill of writing the contract.

MR. ROB HINRICHS: In the spectrum of enterprise risk management, what have you seen in the murky world of operational risk? Are there any tools that you've come across? Or is that an area that's too ill-defined to come up with tools?

MR. PRINCE: It's not too ill-defined—it suffers from lack of data. We've talked to a few big financial institutions about modeling their operational risk and we prided ourselves on the creativity and imagination of our approach. We were told that there are internal guys that come up with the same thing, and there wasn't any data to go with it. There are databases available that give you the claims information you want. We don't sell it, but there are firms that do. The databases suffer from conformability; what are the odds of a \$100 million dollar lawsuit? The answer is that it depends what business you're in, and it's hard to answer that question by looking at 10 \$100 million dollar lawsuits and saying that we might get hit with two of those but not the other eight. In terms of the structure of the models, again, we prided ourselves on the brilliance of our approach. I actually found an article in one academic journal that described the approach I came up with exactly. But it then went on to criticize it. Not only were we not very clever, we weren't even original. To answer your question, I don't have a great solution, but I think I'm on the leading edge of the vagueness of it.

DR. RAVINDRAN: I'd like to add something to Steve's comments. There are some enterprise-wide risk management models if you go to other markets. Not in the reinsurance market. But if you go to the energy markets, for example, you can see a lot of that. People there have actually implemented some of them, especially the large, billion-dollar corporations.

MR. PRINCE: Some specific examples of operational risk management tools that I've seen in the market include a "heat map," which basically takes a look at all of the different risks that have been identified with your management and the heads of the various departments within the company. Basically it's an interview process in which you go through and identify an encyclopedia of all the potential risk exposures that you have, then try to narrow down the critical risks and less critical risks. It gives company management a good idea of where the hot spots are. Another one is a "flight simulator," which basically models the business of the enterprise, and by taking a look at changing various factors, you can set it up so that management can change various parameters, or in the form of dials, you increase or decrease commissions or expenses.

Basically it's a "what if" scenario analysis, and it shows you on an instantaneous basis, that "if this happens," "this is the impact" on the company.

MR. MICHAEL PADO: I have a question for Dr. Ravindran. You mentioned bridging the gap between the actuarial world and the trading world. I know you're quite

experienced in the Canadian seg fund concept with the maturity guarantee. How would you describe putting in a risk management process that recognizes variation in the expected insurance assumptions as you move through time?

DR. RAVINDRAN: There are two answers to that. One answer is when you are at current time and you're looking forward to another point in time, in terms of what you perceive happening. The other answer is being able to factor out the effects of each of these things as you are actually walking through time.

One answer is predictive and one is realization. Realization is a little bit easier, but with the predictive part, you end up making quite a few assumptions. We have done some work for clients where you have to make assumptions in terms of where the volatilities are going to be in the future. It's all based on the "what if" approach, and there is no shortcut around it.

The only answer is based on the fact that you have to be able to simulate things throughout time, but as you roll forward, you have to make the assumptions in terms of how markets are going to behave. The new way to do that is to run a different set of assumptions for every set of paths that you want to take. Then look at the impact from all the varying assumptions. The key thing, however, is to be able to not only look at the predictive, but also be able to work in realizing what exactly you are seeing in market risk. For example, from last month to this month, what percentage have your numbers changed because of basis risks? What percentage is because of slippages in volatility? What percentage is because of slippages in lapses?

Those two things have to be connected. Now one of the things that you can also do is have the predictive—the history. Clearly, you can actually start if you have enough history. As I said, in my experience, the things that I've seen we never seemed to have enough history or structural details of in force. You can actually build up a history, but with the predictive one, you've got no choice and you have to do a lot of "what if" scenario modeling. There's no way around it, and there are no shortcuts. You have to do that.

The realization part is the ability to take the predictive part, work along the same type of concept, and be able to start partitioning the risk. At least you have a good feel for how these things have been performing in the last three or four months. You have a better handle in terms of what your predictive parts are.

MR. PADO: As you're moving through time and have some history building up, you're predicting on, for example, a seg fund guarantee and you expect 70 percent or so of the people to remain there after the tenth year. You're moving through time. You notice that the persistency is either greater or less than you'd expect it to be at that particular point, if you look at it from an issue date point-of-view. In talking to traders it strikes me that they want to make the adjustments for that as they move through time.

The actuary is saying, "You're crazy to make those adjustments because we know it's not a flat number." We think it will ultimately be right. But there's noise around this—there's a distribution. The actuary doesn't think you should change a thing because you're spending more time, money, or effort in making micro adjustments. Who makes the call, and how often?

DR. RAVINDRAN: I think the question that he's asking is about the ability to understand. Let's say you've already made a long-term assumption in terms of what those facilities are, then the next question that he could ask is if that's an assumption that you are going to make and if those guys are going to be managing the risk on changes or fluctuations from that.

The question is, "What kind of fluctuations are your prepared to accept?" This comes back to one of the points that Charles and I both made earlier about the idea of tolerance. You have to be able to quantify what percentage of dollar value limit you are assigning to the slippages in persistency. You can work within that. This is why it becomes important to be able to start de-composing all of the different pieces. That is when you move from a day-to-day, mark-to-market, from one jump to the next, and you will know what percentage was attributed to this particular type of fluctuation. Therefore, it is actually warranted to make an adjustment when breaching this tolerance limit. That's when you go out re-balancing.

You've got to work harder, and that is the only practical way to do it. I think people, especially the trading guys, would be tempted to change it, too. But then the problem is, as you very correctly said, that you have a good feel for what this thing is going to be over the long term.

Now, the trick is to put a corridor around what you believe this long-term behavior to be. Then, try to convert that into a dollar value type of payoff so you can tell the trader that this is the attribution due to the dollar value slippage-in persistencies. If at any time when you rerun your models and if it changes by this amount, you're not going to do anything. This is the way it is. You can change anything past this.

MR. PRINCE: In practice, what would happen if you were running a dynamic hedging program and typically, insurance companies would refresh or upload a snapshot of their liability file on a weekly or monthly basis? For example, if your actual experience that emerged was different than what you assumed in projecting those liabilities and modeling the embedded option in those liabilities, you would have new options sensitivities that would, in all likelihood, cause you to rebalance as a result. You can reflect it as you move through time.

MR. PADO: You mentioned at this point about updating the in-force portfolio and making adjustments. It strikes me that the reinsurance industry, particularly on the life-side, is very inefficient with respect to administering business and updating that in-force file. When you move into the annuity world—and particularly, the equity-based annuity world—where people are actively trying to manage this risk here, you

may want to rebalance daily if you get enough information on a timely basis.

As a major reinsurer, we're not there yet in terms of being able to get that level of cooperation in the positive sense or in terms of getting this data from all of the potential clients with that frequency, because it doesn't arrive in the same form. It's not always correct. Data issues are paramount with respect to trying to manage the risk.

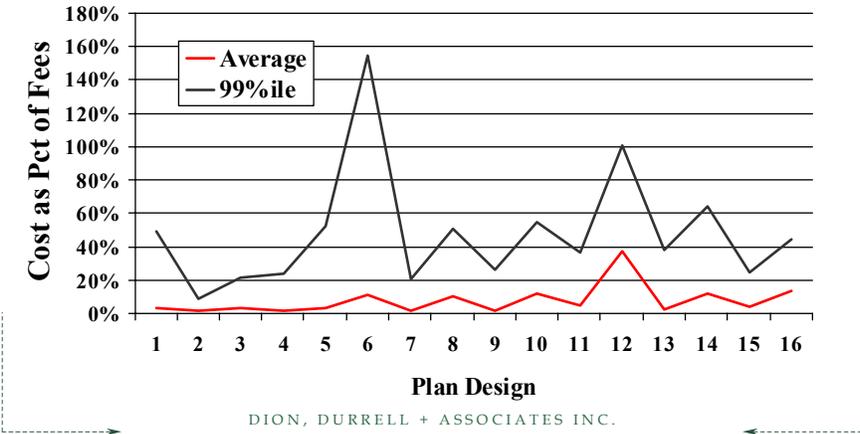
MR. PRINCE: I think the point is that you rebalance on a real-time basis as the capital markets move—not on a daily basis. The fact that you're not uploading a snapshot of your liabilities on an instantaneous basis, you do that maybe on a weekly or a monthly basis. This doesn't preclude you from being able to value what your options are and your net exposure is at any given point in time throughout the trading day based on your assumptions of your projected liabilities.

MR. PADO: My only point as a reinsurer is that you are always subject to the slippage part because you never have your whole portfolio today. You're always waiting for it to arrive. I know we practice a monthly reporting regimen, but even that takes a couple of weeks after the month closes to get it, then you have to clean and reorganize it. It's a significant effort.

MR. JEFFERY RABB: Regarding the question about the administrator practices, they do become important and are sometimes overlooked. Especially when you're hedging internally in the company because you have to consider what their administrative practices for crediting different values are and how you actually are investing on the other side. Those slippages can cost a significant amount of money. I don't know if other people have noticed that too, but we found that out from time-to-time.

Chart 1

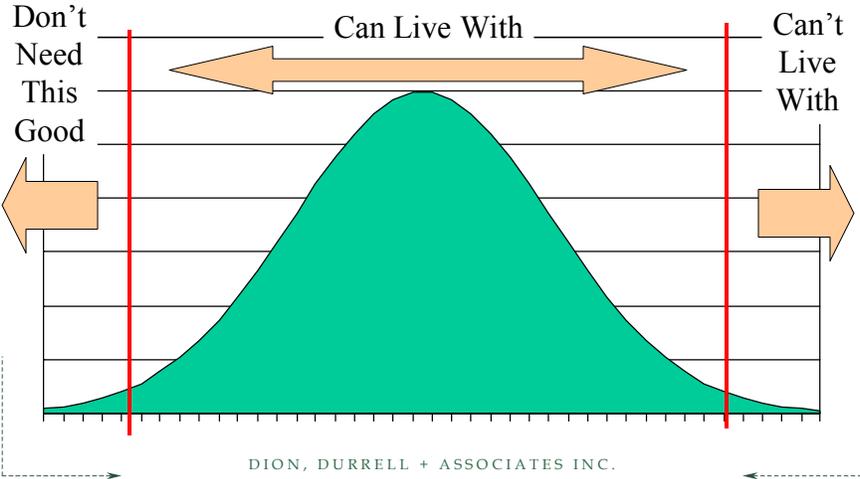
Average Cost & Percentiles 16 Different Seg Fund Plans



6

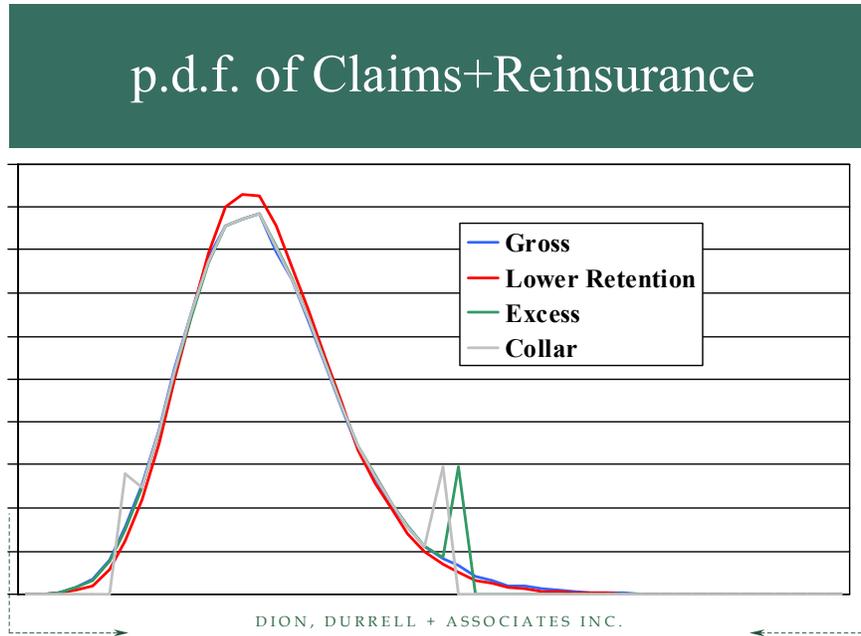
Chart 2

Total Claims



24

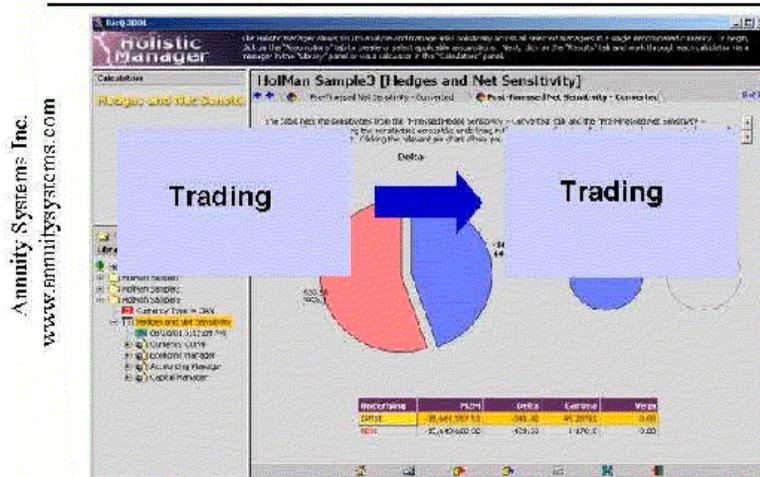
Chart 3



28

Chart 4

Features of a good risk-management system



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