

RECORD, Volume 23, No. 3*

Washington Annual Meeting
October 26–29, 1997

Session 96PD Risk Management

Track: Financial Reporting
Key words: Financial Reporting, Risk Management

Moderator: SHIRLEY HWEI-CHUNG SHAO
Panelists: THOMAS S. Y. HO†
ALASTAIR G. LONGLEY-COOK
Recorder: SHIRLEY HWEI-CHUNG SHAO

Summary: The financial services industry has become increasingly interested in understanding and managing financial and business risks. While often perceived in terms of risk reduction or mitigation in the past, today's focus has expanded to improving performance and adding to the value of the firm. Many banks and securities firms have built risk management areas to better manage their financial risks. Some insurance companies are moving in a similar direction. Some of the latest developments and actuarial involvement in this area are discussed.

Ms. Shirley Hwei-Chung Shao: We're going to talk about risk management and how it applies in the insurance industry. There are hundreds of risk management seminars out there and 99% of them are on derivatives. I always wonder how they apply to the insurance industry because while actuaries are really in the business of managing risk, we don't see too many seminars or sessions that are designed for risk management in the insurance industry.

There are two reasons I'm interested. One, I work for Prudential Insurance Company of America, and our CEO is a banker. He has a lot of interest in doing a great deal of risk management because he comes from that culture in the bank. We had to learn quickly in our firm how to do risk management the same way banks are doing risk management. From a professional perspective, I think the risk management arena is wide open. I think all of us probably could enjoy a lot of job

*Copyright © 1999, Society of Actuaries

†Dr. Ho, not a member of the sponsoring organizations, is President of Global Advanced Technology in New York, NY.

and career growth if we could develop that as part of the future of the actuary program. We designed this session to bring you up to date.

I'll talk about why there is so much interest in risk management, and also what a risk management process is like. Then Tom Ho's going to give us a lot of heavy math and talk about value-at-risk (VAR), which is the method used at banks and also at my firm. Then Alastair will talk last about how VAR is being used by his company, and what some of the challenges and issues are.

Let's first talk about when risk management started. I think it all started in China, of course, about 1500 B.C. That's the time when the first writings were used. Pictorial graphics were used to communicate. In about 800 B.C., a formal character system was invented to communicate some of the ideas that are not concrete, such as water or whatever. This formal character was used for concepts.

In Chinese, risk management is made up of two words. The first word means dangerous. We can all relate to that. The second is the one I really want you to remember. It means opportunity. This is very much in line with the Chinese philosophy of the yin-yang. For every risk there's opportunity, and that's what we're talking about. Risk management is not just a defensive tool; it is an offensive tool to help you gain strategic advantages in the marketplace.

The world has become a risky place. *World* and *risky* are two key words. If you look at any chart, whether it has to do with exchange rates or interest rates or commodity prices, you always see huge volatility along the time line. There was this seesaw pattern, and there are more people interested in volatility, not just the expected return.

There is an increase of market risk, and there are many losses. We see in *The Wall Street Journal* almost every other day how some firm loses out for one reason or another. Even the insurance industry has its share of losses with several companies going down. It's either because of asset concentration of risk or interest rate risk or low-quality bonds. We have our own share of losses as well. The other reason there's a good deal of interest in risk management is because we're very highly leveraged these days. We have never had so many tools and so many people working on leveraging, whether it be leveraging through leveraged buyouts or asset securitization or derivatives. We have all kinds of tools in place to do that these days.

There seems to be an increasing need to understand what we're really getting in return for taking this risk. What is the real return? These questions are not just coming from management; they are also coming from regulators. That's why you

see more and more regulators regulating and trying to understand the risk profile of the company. I don't know if anybody is familiar with the SEC disclosure requirement that's going to become effective next year. It was supposed to be for derivatives originally, and then was extended to all assets. Now even liabilities might need to be disclosed. My company says that probably all the Source of Profits (SOP) products and also *Financial Accounting Standard (FAS) No. 97* investment contracts are subject to disclosure rules which means VAR is one of the methods that's required under the disclosure. Our next two speakers are going to talk about VAR in this context.

I have a list of a whole bunch of profits and losses. These are largely derivative and swap kinds of transactions. One that's very famous is Orange County. Let me just give a quick definition of risk management. I think it's really a process whereby an organization optimizes the manner in which it takes the risk. It's not a number calculation. My talk is going to concentrate on how that process flows, and what it begins with. I really feel taking risk is part of being in business. Of course, no risk, no reward, and that certainly applies in our line of business. We're in the business of risk pooling and risk financing. It's very obvious why actuaries would be interested in risk management.

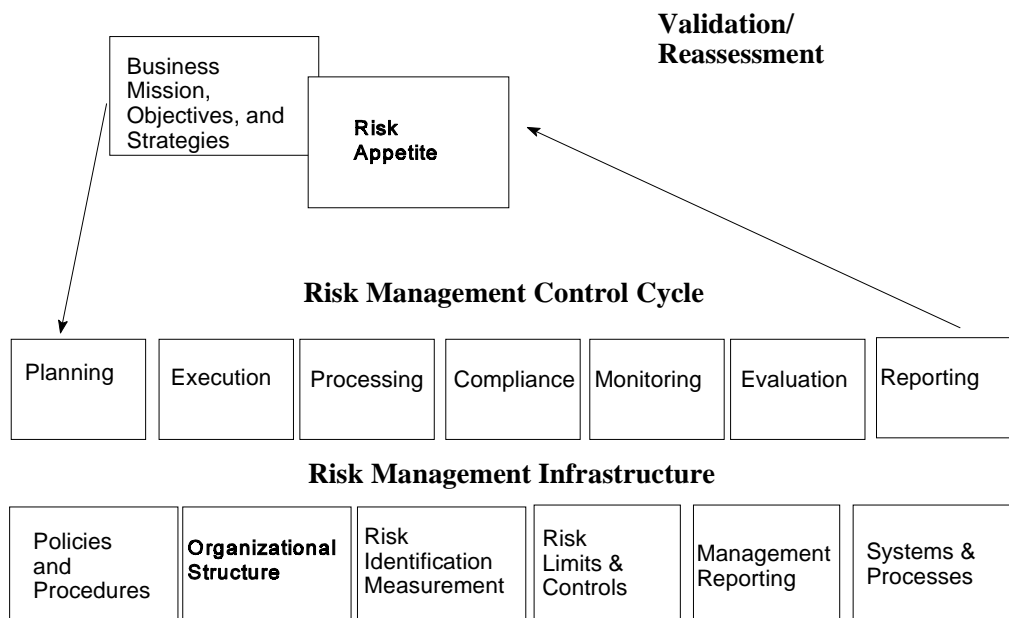
PUBLICIZED LOSSES

AIR PRODUCTS	\$60 MILLION LOSS FROM DERIVATIVE USE
PROCTER & GAMBLE	\$157 MILLION LOSS IN SWAPS
GIBSON GREETINGS	\$16 MILLION CHARGE FOR INTEREST RATE SWAPS
ORANGE COUNTY	\$2 BILLION LOSS IN 4 MONTHS DUE TO HIGH RISK MORTGAGE DERIVATIVES
METALLGESELLSCHAFT	\$1 BILLION LOSS ON ENERGY DERIVATIVE
BARINGS PLC	VENERABLE COLLAPSE UNDER \$950 MILLION LOSS

Actuaries are really involved in risk management on a day-to-day basis, but somehow I think the actuaries are not being viewed as risk managers, even in the insurance companies. We have to constantly fight with the investment department and plant the thought that we are risk managers. I think many actuaries have now come to the realization that that's what we do, and they'll have to communicate that to senior management. What I'm trying to communicate is there are offensive tools as well as defensive tools that you can use to seize smart risk opportunities. Once you understand where your risk compares to advantages and disadvantages, it will help you further along with your business planning, and also with your performance. It's a very offensive management tool.

Chart 1 shows the risk management process. It's really a looping process, as you can see. We have planning and execution and all of that. I'm going to concentrate my talk on the lower left part of the diagram, which is the risk management infrastructure. We start with risk policies and procedures. To me, the policies really set a tone of what the organization, what the CEO, and what the other strategic managers are thinking about doing. These policies create a risk culture, a risk culture for the company. It's not only a matter of what's being written; it's also what you do. In fact, what you do is often more important. If you read *The Wall Street Journal*, can you tell if the management knew what was going on in those loss situations? It's more than likely that management does. In fact, most of those people in management are actually high performers in their company. Oftentimes the senior managers tolerated the situation. They understand. They just did not do anything with it. It's action that sets the policy and a culture. The procedures lay out a set of rules to try to implement the policies. They give people more guidance on exactly what should take place and what kind of a sequence to come to. What kind of actions should be taking place in sequence?

CHART 1
RISK MANAGEMENT FRAMEWORK



Let's discuss the organization structure. This is very political. When you talk about a new risk culture, you have to have some kind of structure in place. Much of that includes some organization issues. There are two schools of thought. You first have to understand who the risk takers are and who the managers of the risks are. Risk takers are the strategic risk-takers. Even if they don't do anything, the act of not doing anything involves taking a risk. The board is the ultimate strategic risk taker,

comprised of the senior managers. Many actuaries are investment professionals. We are really more tactical risk takers, who try to implement certain strategies.

I group risk managers into two models. Model one is more of a facilitator. There's a dividing line between the risk manager and the risk taker, and the manager is not trying to go across the line to actually manage the business; rather, he is trying to help define the roles and responsibilities and make sure that risk management information is flowing fluently and to promote a culture. The second model is much more aggressive. It goes over the line and tries to advise what kind of risk should be taken and what type of risk appropriate for the enterprise. Then you actually set risk limits and risk policies. There are people arguing about which type of model is more effective. For example, my company is implementing the second model, and some people will argue that you end up with too many chefs in the kitchen with nobody responsible for the food at the end.

The next one is risk identification and measurement. When thinking about risk management, many actuaries actually first come to thinking about identification and measurement. We have the famous C-1, C-2, C-3, C-4 risks, a type of identification. We try to have an inventory of all the risks. The next step is try to measure or quantify these risks. Risk-takers will have to understand what they're doing, what type of risk they are taking, and the managers will have to know what has been done and whether things were done within the guidelines. Of course, risk must be measured. We're going to be talking about VAR, but I think VAR is just one tool. The most important thing is to have a tool in place so there will be discipline. You must also have the buy-ins from different business groups. At my company, where there are many business groups, we often run into the situation where people say, "This is your risk number, not my risk number. This is according to your calculation, and I don't agree." It's very important to have the company following the same framework. That doesn't mean that all the calculations will have to come out exactly the same, but the same line of thinking should be used in defining the risks and measuring the risks. Oftentimes we try to encourage people to think of risk numbers more in terms of monitoring our tools. In other words, we ask them to look at them more on a relative basis rather than an absolute dollar amount. Measurement is the area in which actuaries spend a lot of time, the tool to help people to further understand the issues.

The next part of the infrastructure is risk limits and controls. Risk limits are really helping us to shape the kind of business we would like to have, whether it's on the liability side or asset side. If we decide that spread business is not our business, we may want to impose a higher risk charge on that. It's not just used to avoid unacceptable concentration which we had to deal with in Prudential several years ago. We sum up all different business groups that have something to do with the

specific risk. At Prudential, we have the bank; the insurance company; our own money; the general account money; and the separate account money. When it all gets added up, we have a lot of counter-party exposures as well. This helps us to set risk limits within a big organization, but also goes beyond that. It helps us to shape the kind of business mix we would like to get at the end of the day. In the control cycle, we obviously need to have a continuing cycle to make sure that we reassess the situation and make sure there's a dynamic flow going on.

Management reporting is the next part of the infrastructure. It sounds boring, but it's very important. After we did all of that work, we converted our data into management information. This is the part that I find to be hard: we do many calculations; we do VAR; we get all kinds of information, and we don't understand how to communicate the information. We're still trying to figure out what real information lies under all this data. Of course, the knowledge must be delivered to the right people so they can make the right decision. Reporting has to be dynamic. This is sort of a chicken and egg situation. In figuring out our risk management reporting system, the ideal situation is a bottom-up approach where you capture every piece of information, just to sort of anticipate what your future reporting needs will be, but in reality it's very difficult to do. We had to do a lot of give-and-take. There's a sort of a change in process, but we need to anticipate as much as we can at this point.

The next topic is system and process. Obviously, you have to integrate your process with your systems. Currently, we have different systems going on. There are different firms, different subsidiaries, and different operations. We have a long-term plan to get the systems more integrated, but, as I said, it's going to be a huge job.

The most important thing to learn from the whole process is to learn about the process and the people involved. Sometimes it's not really what you decide to do but, rather, to observe people going through the exercise and understanding the implication of each person's role. Most importantly, we must create this kind of risk culture. Make people think about risk, about their role in the process, and about how they can influence the process. Make people question what would be the best way to share information. We need to build people's accountability. It would be an ideal world if everybody were aware of their role in risk management.

That concludes my presentation, and I will let Tom start his.

Dr. Thomas S. Y. Ho: Risk management is a very big topic now; there are many challenges out there. One thing I want to emphasize is that so much is going on outside the insurance business. Originally, much of the risk management impetus

came from the trading portfolio of a bank. Much of the research and much of the system integration comes from the trading part of the bank business—the J.P. Morgans, the Banker's Trusts, and so on. They first started to talk about the principles of how you issue risk management. All principles and guideline policies are really geared for a trading floor, which is why there is so much discussion on risk management in derivatives.

There are annual conferences on risk management, and they're well-attended. Irrespective of what the topic of the conference is, people talk about risk management, and if you review all the literature presented, you will see there is still very much a trading floor concept. The committee is setting guidelines for banks, with a trading floor concept in mind. Recently, banks in the U.S. have begun to follow some of these initiatives and ask, can some of these guidelines and policies be used in the U.S.? Initiatives in those guidelines begin to incorporate representatives from the insurance industry. In the last year, that impetus and momentum has spread to the banks. What do you call the structural balance sheets? How do we manage assets and liabilities? When we move to the asset/liability management (ALM) and how to deal with structural balance sheets, it's the Europeans that are coming in and setting those standards. Therefore, this meeting and opportunity to discuss this issue are so important for us because, first of all, it is a challenge. We are really lagging behind, and we should learn from what they have done. We don't need to reinvent the whole wheel. We must learn what they have done outside the insurance industry as well, and use European and other international financial institutions as models of success that can be imported here.

The second challenge is really adjusted for our own purpose. We're in the insurance industry; we hold long-term assets and liabilities; we have a whole new set of regulations, and rating agency requirements in front of us. All of these have a different set of requirements. We can learn this from others and adjust it for our own purposes. It's a really voluminous subject, so I would like to focus on two topics. One is the procedure: how do we do VAR? What is the right methodology for us in the insurance business? I will go through a numeric example of how to do that calculation.

The second topic I want to emphasize is the application. Much research is done for the trading floor. If we do these calculations, how do they apply to us? My proposition is that perhaps the methodology is similar, but when it comes to the application side, insurance is very different. I fully agree with Shirley that we should think in terms of a control cycle. On the trading floor, you measure risk on the floor. Senior risk managers say, measure the risk here and look at all these traders out there. They all have their own businesses. They all act separately. They all have their own profit and loss (P&L). Just think of the many entrepreneurs here

doing business; that's how we measure the collection of risk. The insurance industry says, "We're all working together as a team, as a control cycle, and so we have to adapt the concept from the trading floor to a whole business organization."

I'll first talk about the framework and how we can do risk management from assets to liabilities. We quickly get out of the mode of trading securities on the trading floor. We'll talk about our balance sheet. How might we describe the portfolio of assets and liabilities? Then I'll talk about the organization map which is so important. We'll have to incorporate all this into the organizational structure of our company. How can we all interact together? Information can then go up to the senior management level. How can you roll the information up to the senior management level? Then we can talk about how to use the information. You would be surprised by how many banks spend millions and millions of dollars getting a risk system. Then they get this risk report and ask, "What can we do with it?" It's really quite a common complaint. We should first think through how we are going to use the information. What's best for us? Then we design the system. It should not happen the other way. There is one lesson we have learned from previous people who built all the risk systems. They rushed to put in a system and never quite thought through how to use the information. These are the three main topics I'll talk about.

If we go for a VAR approach, we're implicitly adopting a fair valuation approach to our asset/liability (A/L), to our balance sheet. In other words, we are not going to use actuarial income and reporting and the usual standard accounting approach. We have to go for the fair valuation, and that is what VAR is all about. In the end, we want to have a systematic way of looking at the present values of assets and liabilities. Then we ask, over a certain time horizon, perhaps around three months, what is the likelihood of losing some amount of money?

I want to emphasize one point that has been learned over the years. A VAR number does not measure the likelihood of default. That's a totally different concept. In looking at default risk, a 99% confidence level is reason for great distress. VAR is more of a way to measure our risk over time. In fact, Goldman Sachs even recommends that when we measure this number, we expect to see such high figures at least three times a year. Don't panic; we're supposed to see these things three times a year. If you really want an analysis of risk management, do stress scenarios, or simulations, or stress tests. That's a totally different thing. On a day-to-day level, or month to month or every three months, we can see where we are. We have some way of monitoring our risk, and we can see how our measures match up to what we predict as an ongoing process.

The control cycle is so important. We talk about process. We're not talking about how once a year we want to report to senior management. If we lose \$100 million, we're in trouble. That's not the point. The point is we have to have some measure for us on an operational level to have a controlled process. When they talk about VAR on the trading floor, that's what they mean. They actually determine, day to day where they are. If something happened yesterday, some other 7%, that's almost a six standard deviation that you're talking about. That's expected. Hong Kong has high figures three times a year. No big deal. I know there has always been a lot of confusion concerning how to stress test VAR, and on the question of lot of distribution affect. We don't even have statistics for this or any kind of processes. How do we do this? It's all beside the point. All these become very statistical measurements of how you handle stress scenarios. We will talk about setting up a system to monitor your risk and be able to perform on a controlled basis as a process.

Most of the items on balance sheets are not traded. One common objection we hear about VAR as it applies to insurance companies is, "That's VAR done by J.P. Morgan on their trading floors, using their prices. They can do anything they want. But with our policies, we don't see anything. We can't do anything." That's kind of unfortunate because, after all, in our actuarial profession, we understand everything based on present value. What's the big deal talking about present value of each item of your balance sheet? There's all the high technology, and financial technologies. The arbitrage-free pricing model just gives us a context, or a framework to talk about present value in a consistent way. Arbitrage-free pricing is no more than a consistent way of talking about present value so that when some actuaries take an item off your balance sheets to trade on Wall Street, that number will be somewhat closer. It doesn't mean that you need to trade; it's a framework for us to talk about present value.

What's the point of doing this present value? If we simply look at book accounting, we would never do anything until the end of the year. So let's discuss option adjusted spread (OAS). For each item on the balance sheet not traded, where we don't see the market price, there is financial technology to show what kind of discount you should apply to provide the appropriate present value concept.

Next is the sensitivity numbers. I just used key rate duration as an example. We have all the items on the balance sheet, and we know that present value numbers change. Can we look forward and see our sensitivity to interest rates? Key rate duration is an example of this as well. If the key rate doesn't move, but the one-year rate moves, what is the sensitivity? What's the proportionate change on the whole balance sheet on each item or each bond? The formula is a proportionate change in price. That's on the left-hand side of the equation. The right-hand side is

key rate duration and a sensitivity number with each change of the rate. For financial engineers in VAR calculation these are called delta. The idea is really quite intuitive: if you look at our balance sheet, think through all the possible risk sources, such as an unexpected change in one-year rate, two-year rate, three-year rate. Stock index change is another. Mortality rate change is another. Whatever risk source you can think of, shock it a little bit. Also think of the sensitivity, proportional change in present value with respect to the shock. That constant number or that proportionality is called delta.

If we have a 20-year zero-coupon bond, and if all the interest rates don't change, except for one-year rate change, would the present value of the 20-year zero-coupon bond change or not? The answer is: no, it wouldn't change. If there's a two-year rate change, but no other rates change, what would happen? It wouldn't change. The only time that a 20-year zero-coupon bond will change is with a 20-year rate change. You calculate a key rate duration of a 20-year bond. You'll see there are all zeros except that you have a sensitivity, and the sensitivity is about 20. That means 100-basis point shift in the yield curve on the 20-year rate will lead to a 20% drop in value. It's very intuitive. Let's say I give you deltas of any bond, for example, a 30-year bond. All it's telling you is the 100-basis point shift on each of these key rates. For example, a 30-year 9% Treasury bond, if the rate doesn't change, except for the 30-year rate, the value of the bond will fall by 3.5%. So, just look across, and that's the sensitivity.

Why do I spend time on this? The method I'm going to present is called delta normal, but is very intuitive. These are the numbers used by portfolio managers on trading. That hooks up to what I talked about earlier. Information rolls up. Risk system, as I see it, should not be setting on a risk committee somewhere, and the risk department somewhere, and they've built a complete risk system for the whole insurance company and try to disconnect to the rest of the company. When you get information, and you want to do something without how do you implement it to the line level? Isn't it more meaningful if we use the system that the line department is using and roll it up, so that we're all in one consistent framework?

For the line level or for those who are actually managing the portfolio of the insurance company, the key rate durations are all deltas and normal daily operations. They want to see this portfolio. What's my sensitivity to each of the rate changes? If they're managing their hedging, you find a hedge portfolio has zero key rate durations, which means it's totally immunized. You can move our value with our change. You want to take back ten-year rate and want to be long in ten-year key rate duration and flat everywhere. If we are managing a GIC book of business where this A/L is put together, we look at a whole book, key rate durations.

We exactly see how to link up, which exposure, which yield curve twist exposure we are facing.

The same thing holds for the swap desk. These are fairly standard methods on the line level, but what do they become with key rate durations? That's the beauty; it's only one step away. VAR says now you take all the resources, and you roll them up together, and then decide on the time horizon. Earlier we looked at a three-month time horizon. The question is, to which confidence level will it fall? The formula now is fairly straightforward. The expectation is that there will be a change in the resource. So, for example, the shift in the interest rates means that under a 2.5 standard deviation translates into a 90% confidence level, or 2.5 times the standard deviation of the shift times the delta. For example, key rate durations times the market VAR of the portfolio. The outcome of this number is the VAR number.

For those who have already set up all the line level common, all the deltas, you just simply roll all these numbers up, multiply with a co-variance matrix, and that is your VAR number. Very transparent. The results are rolled all the way up step-by-step. We all agree on the deltas. We all agree on volatility. If you agree on these numbers, we have to agree on the VAR number, and, therefore, once we agree on the VAR number, senior management can have some idea where the number comes from.

Before I get into the details of these numbers, let's go through some of what it means when you come up with a VAR number. If you roll all this up and come to a VAR number, with well-matched portfolios, all the exposure to risk is very small and obviously your VAR will be very small. So, you say, but we have a lot of embedded options. Single premium deferred annuity (SPDA) has common lapse risk, and mortgage-backed securities have embedded options. We have negative convexity here and there. Where is it captured? It's all captured by these deltas. You already built in. All the procedures talked about have already adjusted for that. Now, there are other extensions. There's the delta normal approach which captures options, deltas, embedded options, and, other things very explicitly. I want to confine my discussion to the most stylized approach, but in principle all these can be kept by the method.

If you think a little bit about the methodology, I just talked about, it is quite extendable to liability. What is missing now? We'll have to build a fair valuation model of liabilities block by block and put it up. It's not an actuarial model that give us a cash flow in one scenario, but instead has to be consistent with modeling, a financial modeling approach to build these liabilities. Once we have that, then we can actually use it for investments. VAR can be used for investments, managed duration, and convexities.

I will quickly go through some numeric examples, and think of A/L, and consider each block of business. GIC is a block of business. We have A/L: the asset minus the liability surplus. What we want to really manage is the risk of the surplus. Go through the steps involved. Every day we actually can see the yield curve. These are the interest rates of the yield curve, and we actually see each rate. What's their volatility? Unfortunately, due to market convention, a volatility is a percentage change in rate. In the delta normal calculation, this becomes an actual shift of the rate. So, what we need to calculate is: the percentage times the interest rate level, which gives us the shift. These are annual, one standard deviation of a shift of the yield curve. Then you bring it to the A/L level. Now you calculate the whole asset, your sensitivity along the curve, your liability sensitivity curve, and then the value net effect to surplus sensitivity curve. If these numbers are actually already useful for asset life, what's our exposure? What we really need is to bring all of them up, roll them all up, and take all the risk into account.

Next we consider the market risk, which is the OAS. I talked about OAS earlier, but now we will look in terms of OAS basis risk. Even, structural balance sheets for bankers face basis risk. I know we are very concerned about our liability, the SPDA in our model. Banks have their own problem with deposit accounts, and savings accounts. They're familiar with the basis risk of each item of their balance sheet. An example would be the mortgage-backed and corporate bonds that pay OAS of each item, the volatility of this basis risk, and then the result when they're calculated. Now you can bring them all together in the co-variance matrix. This is a simplified picture, but typically you'll have 200–300 resources all put together: all the key rates, all the basis risk of all the sectors you're in, and then usually the correlation—people assume now with mortality and lapse it's quite independent of all these rates. You have blocks of the liability risks, the product risks keep going but there is a lack of data for finding correlations historically. It's not clear how you really interpret those things, in most cases you can assume that the up diagonal blocks are zero. We have our own product risk as a box. Then you can operate all of them together to calculate risks, which is how we'll calculate it. You'll calculate the VAR for each—your whole surplus position on each of the key rate and resource, and calculate the co-variance.

In a marginal contribution risk they are independent of each other or they're correlated; much of that risk gets diversified away or hedged away. You need to calculate the actual contribution of risk by each of the items here to get to the final answer.

Now we come to the organization map which says the following: You look across—remember I was talking about a business unit-your annuity block and the GIC block. What's there? VAR risk but also each of the rates. Right? Each

business unit has its own VAR, and then you have this total sum of them, but when you add the sum of them, they don't add up because of the hedging effect. So, the risk contribution is calculating what the contribution of each of the items is to the final number.

The first column is really just the balance sheet, but measured in terms of fair value. With each item we calculate market value, and then the net of the asset minus the liabilities will be our surplus. We are managing at one point \$1.07 billion of surplus here. Now we can calculate the VAR of each of the items and come up with a VAR of \$10 million. Look across to the next box, and the \$10.59 million is the same as the VAR, which is what you want. What you want is not beta but the contribution of all the items of the resource to add up to \$10.59 million. If you add up all those numbers in that column, now this time you get 10.59 million. If you add up all those numbers along the VAR outlook, they do not add up to because of hedging and the diversification factor. Once you have those numbers, they're really useful. Now you actually see which items contribute the most risk to your total divided risk. For example, negative numbers means that both items are very good at hedging the major sources of risk. The beta divided by market value is per dollar of that item.

What is the contribution of risk to you? I find the last column, which is risk value divided by market value per dollar of contribution risk, to be so useful for us. Through the OAS number, the spread number, we already have some measure of profitability, and this is the marginal risk cost to be deferred. Plotting the return against a margin risk deferred is really defining the profitability of each item on the balance sheet. I believe that is a very good foundation for us to look at the risk-based capital.

In conclusion, I just want to go through some of the thoughts on the application. One thing I have not had time to go through is that you can actually see how we can now incorporate the control cycle that Shirley talked about to the VAR. In fact, we can talk about the strategy for thinking having a certain benchmark. In that portfolio, line businesses have their own benchmark. It can all link up together through the VAR. It can actually reveal which business unit—which phase of the control cycle—is contributing to risk and how each is providing return. It's a fascinating area, that we should look at our organization charts and see how information like this can be used for the organization chart of the firm. I'm going to just raise two more items. It can be useful in investment decisions, as I described. We can use this on capital assignments because we can cost up profitability and risk management level. Finally, it can also affect the product level. Very often we just look at one product, its own profitability set in crediting rates, when really the total risk contributed to the firm is what counts. So, if you actually understand how this

product affects the whole firm's bottom line and the total risk, we might have a better idea how we should be setting our rates or how we should design our products. Without understanding the whole firm, and the contribution of a product to the whole firm—taking diversification and hedging into account—we are not really measuring risk in a proper way. VAR allows us to roll up all the information to the enterprise level.

Mr. Alastair G. Longley-Cook: I'm going to try to synthesize a little bit what Shirley and Tom have talked about and describe some of the issues that have arisen as we have implemented a risk management process at Aetna similar to the one they have described. We've been doing this for a couple of years now, and I'd say we're about three quarters done. We'll probably always be three quarters done, because no matter how far you move along, the target keeps moving ahead of you. I do think we've come a long way. We've run into some problems which I'm going to talk about because I think that's where the real gist of this lies. As you can tell from Tom's presentation, the math here is not really that hard. This is not rocket science: it's basic statistical analysis. What's hard, as Shirley pointed out and as Tom was getting into, is how you do it. I'll get into some of the issues that we've run into.

We ask each business unit to create a risk profile. The risk profile starts out by identifying risks. We encourage use of different categories. I try and break them down into two, although usually they end up with four or five different categories. I look at them as two types. One is the financial risks that tend to behave nicely under statistical models. The other is what I call operational risks, such as competitiveness, legal risk, compliance issues, misrepresentation issues, and the ones that do not comply very well with stochastic or other statistical models.

Shirley mentioned the SEC disclosures that are required for 1997: market exposure to derivatives and investment contracts. As you get involved in these, you'll realize that they are asking companies to quantify market risk. By market risk, I mean interest rates, foreign exchange, and equities. That's even limited to a subset of these. They don't even have defaults in there, but if you throw in defaults, you're talking about the types of financial risk and market risks around which VAR has been created. There is a great deal of data. There is a lot of literature. There are all these correlation coefficients you can download from www.jpmorgan.com every night, and you'll have all you need, or probably more than you need.

When you start moving on, you run into some real unknown territory. What I see as a challenge for the actuary of today and tomorrow is to move the same degree of specificity into these areas. We'll probably be partially successful in that because, again, some of it does not lend itself to very good models. We have encouraged quantification around mortality, morbidity, which would include health trend, for

instance, and again these operational risks. A lot of them overlap. Aetna announced about a month ago that we would miss analysts' estimates and put up a reserve of about \$100 million for managed care. Is that health trend? Yes, part of it's health trend, but if you read our press release, you'll find out that a lot of the misquantification had to do with merging Aetna and U.S. Health Care and the system transformations and loss of data during that period. Oxford made a similar announcement and cited the fact that their systems were down for periods of time. An analyst remarked that, in his opinion, they kind of lost track of what their earnings were for a while. Is that morbidity? Maybe, but there are also a lot of other things that I call operational risks.

It's kind of like that old story about the guy who's looking underneath the streetlight. The other guy comes along and says, "What are you looking at?" "I'm looking for my keys." "Did you drop them there?" "No, I dropped them down the street." "Why are you looking there?" "Because the streetlight's here." Financial engineers and actuaries tend to look where they can find a light, and that's not necessarily where the real risk is going to hit.

The next step would be quantification. We're using VAR, which is not the only measure out there, but the best one for now. Maybe we can improve on it over time. The point is to find one, because if you can't quantify your risk, you can't manage it. Tom has already talked about that. We do tend to use a 95% one-year time horizon; therefore, you get 1.65 times your sensitivity times your driver volatility type calculation. A key consideration here is to make sure your assumptions are consistent. If you have different business areas quantifying this, you'll find that one will assume a volatility of x and another one will assume of volatility of y ; both will be talking about the same thing. You can't roll it up or compare it, and you can get this out of reserve cash-flow testing. I'll come back to that later.

The third step is to list controls and monitoring processes. Decide which risks can be eliminated. There are only three things you can do with risk. You can eliminate it through underwriting by not taking the risk. You can transfer it through reinsurance or product design; for example, you're going to write variable annuities. The third one is to actively manage it. There are many risks that you do not want to get rid of. In fact, that's the way insurance companies and financial institutions make money, by assuming risks. You have to actively manage and control them and know where you are. Of course, you still need your reports and underwriting authority, which are the most important parts of this whole thing. Until the people making the decisions see this come back to influence their compensation, they will pay lip service to this entire project.

So you need to find some way to make sure they are very, very focused on what the risk management reports are saying, and how they are being communicated to senior management. This is very difficult to do. You can implement a risk management process, have these risk profiles, and VAR calculations. They'll say they'll put their planning officer or their actuary on it. When you start talking about their compensation, suddenly they get very, very interested, and they start arguing a lot. They say, "What do you know about our business? You don't know anything about managed care. You don't know anything about investments." Whatever they know about, they assume you don't know about and that you're in no position to judge their risk exposure. The counter argument is that if you leave it entirely to them, then you're leaving the fox in charge of the hen house. You need to have that loop. It's very important. It can be done. You can certainly have part of their bonus, for instance, qualitatively or quantitatively directly linked to the management of risk exposure.

What action steps are they going to take as part of the plan process? One of the things we found at Aetna was that we had these risk profiles created, and they were done as part of the plan. You know what happens to plans. You put them in the drawer and forget about them until next year when you do another plan. Nobody ever looks back and sees what you did with the original plan. This year we have included, as part of the quarterly update process to senior management, a little section called risk management. The questions are, "What happened in the most recent quarter to change what you told us at the beginning of the year was your risk profile? Did equity markets suddenly move? Did you take out a hedge? Did you come out with a new product? Did you lose a handle on your data because systems were down or being converted? What was going on that affected your risk exposure?" It's a continual ongoing process.

Uses have been discussed a bit by both Shirley and Tom, but some of the ones that we use it for are fairly obvious ones in terms of comparing risk exposures and evaluating performance on a risk-adjusted basis. Obviously, reserve capital levels can also be used. We're trying to use this more and more with regulators and analysts. So far, it seems to be a minimum requirement that you have a risk management process. An analyst or a regulator will ask, "Do you have one?" If you say "Yes," then they kind of move on to something else. It's a negative if you don't have one, so make sure you get one. We haven't yet reached a stage where the analysts are, proactively saying, "What does it show? I mean what is it telling you? Tell us something about it." I think that will come over time. Make strategic decisions. I can't emphasize enough that if you're not focusing on the SEC disclosure requirements by year-end, you'd better get on it real fast. It does not require VAR disclosure. You can use other measures like sensitivities, but VAR is one of the three methods that are mentioned.

What are the roles and expectations that we have implemented? The role of the corporate risk management area is basically to provide leadership. You really have to drag people kicking and screaming sometimes into this process, and it's a constant advocacy type of role that you play. Determining the corporate level of risk tolerance is an interesting exercise. You should also ensure that the CEO and CFO understand the risk exposure. Corporate risk management is, in many ways, a way to translate and communicate. Make sure that the right message is coming through.

Ensure consistency and aggregate risks across business. As you see from Tom's example, you can take different lines of business and add them up, and they don't add up because of the correlations. You can see whether or not, in fact, you have some natural hedges built into different lines of business. Many times you do, and sometimes you find you don't where you thought you had. The role of business management is to identify, measure, manage, and monitor risks, and make those procedures an integral part of planning business and management process. The thing that we have emphasized again and again is that they own their risks. The corporate risk management department does not. I am the corporate risk management department. All I do is try and make sure that it's being done. I don't do it; I don't own it. Make sure they do it, and don't let them dump all their monkeys on your back.

Let's discuss some of the more interesting material I wanted to explore. Most of the theory, and much of the practice around VAR has been, as Tom said, in the financial area, specifically with regard to derivatives and other very market-sensitive portfolios. If you choose VAR, and if you try to apply this in an insurance environment, then you run into some very serious problems. You would think the assets would translate easily, but you run into the problem that most insurance companies have a buy-and-hold strategy.

The definition of VAR begs the question: what's the maximum amount I can lose with a certain probability associated with it (95%, 99%), over a certain time horizon (delta t), where the time horizon is usually very short? It's chosen specifically as the time it would take me to unwind my position. It might be a day. If you're actively managing a highly sensitive derivative portfolio, you might literally be choosing a day as your time horizon, because that's how soon you could get out. That has very little meaning in the insurance environment, where you're talking about buy-and-hold assets and time horizons of decades. We tend to use a year, but you could use a quarter, or as Tom mentioned, you could use something else. The important thing is to apply it consistently throughout your company.

The methodologies that are employed in some ways may be overkill. In other words, because of the good work of Tom Ho and others, there's a lot of information around key rate durations, and key rate convexities, and for some portfolios that's absolutely essential. For a block of business like managed care, it'd be a waste of time for you to spend hours and hours building in key rate duration sensitivities because that's not where your risks are. You probably have a very short duration asset portfolio there, and it's just not going to matter. You need to focus on other areas. Be careful where you're spending your time. Again, don't look for the keys under the street lamp just because the street lamp is there. As I already mentioned, daily or even monthly recalculations may not be necessary.

Liabilities get even more difficult because they do not have a readily determinable market value. Yes, you can sell your liabilities, but the market price does not necessarily determine what the true fair market value of those liabilities are. Instead, you're talking about present value of cash flows.

I won't get into the issue of which discount rate to use because we could debate it for a long time, and Dave Becker has written some good articles on that very issue. I refer you to his writings. One other issue that pertains to the time horizon is that as you move to a longer term period, a longer time horizon, the linear approximation techniques that are assumed in the simple VAR formula (the delta formula) might fall apart. Delta gamma might help or it might not. You might need to rethink some of those simplifying assumptions.

I do not want to overemphasize the operational risks. Many of the most serious insurance risk exposures are not quantifiable by standard statistical measures, which doesn't mean you shouldn't try to quantify the ones you can; however by their very definition, it seems like those are the ones that catch you most unprepared. Once you've done that, and you know how to quantify it, it doesn't help you necessarily find the next one.

I mentioned earlier that I would spend a little time on developing VAR from asset adequacy analysis (AAA). I want to emphasize that if you're doing cash-flow testing, this can give you the platform you need to calculate VAR on your liabilities and the assets associated with them. If you have calculated present value of statutory earnings either stochastically (with an interest rate generator that gives you a distribution right off the bat), or through shock changes (based on interest rate changes or the other risk drivers), you can calculate the kinds of deltas that Tom was talking about. That then flows directly into the VAR formula. You need your correlation co-efficient. As before, you're into the VAR. The key thing is that a lot of it can come out of the cash-flow testing with just some minor adjustments. If you have nothing, it's a lot of work and effort to build a VAR quantification process, but

if you're already doing cash-flow testing, then it's a small step to go from there to these kinds of calculations. The important thing is before your valuation actuaries run the tests for this year-end, sit down with them and say, "Before you do what you do, can you also plan on giving me these additional runs? They might be runs with either different discount rates, or a different use of required surplus, or an additional sensitivity that the valuation actuaries don't need for what they're doing but which you might want to look at. With a little preplanning, you can end up getting what you want immediately from that.

Ms. Judy L. Strachan: I was very interested in hearing you elaborate a little bit on how this would apply to something like managed care.

Mr. Longley-Cook: Considering managed care is about 70% of our business, it's certainly something we need to focus on, and yet that's where we have the fewest databases and sensitivities. I've been spending quite a bit of time with the health care actuaries, and I think they would say that they're not yet three quarters of the way there. They're closer to a third of the way there. They have started to model their business using basic spreadsheet types of models. You don't need big A/L models to do this. The important thing to focus on is looking at business in terms of how long it stays with you. In other words, the persistency of the business ends up being the key risk driver. Focus on the business you have. The cash flows would end up being either premiums or considerations, and the claims are a usual thing. Look at how it would persist over time, and then check sensitivities to health trend and premium increases, and how stable or unstable the business is under that situation. The expenses end up being a very important part of that formula. You can learn some very fascinating things. Health trend is important, but how it combines with expenses and persistency ends up being the most fascinating thing. There is much more work to do before we can start combining it with other VAR calculations. What they have found so far is that it tends to be the biggest sensitivity.

There is a fair amount of data out there on the volatility of the health trend, but it's not necessarily very useful. For instance, if you look at the medical CPI, you will not find this type of volatility. Volatility occurs mainly in utilization and other items. In managed care, which tends to be not 100% capitated, and considering there are fee schedules that have been negotiated, then there's a certain amount of set exposure. Recontracting can become an issue, but if the risk is in the utilization, that ends up being very, very volatile, as we've found. You need to model that.

We do keep those data, and we have enough so it is statistically significant. We keep it by type of exposure, Medicare versus commercial HMO versus Medicaid. It's very important to look at the different parts of the business because they have

very, very different risk exposures. I'm hoping that over the next few years there's a fair amount of research done in this area because I think it's really needed. When I talked to health actuaries a year or two ago about group health, they said, "It's all risk controlled," and if something is going wrong, they know right away and can fix it by just raising the premiums. It's not quite that simple. I think we're learning that there are risks there, and we're beginning to get a better handle on them. I'm looking forward to seeing more research done in this area.

From the Floor: Alastair mentioned how critical it is for incentive compensation to reflect risk management. I'd be interested in what any of the three of you have seen by way of either qualitative or quantitative representation of risk management and incentive compensation.

Ms. Shao: I think we used to have a risk management framework that's like risk-based capital. We called it attributed risk in my company, and it is part of how we measure the ROE. We would replace the "E" with the risk. We have not finished our work on the quantitative new risk management framework. We're not exactly sure what we want at this point because we are also unsure about what "R" we want to use at this point. We do think it's very important, and we want to get into next year's multiyear planning. We already missed this year's multiyear planning. The qualitative statistics that we do have are part of the multiyear planning, or what we call risk drivers. We try to describe the risk drivers, and then come out with certain ways to measure these drivers. That's more in the area of the qualitative incorporation of the risks.

Mr. Longley-Cook: I'm ashamed to say that this is the most incomplete area, and it is hard to get to that final step because there's a lot of push-back. I'll tell what I'd like to see. You can combine an economic value-added type calculation with appropriate risk adjustments based on VAR-type calculations, and management would be compensated based on the extent to which they increase risk-adjusted economic value. That would be the ideal. Will we see that before I retire? I doubt it, but that's kind of my working goal. For now I'm settling on having a plan. We have what we call the quarterly results report (QRR), which is sort of a qualitative analysis. If you have an increased exposure, what are you doing about it? Should you put in a hedge or did you hedge something you shouldn't have? Did you overreact? That kind of qualitative aspect factors into review of the line-of-business performance.

We also do have return on equity where the equity is a risk-based capital type of number. There are risk management processes out there which hype that. I think Banker's Trust for instance, tends to focus on that. Divide how much you make by your risk-adjusted capital. Then you have a risk-adjusted measure, which is a good

way to measure performance. The trouble with that is, in the insurance industry, we tend to use either risk-based capital from the NAIC, or one of the rating agencies, or maybe we created one ourselves, but we don't change it enough. It's not dynamic enough. During the 1980s, some of us had problems with mortgage loans and GICs. If you read some of the pricing memos from that period, you'll see these references to 15% return on equity. There was no adjustment for the fact that the real estate market was taking a nosedive and there was no sense of sensitivity testing and volatility around that. I think, even today, whatever process you have in place for using capital type of adjustment in the denominator, it's just not dynamic enough. I think this gives you the opportunity to say, "What happened last quarter? What happened yesterday that changed your view of the world?" It can adjust for events such as are found in a catastrophe theory. You might be along on a plane, and suddenly you sort of fall off the edge, and find that there's discontinuity. What has happened to change your view of the world radically? What are you doing about it? What about the financial world?

Dr. Ho: I think this is dealt with by the people on the trading floor, in VAR. They do have daily P&L now, a very well-established system for them. They divide that by the VAR of each trader. I talked about how each trader is acting on his or her own. There's no need to consider other traders, and how this all impacts the whole trading floor. Each trading desk is linked very tightly to the capital at risk. The challenge we have is how to extend that concept to a whole insurance company. I was alluding to how the contribution of risk is a more appropriate denominator to use to adjust for that risk. There are other issues involved. I think that's very much frontier research at this point.

From the Floor: I didn't find each risk identified as 95%. How far along have you come in summarizing it all into one number and getting the correlations? Are you able to get the correlations that you need, or are you finding that you're just looking at each risk separately in terms of the morbidity and the interest rate risk and the different blocks of business that you have?

Mr. Longley-Cook: I'll give the Aetna perspective. I'm looking forward to rolling those numbers together next month. I've done it sort of on my own on a back-of-an-envelope basis over the last couple of years, literally getting the numbers in on a consistent basis from all the business areas and rolling them up and into an Aetna, Inc. risk profile is something I plan to do next month. It has taken so long because it's very hard to get all the areas on a consistent basis. Even interest rate volatilities may seem fairly straightforward, but I found that in two areas one was twice the other. They're really far apart. Theoretically you can get those all on the same basis. But what about health trend mortality and interest? I mean it just doesn't lend itself to a definition of volatility that is easily determinable to be consistent.

Whatever we do next month is going to be very rough, and then we'll refine it over time.

Again, you're never going to get a full picture, because some of the biggest risks, and some of the ones you've really got to focus on the most, are the ones you can't quantify very well. I don't pretend to think that in a month I'm going to have something that I can show to the CFO that literally puts one number on this VAR. However, I think the process is the most important thing. It forces us and the business areas to think through the risk exposures. Combining them is problematic.

Dr. Ho: I think we have to look at a sector or sectors of all the resources. For example, you can estimate the interest rate risk and the basis risk. Credit risk is one for which we have to bring in the transition matrix and agree on those risk sources. J.P. Morgan recommends a stock index, but I think we really are using some underlying factors of the stock market, so there'll be a limited number of sources to represent the equity risk. Then move on to the product risks. I think the best comparison would be to look at prepayment of mortgage-backed. It's not so much a prepayment risk, which is linked to interest rate risk and is already captured by the model. When we talk about prepayment risk as a source, that means the prepayment model can be wrong. We look at a prepayment duration by jacking up the prepayment speed, and then link up to the delta of that.

At the product level, this compares to the lapse risk. Lapse risk is not so much an interest rate sensitive product. It is really a matter of asking, what if your lapse model is wrong? Lapse models are really dependent on your financial model of the product and the calculated delta with the products. In those cases, our experience has been to try to make those resources kind of independent of the market risk because, intuitively, there is no reason why the lapse model would suddenly be wrong because the interest rate comes down. A lapse model is supposed to capture the interest rate falling down and all those issues. We try to use a correlation of zero in those cases.

Mr. David N. Becker: I want everybody in here to understand that there's an incredibly important point that has not really been elucidated, and that point is: what is the objective function of risk management? Tom has proposed using a logical construct by applying the analogy of finance theory to liabilities. Alastair is using the concept of the free cash flows of an organization, which we, in our industry, call distributable earnings. Rather than go into detail on that here, I would like to mention that I'll have an article in the December *Risks & Rewards* with the title of "The Objective Function of Asset/Liability Management (ALM)." That article precisely focuses on this particular question because, until you answer this question, your quantitative basis is totally uncertain.

One point I would like to make, though, is we did a demonstration with a multibillion dollar block of single premium deferred annuities. Because the market value or fair value of liabilities is inherently an ambiguous concept, we chose different but logical choices of spreads to Treasuries to discount back to obtain a fair value of liabilities. Then based on shocking the curves, and using option pricing theory, we calculated the resulting option adjusted durations of these liabilities. Now, we use spreads from zero all the way up to a cost-of-fund spread. When we did the fair value computations, and the shocks, and more fair value computations, we calculated all the different option-adjusted durations you could get. When you took the longest such duration, and divided it by the shortest such duration, that ratio was over seven. What that means is: if the shortest duration had been one, the longest would have been between seven and eight. This is a fairly broad range. If you're actually going to try to manage your business, then when you go to your associates in the investment area, you need to know precisely what number you're giving them. At that point, it's no longer a relative risk measure that you're tracking over time. You're actually telling somebody to do something. Make a bet on how you run your business. I just use that to graphically describe the significance of this issue. That's perhaps the most important thing to walk away from here with.

From the Floor: I looked at multiple scenarios of multiple horizons and tried to develop a matrix of values. When I look at all the work that's being done now it's, in effect, saying that it's very dangerous to look at these numbers that are simply rate-of-change numbers on a very marginal basis because that calculation at the margin requires a lot of assumptions that you cannot test. If you do test them and stress them, then it's very difficult to put error factors into your measures. A simple example is if I calculate a duration of four, I don't know how to build in a margin of error around that figure. Do I add 0.5 to it? Do I subtract 0.5 from it? Is my duration four plus or minus 0.5? Does that help me in evaluating the risk exposure for that product? Instead of focusing on these single type numbers like duration, convexity, and so on, what we are trying to do is get a picture of the fuller landscape, and the exposure of risk over time. If we are successful in doing that, and in building an objective function that Dave talks about, and in building in the measures that I've heard about, then maybe we have some hope in at least trying to earn a better bonus whenever compensation catches up with the analysis. I want to congratulate all of you on the work that's being done here. I certainly think that there is a significant difference between the way the banks are looking at this and the way the insurance industry needs to look at this. As Tom said, on the trading floor level you can do this as many separate businesses, but at the insurance company level your real value added is the fact that you're aggregating a lot of diverse exposures into a portfolio. How are you going to be able to handle that and still compensate people sufficiently?