RECORD, Volume 23, No. 3*

Washington Annual Meeting
October 26–29, 1997

Session 3PD
Financial Engineers: Who Are These Guys?

Track: Actuary of the Future
Key words: Investments, Product Development

Moderator: PAUL V. BRUCE
Panelists: RANDALL L. BOUSHEK
SHANE A. CHALKE
THOMAS S. Y. HO†
Recorder: WILLIAM N. KOCKEN

Summary: A search of the Internet under the topic of financial engineering leads to the discovery of topics like risk assessment, portfolio management, default risk, value-at-risk, pricing, hedging and trading derivatives, asset/liability management (ALM), contingent claims, financial mathematics, stochastic analysis, and market forecasting. This panel sheds light on this new "profession," and how it relates to what actuaries do.

Mr. Paul V. Bruce: Several years ago I read a newspaper article about a new field emerging on Wall Street. This article stated that the business world and Wall Street, in particular, was generating demand for people who could perform intricate financial analysis beyond the capabilities of the typical finance masters graduate. Ever since I read that article, it has seemed to me that financial engineering is a field that actuaries would be well suited for. We have an excellent opportunity to test that theory, learn just what financial engineers do and how it relates to what actuaries know and do.

First a quick comment on the title of this session. The title comes loosely from the movie, *Butch Cassidy and the Sundance Kid*. In one scene, Butch and the Kid are being pursued relentlessly across the desert. Finally, either Butch or the Kid, I don't

---

†Dr. Ho, not a member of the sponsoring organizations, is Executive Vice President of BARRA, Inc., in New York City, NY.

Note: Some of the visual presentations referred to are not available.

remember which, turns to his partner and says, "Who are these guys?," to which the other responds, "I don't know but they're good." Our panel is made up of three gentlemen who are very good at what they do. Tom Ho will lead off the presentations. Tom is an executive vice president at BARRA Incorporated in New York City. Tom is not an actuary and yet is very familiar with the technical aspects of actuarial work and the insurance industry. His perspectives are well based and always interesting. You may be more familiar with Tom in his role as president of Global Advanced Technology. Tom will talk about modeling, securities valuation, and the ALM building blocks of financial engineering.

Shane Chalke will follow Tom. Shane is chief executive officer (CEO) of Annuity Net, a company that provides comprehensive technology enabling the solicitation and customer management of annuity products over the Internet. Previously, Shane was executive vice president of SS&C and before that, founder and CEO of Chalke Incorporated. Shane has served the Society in a wide variety of ways, and is a prominent speaker and writer on macro pricing theory, retail financial services, and the future of the insurance industry. Shane will cover the liability side of the balance sheet including product design and efficient frontier concepts from a financial engineering perspective.

Our third speaker, Randy Boushek, is vice president and senior life company portfolio manager for Lutheran Brotherhood in Minneapolis. Randy will wrap up the presentation part of the program by covering the asset side of the balance sheet with topics such as actuarial underwriting and busted credit in real estate analysis. Randy has extensive experience in asset segmentation and ALM and has been part of Lutheran Brotherhood's investment division since 1987. His asset management experience extends to quantitative investment research, derivatives, mortgage-backed securities, and bonds. Randy is a frequent speaker at Society and other insurance industry conferences.

Dr. Thomas S. Y. Ho: I think financial engineering is a very interesting, and fast-growing profession, and it's particularly important for actuaries because there's such growth. Now we're moving towards insurance businesses and security pass-thru products and so on, and all these issues are very close to what we're doing.

So who are financial engineers? That's a very tough question and similar to if we were to ask who are physicists? We must give some thought to the question, because it's such a broad topic. Maybe we should start thinking about the basic principles that physicists look at. There are businesses that deal with our basic principles. Then, there are physicists who can take those principles one step higher to develop the tools that can be applied on a daily basis. So then we can think about financial engineers in these contexts if we want to understand the profession and what all the Wall Street financial engineers are doing and how we are interfacing with insurance products and creating products in several lines. We must first think about what kind of principles they use, and then how these principles can be applied. Finally, how can we actually use them in the operations?

I want to focus most of my talk on the principle part. I'll try to share with you some of my thoughts in this area because, as professor at New York University for some time, my work was in research and evaluating bonds by using these financial techniques.

At the end of my talk, I want to challenge you with one of the problems that we're facing which I find very challenging in this principle concept. After doing all these analyses and developing all the tools, is there a way, by doing research, to find the building blocks of all the financial products? Can any financial products, from single-premium deferred annuity (SPDA) to commercial products have replacement parts? Can you rebuild them from an engineering point of view? If a car is broken, can we break it down into its basic essential parts and reassemble it again? If we have this technique in place, and we know the price of each of these essential parts, we have a very clear way of valuing the product as a whole based on all the parts. I think that's a very interesting challenge. I think it's one of the topics with which a lot of financial engineers are dealing.

The very basic part of financial engineering is valuation models. Given any security, whether traded or not traded in the market, how do we price it? There is a very important basic principle that has been applied over and over again, and that principle is arbitrage valuation. Arbitrage valuation says that if two securities have the same cash flow, they should be priced the same way, once assuring that value to be similar. In a capital market, we can arbitrage. If two bonds have different names, but in fact they offer the same cash flow, we can buy the cheaper one and sell off the richer one and make a profit. That's an arbitrage profit. So our market is functioning this way so that firms can get into the market and buyers sell to ensure that the lower one's price holds. That is the basic premise of the flexible model.

For those who are familiar with the equity option pricing model, it basically says that while an IBM option looks different to IBM stock, if we have a way of buying IBM stock at the margin in such a way that I can always replicate the behavior of this trading position in the same way as the IBM stock, then I have a way of doing arbitrage simply using the IBM stock and the risk-free rate to price the option. Therefore, I don't care about whether you're bullish with IBM stock or bullish with the market. All I need to do is look at the IBM stock price. I should be able to price the option on the IBM stock. This is a very fundamental concept of arbitrage valuation.

I think we want to step back a little because the Black-Scholes method and this arbitrage concept has been discussed so much that we must wonder, what's the alternative? For a long time, investors priced options by thinking that we need to know when the stock is going to appreciate, then you look at the present value of the appreciated cash flow, discount bank, and that's a price, and we ran into tremendous problems taking them at the dollar rate simply because we have to make so many assumptions about how we think IBM stock will appreciate. An arbitrage free, option valuation approach gets around all these problems. Just think about the way they work now, the way we price our profits so long. We still very often use this simulating the future and make errors, the discount back procedure. We should apply this option valuation approach to get a more accurate assessment of our risk methodology.

The issue is that a lot of our securities are not based on underlying stock. It is not clear what is really underneath in some of our cases. Many of the securities we deal with, and many of the products we deal with are in fact sensitive to the interest rate level because we are using a discount rate. So we need to apply this whole arbitrage valuation concept of Black-Scholes for stock options to interest rate sensitive securities, and the standard methodology now is arbitrage-free valuation. So a pricing model really has four parts. When we talk about financial engineering, we mean they're developing the valuation model of a product, like an SPDA or the commercial loan and so on. It's really not a simple equation, there are really four steps. First, we really had to estimate the time value of money. We will have to reject the concept that there is one fixed interest rate. There's a whole term structure of interest rate looking at present value of $1 into the future, and that present value number depends on the term structure and the whole spot curve. We need to find what is the right type discount rate along the whole interest rate path.

Then we need to set up something called the binomial lattice model. That means we have to have some way of generating our discount rates into the future in such a way that it's consistent with arbitrage concept that I just talked about.

Finally, we have thought about some kind of sampling of these interest-rate scenarios. For those who are working with and familiar with stochastic interest rate simulation, you'll find them thinking about all the interest rate possibilities. There are so many. Is there any systematic way of picking these interest-rate scenarios so that we can do our stochastic testing? What's more important and the point I'm really trying to make about financial engineering is that we have to pick these interest rates that are not only projected in the future, but those that are consistent with this whole arbitrage-free concept so that we can use these scenarios to value bonds in a consistent fashion. Then we extend this concept to other risk sources.

I started off talking about the Black-Scholes model for equity options and interest rate models. As we know, there are many risk sources. The art is bringing another risk source into a consistent framework so that we take all of those into account. These other risk sources could be default risk or the inflation rate. So how do we bring all of them together? These are referred to as multifactor models. In this brief overview of all these basic principles of financial engineering, I just wanted to use a simple example with all of these four steps. There is a tremendous amount of research going on to improve each of these steps and give us better and more efficient answers and a different requirement for different purposes. The purpose of my talk is really to give an overview and to come to the conclusion that we are discussing what I think is kind of the important project as we go forward.

The first step in setting up the arbitrage-free rate model is to determine what we call the forward rate. In the forward rate, if you have a present value here, supposing there's absolutely no interest rate uncertainty, what would the future interest rates be, and that is a risk methodology. In the concept of an arbitrage-free model, once you develop this forward rate, you should fluctuate the yield curve around the forward rates, which creates a lattice of interest rate movements. Once we have these interest rate movements, then we can do the valuation. This is what is sitting inside many of the computer systems now. This initial point is that on new terms, principally we are certain and then we project typically for our long term life products. We will project one month. If you short rate a product, it could be one day or one week. So each time you project one month, we say the yield curve could go up and down. This is referred to as a binomial lattice. There will be many ways of generating these yield curve movements and saving them in the computer systems in such a way that they are assured that the movements are arbitrage free. What do we mean by that? If I tell you that we are thinking there was a 50% probability of going up and down with these yield curves can we now, at time zero, buy bonds and sell bonds in such a way that we can make arbitrage profit with these scenarios realized? Can we create a strategy so that we guarantee making money?

There's no way you could actually make money if I feed all these yield curve movements into the computer system. There is a lot of research going to determine the most efficient and accurate way of specifying these yield curve movements such that it remains arbitrage free and remains realistic and captures most of the yield curve movements that we see historically.

Now I'm going through the step-by-step methodology very quickly to give you some idea of how we make use of these yield curve movements to value bonds. The one-year rate initially is 9%, and then the rate can go up to 11% and come back to 7% and so on. So these are the interest rate movements into the future. When you price a call option on a one-year zero-coupon bond, these movements are going to happen. The one-year bond values are at $88.90, $90.05, $93.02, and $94.78. The payoffs reaching down on the line. Now the computer will roll it back looking at expected present value on expected payoff and roll back to a mixed number, 1.24 is derived as the average of 0.43 and 2.19 and discounted at a prevailing one-year rate. If you follow this procedure and roll back, you'll get the 35¢ as the initial price. Typically, we must estimate the yield curve and save all the yield curve in the future. We have exactly what the yield curve looks like at each state of the world. Imagine yourself on the time machine of each state of the world and asking, How should I price this option? You give the price and step-by-step you roll back and get the price. So we have the whole positions of all these options, bonds, and so on following the same procedure to price bonds.

Now step back. Why is this procedure so powerful? That is because if we have any securities or bonds that are not traded, like private replacements, commercial mortgages, or these bonds that don't trade, what is the value? Let's go back to the law of one price now. If this procedure works for the traded bond, what's the sense that the price we get here is actually consistent with the market price we see in the capital markets on Wall Street. The law of one price is that my private placement, my commercial mortgages, and the same cash flow, I price the same using the same methodology. The price we get by the mathematical approach is in fact giving me a value that's relatively priced in the capital markets. So we are not arguing or suggesting that we need to trade the private placement or trade commercial mortgages before we are able to establish market value. We are arguing that if this bond could be traded and we have to rent the security, and benchmark all the capital markets, then this is a good benchmark price that we can use for managing our assets and liabilities for other purposes.

So we can now extend the whole concept of what is market valuation if a security is not traded. If this framework is in place, then we can actually have assigned values to securities that are not traded in a meaningful way in a consistent fashion. That applies to callable bonds. So a bond can be called at $80 in this case, so we follow the same procedures in roll back. When you roll it back, it is $79.88, $83.97, and $88.58. Those are the present values of those bonds in those scenarios. Now the computer checks whether the bond will be called or not. When the bond stays at $79.88, which is below the called price, the corporation will now have no incentive of buying back the bond which is at a lower price than the call price. So it will stay traded in the market at $79.88, but when the bond's actual value is $83.97, then the corporation has a right to buy back the bond at $80, and the bond will be called. Consequently, bonds should be traded at $80.

This methodology can extend to a lot of securities that we can think of, but there's a spread. Bonds have to be traded at a price that is cheaper than the markets and the Treasury curve because of the inherent risk and liquidity. So we add a stretch to this rollback. It's commonly called option-adjusted spread. So for securities traded in the market, there are the assigned option-adjusted spreads. How is option-adjusted spread applied to products and securities not traded? What would be the right spread one should use to create that? In summary, once we have the yield curve we have the characteristics of the bond. We can assign the payout, and we can always roll back the discount along the yield curve and along the prevailing interest rates. Together with a particular spread, you add on to capture the liquidity and default risk and other risk, we will get the market price, the fair value amount.

In mortgage-backed securities, it's dependent on the yield curve going forward. The interesting theory is if you take all the possible interest rate paths into consideration in the lattice I talked about, and you actually know the cash flow, you just discount the cash flow along the interest-rate scenarios.

The complication of this approach is that you have to take all the possible interest rate paths into account when doing this calculation, which you'll find is impossible. So a lot of research now is geared to finding out what is the systematic and clever way of selecting an interest rate path. There's a huge path space such that we capture the value in doing all the work that is necessary, and this whole area of research is construction sampling. Monte Carlo random sampling is very complicated and time consuming—it's almost impossible to do. There are clever ways of selecting these interest rate paths by creating scenarios.

I won't have time to go through some of these methodologies, but here's one very quick way to show you that if you have a represented part in this huge binomial tree, you can think of each of these as a representative of each of these parts in the whole binomial lattice. That's why we ended up with an interest rate scenario with weakened probability.

Here's a way of pricing a zero-coupon bond. On the left hand side, there are many path space scenarios, which are representative interest-rate scenarios. The weights are a mathematical item you calculate. This is representative of how many of these binomial interest rates we're talking about. That's a weight. Path wise value is the present value of the cash flow along that interest rate scenario. If you multiply the path-wise value times the weight and add them all up, you will get a very fast convergence to the value of the bond. If you go through this idea, you become very powerful. Think of an SPDA. We look at interest-rate scenarios going into the future. We have calculated cash flow, and now this methodology is suggesting that you discount the cash flow at the present value. If these interest-rate scenarios are picked from this arbitrage-free model, then all you need to do is add the path-wise numbers to the weakened average, and that's the market value.

You can apply the same procedure to products like an SPDA where you already have the model of general cash flow. Now it's a matter of calculating the present value and getting the answer. What's different about the SPDA versus the multifactor model? What major aspect will be the behavior? We have to start our research for the behavioral model. Something that's a real challenge to our industry is that we really have to understand our customers behaviors and create models of their behavior. Once we complete that research, we can generate those interest-sensitive behavior cash flows into our model. Now we can proceed with this methodology.

Now I come to my conclusion. This lattice that we talk about a lot is to generate all these values and we get a price. Then we use the price and do asset and liability management and other applications. As I said earlier, there are all these financial engineers. Now take these tools and principles, and take the application level. What always fascinates me is that we do all this work and then throw all the information away. We get the average of these path-wise numbers and that's all we use. That's incredible. We should step back a little bit and ask ourselves what these path-wise numbers that I calculated really mean? What you're looking at is all the scenarios we have used—the generous stochastic cash flows. On the left is weighted probability of those scenarios. The right two columns are the present value of the cash flow along those scenarios. These are numbers. What do they really tell us? What they tell us is that if that first scenario happens, the present value of that cash flow is that number. If I have the path-wise number on assets and liabilities equal in all the possible scenarios in the binomial lattice, what does that mean? That means if interest rates go out in the future, if you follow any of these interest-rate scenarios at all and the end result at the end point at the end of the life product, you have actually zero cash flow. So if there is any mismatch of cash flow, and if we take the reinvestment of borrowing a new account, then we're sure that there's no surplus in the end. Conversely, looking at my asset side, the path-wise value is higher than the liability value. That means if you take reinvestment borrowing into account going into the future, that means we always have surplus at the end of the life of the fund. So much of our cash-flow testing is to look at the end of a life product. This methodology shows that we could look at our present value bases and compare them. The power of this whole methodology is so we have a systematic way of taking the sample interest-rate scenarios that properly span the whole scenario and path space, and then we assure them to be the same and then manage them accordingly, you can even plot them. If you plot the assets and liabilities together, that means any plot above the 45° line, is above liability, and any path below is below the liability.

The conclusion now is that you can use this path-wise number and actually manage the assets and liabilities not only on a market-value basis, but actually on a scenario basis to see which scenario you're ultimately forming or not. Now we pose a problem in another way. Given the liability products, I have a way of finding exactly what the bonds are, what the cash flows are, and what the options are so that, as a portfolio, all these path-wise numbers are equal to your liability—the SPDAs, universal life (UL), whatever. In fact, I have a way of replicating the products into basic tradable securities and that is really powerful because now we have a way of transferring liability management to asset management. But what I'm saying about embedded options that we have sold to our customers, is we have a precise way of identifying that. So many times we have heard that we have sold our products with embedded options, but we really have not come to the methodology of saying, what is that option, what is the value, what do you mean by that? We need to have a systematic way of classifying the kind of products, the kind of cash flow, and the kind of options. If you can identify those options in the security markets, it will be tremendously helpful.

From this comes very powerful tools that we believe can actually build a complicated product and do basic complementary parts.

Mr. Shane A. Chalke: We're about to experience a fairly radical transformation in actuarial science and what actuarial science actually means. I'll start with a quick definition of what I think financial engineering is. Although Tom implied it, I'll say it. I think financial engineering is the application of mathematical finance within a domain. Tom did a great job of just outlining a few of the tenants of mathematical finance.

We've been in an environment for ten years or more where certain actuaries have skirted around these issues quite handily, particularly in ALM. There has been an enormous amount of activity in applying interest rate models, option pricing theory, and mathematical finance to the issues of risk management. Very little of this has snuck over to the product side, but there have been developments in some products in the past year or two that have hit us right between the eyes. One example of this is equity-indexed annuities (EIA). People have been pricing products on an expected-value, single-path basis since the beginning of time, and now we have a new product where that doesn't work at all. For the very simplest of products, you can come up with approximations if you can, for equity-indexed annuities and calculate some spread that's required for hedging. I'll use the rest of the price in a single-path basis. But, if you get beyond the simplest of products, it just completely falls apart. This thrusts product actuaries into the domain of mathematical finance very rapidly whether they like it or not. If most of them like it, I think it makes the job a lot more interesting.

Not only are we thrust into mathematical finance, but we're also thrust into perhaps the most complicated venue of mathematical finance. Suddenly, we're required to apply these stochastic models not in the arena where we only care about interest rates, but we must also care about interest rates and equities. This adds a dimension that's not particularly well developed in the finance theory. They thrust product people from being substantially behind the asset/liability or risk management people to right in front of the risk management people. This is kind of interesting.

Now what's driving this trend? EIA might be a good example, and might not be a good example. Are they going to become more popular or less popular? I don't know. As a matter of fact, I don't even know what's happening today. I know the Hong Kong market fell earlier today by about 6%, and that's pretty extreme. What happens to us? "You" also applies to "them."

I'm going to start with a quick little model that I've been using for about 18 months now that at least helps my thinking about where a product is headed and what twists and dimensions a product is taking. It's a model of a human. I've become fascinated with humans in the past couple of years. Before that, I only really cared about finance theory, but it occurred to me that, ultimately, humans buy all these finance products or else we don't get to make them. It's sad that it has to work that way, but actuaries just don't buy financial products. I don't know why that is. You can't sell an annuity to an actuary.

I have an example of what yuppies' income and expenditure patterns look like over their life spans. What I've done to create this example is I've stripped out all the financial products either explicit or implied, so I stripped out pension plans, 401(k)s, and employer provided health insurances. This is just the raw accrual of earnings and expenditures. When you hit age 22, expenditures pop up. That's because you buy a car when you get your first job. You have three paychecks with about $130 in the bank, and you go out and buy a Honda Accord. Then you get this mismatch right between the eyes early in life. It just continues, and it gets worse and worse. After a few more years, you do the prudent thing. You buy that first piece of real estate because that's the traditional path that people take. In a couple of years, you trade up to another piece of real estate and accrue a little more expense. All through this period, you're buying cars every four years or something like that. Then things calm down a little bit until you hit about age 45 or 50, and you start buying copious amounts of education for your kids. You get a spike there in the middle and that causes some additional matching problems. The current wisdom, of course, is that once you hit age 65 and retire, maybe now it's age 62 or 70, retirement age is just becoming a barbell. The average age may not be changing very much, but the variance is changing considerably. At age 65, your expenditures go down and then you start buying lots of health care services and expenditures start going back up.

On the income side, remember that I stripped everything out and I've also put it in real dollars. Current wisdom says that when you hit about age 43, the income, in real dollars stagnates for an average, white collar professional. That, in fact, is not true. You strip off the financial services products because generally you have a series of employer-sponsored, semi-sponsored grant that are semi-grouped to benefits that continue to expand in cost quite dramatically through retirement age. Pensionable wages probably keep in real dollar terms about age 43 which might explain a midlife crises as well. What happens here is that the pattern of income is fairly smooth provided you're an employee, not an entrepreneur, in which case, it looks more like an expense line. It is more unpredictable. This fairly smooth pattern doesn't look anything like the expenditure pattern, and this is the issue that humans face. We try to sell them products to try to solve this puzzle.

I think there are two dimensions of this puzzle that require solving. The first one is just to make the lines match in some fashion, and that's not particularly difficult if you know what the lines are. In fact, we sell as financial services a whole series of products that help you switch cash around on this life line. There are credit products when you're young and when you're older, and accumulation products as you advance in age. These are cash-matching products that just move money around on these two lines to make the two lines match. What complicates this problem is that both of the lines are unpredictable; they're both stochastic events. With income, you don't really know whether you're going to have a job next year, or whether you're going to die, or whether you're going to get disabled, or whether you're going to get a different kind of job, or whether something will change in the economy that changes your income flow. You don't really know on the expense side whether you're going to crash a car, burn up your house, or sink the boat.

There are a lot of variables on either line, which makes them both stochastic. So we sell a whole other series of financial products that help people reduce the volatility of these two lines. To reduce the income line, we sell disability income life insurance. To reduce the volatility of the expense line, we sell things like personal life, property and casualty insurance, general liability insurance, and so forth, just to control the expenses a little bit more. Humans have a very difficult problem with trying to fit all this together and make this work. It actually is an asset/liability management problem of huge proportion. It actually makes some of the problems we deal with in doing ALM for insurance companies pale a little bit because of all the dimensions that people face. So how do they do it? We offer them about 120,000 different choices of product, and they pick and choose from these 120,000 different kinds of products. Your typical while collar worker might own 30 or 40 financial products at one time to piece all this together. The problem is that humans do a reasonably poor job of making this all work. Now this hasn’t really been highlighted as a Society problem yet because, up until now, humans have had a lot of externally imposed structure on this problem, both in terms of past credit availability and in terms of retirement planning. People have had major doses of retirement planning externally imposed by defined-benefit pension plans and social security in the past and the present.

So this external imposition helps people solve these problems a little bit better, but we're about to see a generation of people that are going to have to make this asset/liability problem work on our own. Actuaries are probably well equipped to do this. I mean you're the kind of people that download your bank statement every day with Quicken. An actuary is not like the average person. Your average person is going to be faced with this prospect of hitting age 65 and having to make sure all the assets match all the liabilities by the time he or she dies, and that's not a very easy thing to make happen.

Another complication to this, and this is really where the product side is driven, is that we now understand something about the risk profile of humans. It helps if you study them a little bit. We used to think that humans were irrational in their attitude toward risk. There was sort of a middle period of time in the 1980s when we thought that humans had asymmetrical risk profiles. We have a different opinion now. We think that humans in fact have a very complicated utility function and their risk behavior changes according to the mean time since the last loss event. So human beings’ risk-seeking behavior is proportional to this amount of time. What this means is that if nothing bad has happened to a human for a long period of time, they become more and more risk seeking in their behavior and less risk averse, until all of a sudden a bad thing happens and they recalibrate their utility profile and become quite seriously risk averse. This explains why people trade in the car right after the transmission dies. This explains why they buy homeowner's insurance after the house burns down, and this is why they sell stocks after the market crashes. It all kind of fits together.

If you do a little mathematical model of this time decay risk profile function, it becomes quite understandable why humans tend to buy high and sell low in their personal investing activities, and we see this again and again in the way people manage their personal finances.

So what does this mean? Well, if we are going to come back to fundamental principles and design products for humans, then we have to be cognizant of the type of problem that humans face mapped together with their unusual patterns of risk management or risk profile. So on a go-forward basis, this will drive products more profoundly than we can guess right now. I think EIAs may be just the tip of the iceberg for this sort of thing. I'm not a great fan of EIAs as they're seen in the marketplace today, but I am a great fan of the concept of EIAs because they do fit into people's time-to-pay function for risk aversion or risk-seeking behavior. I believe we'll do more of this as this goes by.

If you look at this equation, what do humans really want out of this? Do humans want interest? No, I don't think interest means anything to humans; it barely means anything to me. I think what humans really want out of this is simply to preserve their lifestyle throughout the generational line, and that has a lot of implications for how we might design products on a go-forward basis. In the accumulation stage, we want to design a product that gives people a payoff profile that matches the way that they think, act, and live their lives. In the disbursement phase, when we're all past retirement, we need a product that is more fundamentally capable of getting the job done which might mean immediate annuity products that are indexed to marginal productivity, human labor, teamster wages, inflation, or something like this. Humans don't do very well with the etch-a-sketch and the point solutions that piece it all together and make everything work.

The balance sheets of your companies are optimally structured in terms of capital usage, capital return leverage, and so forth. We tend to think of financial engineering and risk management, which is where it's blended most firmly with actuarial science today. I agree with Tom in thinking that the fundamental principles that are in play are the same; regardless of which activity you're engaged in.

Let's get back to financial engineers in applying mathematical finance within a domain. What kinds of things work on the product side? Equity-indexed annuities is an example. Let me give you a couple of others. It's quite popular now for large corporations to offer their executives loans to purchase the company's stock. The current trend, however, is a little bit more unusual than that. Many companies are offering executives loans to purchase the stock, but if the day the loan is due the stock value is not sufficient to retire the loan, the company will forgive the shortfall between the stock price and the loan. It's a fairly common thing. Is this financial engineering? Sure it is. If you take that fairly complicated sequence of events, which I think most executives will perhaps understand and like, you reduce it down to principal plus a stock option. It probably has different regulation in taxation, but it's still just a stock option. How different from an EIA is that arrangement? It's not very different at all, which should send two messages to us. First, there are equivalent problems that exist elsewhere in the economy, and second, there are people other than actuaries solving these kinds of problems in the economy and these problems are really quite similar.

Another funny example just came up a couple of weeks ago. The First Bank issued the first millennium bond, which is a thousand year bond. They sold a fair amount of this bond—about $400 million or something like that. This is pure financial engineering for it to get to that kind of extended period. I'm just guessing time-year models go a thousand years, but it's quite interesting stuff and it's hard for people to intuitively understand these kinds of things. As a matter of fact, I asked one of my classes, “Do you think that the price of bonds changes much if you just knock off the last 700 years of interest and principal?” The funny thing was, a bunch of Ph.D. students in finance had to think about it for longer than about three seconds, at least until someone punched up the calculator and said, “Oh, yes, to fund that last 700 years of payments is about a fifth of a penny on a $1 million bond.” It doesn't matter what interest rate you pick; it just has to be nonzero.

So where are we going with the product? We have these few little peeks at things right now which absolutely mandate the use of finance theory, such as equity-indexed annuities and minimum guaranteed death benefits (MGDB) on variables. I think the activity's going to change quite dramatically in both accumulation and payout design when we start to map this better into the way humans need to receive or perceive products in order to make these equations work for themselves personally, and we're a little bit behind the curve on that right now.

On the product engineering side, we're going to complete this transition from expected-value pricing to stochastic pricing to what I call component pricing. When Tom refers to breaking down any financial instrument into little components that we can price, I use the euphemism component pricing, but in product, we may just skip over a lot of the stochastic work and go right to component pricing or right to the direct application of finance theory. I believe that these will be the fundamentals of actuarial science on a go-forward basis. We're struggling a little bit to define what actuarial science is. I would say that actuarial science is the application of finance theory to a particular domain. Do we have any science that's all our own? I'm hard pressed to find any. That's not a bad thing; it is just a reasonable realization. Actuaries will have to be very well schooled and know arbitrage pricing or arbitrage repricing, but there's a counterpart to that which is equilibrium pricing and that skirts the issue of the kind of stochastic simulation work that we do. I believe for actuaries, these should be given somewhat equivalent weight so we understand both equilibrium pricing and arbitrage-free pricing.

There's a lot of work to do here on the educational side to bring all of us up to speed so we have the proper tools to do the right kind of job. We're starting to see that there's a higher premium paid for people that understand finance theory and the insurance domain. Actuaries may be the only people that have mathematical capability and the domain knowledge to wear these hats. I think that's generally positive news. I guess the answer to who are these guys is that it better be you.

Mr. Randall L. Boushek: My assignment is to wind up our discussion on financial engineering by moving us from the right-hand side of the balance sheet to the left or from liabilities or product solutions to assets.

There's a wealth of information or material that we could mine on the role or impact of financial engineering in the investment world. What I'd like to do is focus on just a few specific examples of how a life company investment operation might employ financial engineering techniques or encounter financially engineered products in their day-to-day operation. In the process, I'd like to offer a few comments here or a few thoughts on what the current role and perhaps the future role of the actuary might be in that process. Before I do that though, there's three things I'd like to do. First of all, I'd like to give you my simple, and certainly less elegant than Shane's, definition of financial engineering. What I would say is it's slicing, dicing, and/or repackaging cash flows and/or risks. Second, I'd like to give you some information on my background. I do have a bit of a dual background sometimes spent on each side of the balance sheet.

As Paul mentioned before, my current responsibilities include overseeing the bond part of our investment operation. I'll give you some background on my organization. Lutheran Brotherhood is a fraternal benefit society headquartered in Minneapolis. We have approximately $20 billion in total assets under management. What makes us kind of interesting in that regard is those assets are split almost evenly between general account invested assets and a form of mutual fund assets, either public retail funds or variable products all managed under the same roof. I'm going to draw on that experience a little bit in a couple of my comments.

I'd like to talk just briefly about where I think financial engineering comes into play in different elements of my job. First, I use it for asset allocation and optimal risk assessment. I'm going to give an example on efficient criteria analysis in a practical sense that we've encountered this year.

Second is portfolio construction or building the portfolio to match the product solution. Certainly the role of derivatives is very significant here. This is not intended to be a session on derivatives, and I'm not going to talk about derivatives, but this is a key area of financial engineering and portfolio management. Finally, there is security selection. I use the term actuarial underwriting. There was a time when the primary research in an investment operation in a life company general account was credit research. In our shop, at least within the general account, that time is now divided almost equally between credit research and quantitative research or again what I will call actuarial underwriting. The classic example of that is collateralized mortgage obligations (CMOs). These have been around for 10–15 years. There are a tremendous number of cash flows that can be sliced and reconsolidated. Many things have gone on in this market and there's a great deal of information on it. It's an area that I've presented before.

I don't intend to talk about collateralized mortgage obligations. What I'd like to talk about are two other examples of newer and more interesting developments in individual security construction. It is what we'll call catastrophe bonds, a very unfortunate label. For those of us in investment management, the standing joke is we all have some of these in our portfolios, but what I intend to cover is a very specific type of bond that deals with catastrophes, in other words, that deals with earthquake risk, hurricane risk, and things of that nature.

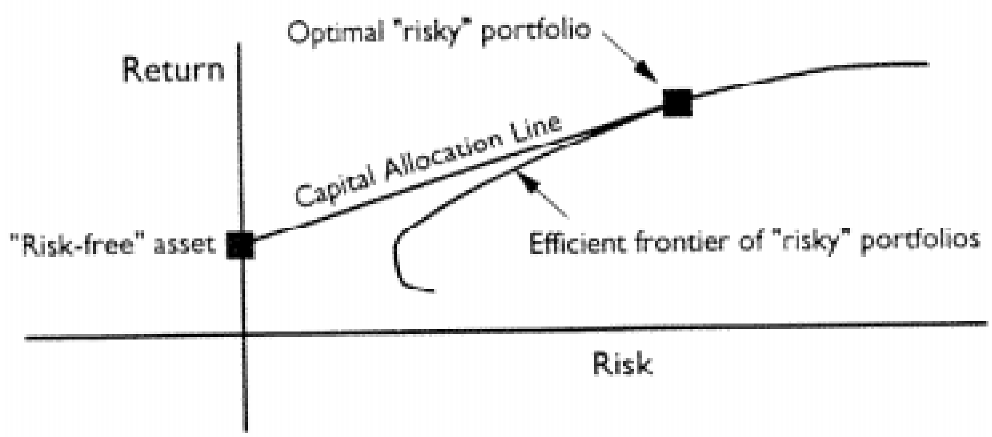
Finally, other structured securities would fall under security selection. Wall Street was so good at combining and securitizing mortgage loans that it has branched off into a wide variety of underlying collateral.

I'm going to look at three specific examples of things that my staff has encountered in the last year that I think involve financial engineering techniques or products. Let me start with the first, efficient frontier analysis. I'm going to illustrate this with something that we did on our mutual fund side, but the same concepts apply to the general account, and we've applied the same methodologies to our general account. For those of you who are working your way through the exams or have recently completed them, you'll recognize this as a classic Markowitz model from Course 220. For those of you who might be a little more seasoned, you may remember Markowitz from old Course 8, but we're going to look at sort of a practical application of this for our clients. We have two objectives in mind. First, we want to develop a tool to assist our clients in making asset allocation decisions (remember we're dealing with retail mutual funds here).

Second, for our own purposes, we want to develop a tool to evaluate the diversification of proposed funds. We want to assess whether there's value to pursuing a new fund, and in a general account sense, we want to assess whether it makes sense for us to diversify into a particular type of asset and to what degree.

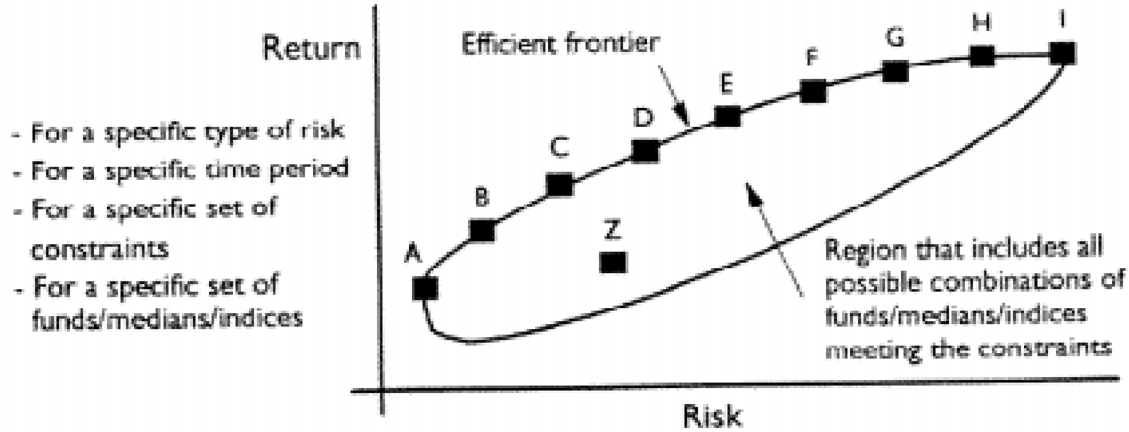
The available data we have to work with include historic monthly returns for various funds, and these are our in-house funds. Where there is not data, we can look at fund group medians or asset class indexes. There are three different measures of risk to look at. The classical measure is standard deviation of returns, but we also define risk in two other ways—the maximum loss experienced in a three-month period and the maximum loss experienced in 12-month period. Again, we're looking at historical data for this analysis. Finally, there is a set of constraints of short selling; in other words, we can't go short on a particular asset. There can be no more than *x*% of total assets in any one fund (and *x* will vary depending on the kind of run we're doing). We might incorporate a second measure. For example, if we're looking at risk as defined by standard deviation, we may incorporate a constraint that says, "*and* no more than a maximum three-month loss of *x*." Again, you may remember from Course 220 that Chart 1 is the classical formulation of efficient frontier analysis—risk-free asset, capital allocation line, optimal portfolios, and so forth. I'm going to look at a little simpler model and the practical application that we employ. This is for the purists in the crowd.

CHART 1
EFFICIENT FRONTIER ANALYSIS



I said there were three different types we were looking at—for a specific period of time with historical data, for a specific set of constraints, and most importantly, for a specific set of either funds or medians or indexes (Chart 2). The region inside the oval represents the finite area of possible combinations of asset classes or portfolios. In this particular case, we're looking at 5, 6, or 7 funds at most in 1% discreet increments of combinations. So we see everything. That leaves literally tens and even hundreds of thousands of possible combinations of portfolios, and they all fall in that gray region. Z might be one combination with 30% of this asset, 12% of another, and 15% of yet another. We focused on points A through I, which is that sort of optimal risk or optimal return for a given level of risk.

CHART 2
EFFICIENT FRONTIER ANALYSIS



We're going to look at a time period involving the last 10 years, so it is 120 months' worth of returns. We're going to define risk to be standard deviation over that time, and we're going to set two constraints—no short selling, and no more than 50% of dollars allocated to any one fund. The universe will be our in-house family of funds where we don't have fund data going back that far. We'll use a Lipper median. So we're looking at seven funds over this time period.

Chart 3 is our frontier. The region inside the oval is the possibilities. A through I are very specific combinations of those funds that give us the maximum amount of return for the risk, which is again what our purpose is. Our ultimate purpose is to develop a tool for our clients and for us to evaluate the diversification value of a new asset or a new fund.

When we stir this all together, Chart 4 shows what we end up with. If you go back just a second, you'll see that we have risk going along the bottom axis at various points, A, B, C out to our highest level of risk. This chart represents, at each risk point, the percentage allocated to a particular fund. At point A, the low risk end, we happen to see 40% in a money market fund, roughly 15% in another fund, roughly 30% in something else, and 10% or so in that fund there. As we move to higher levels of risk, like point B, we see a different combination of portfolios. Point E has only two portfolios, each 50%. These are our two highest risk funds, each having been allocated 50%.

CHART 3
EFFICIENT FRONTIER ANALYSIS—SAMPLE RUN

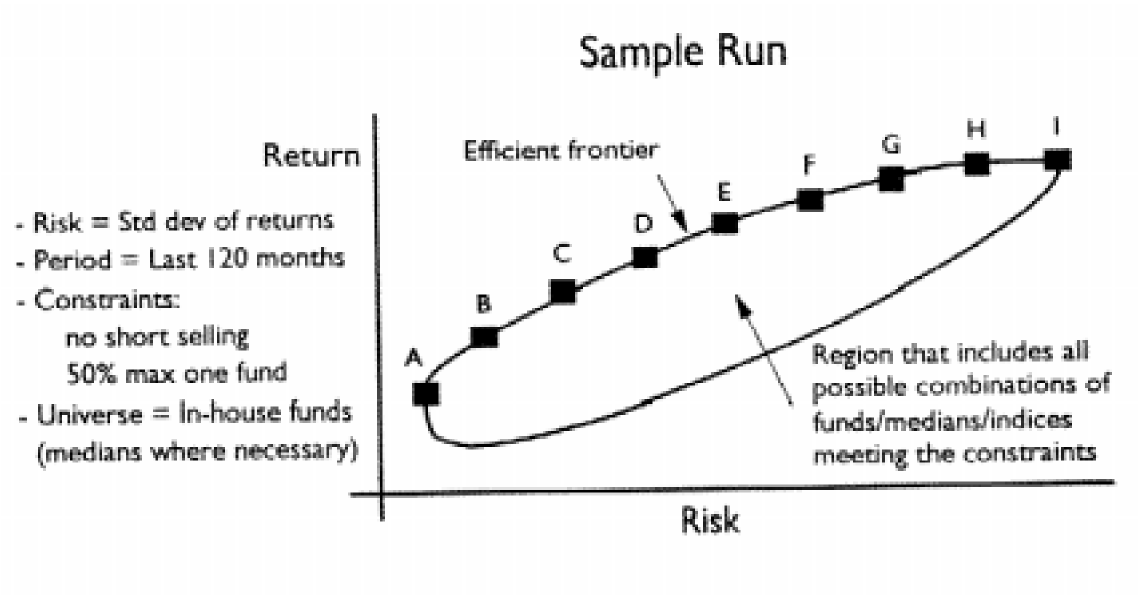
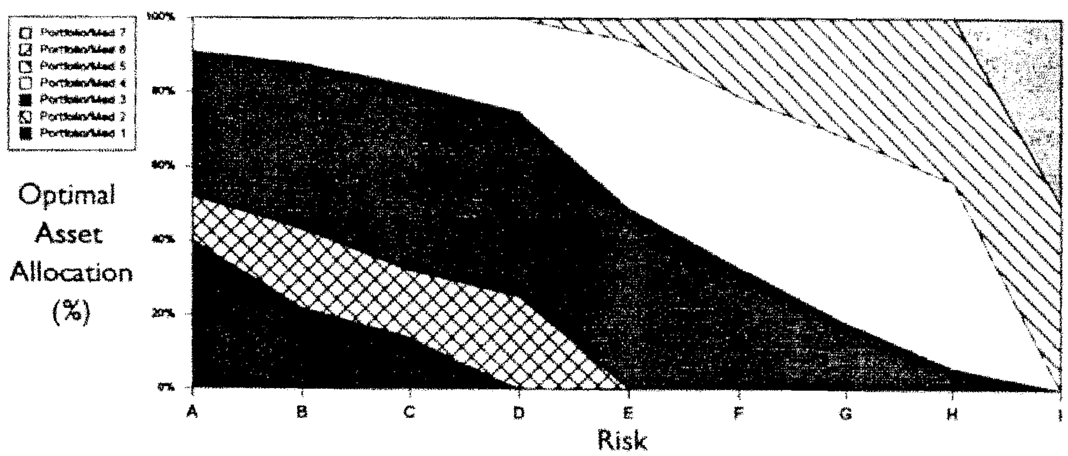


CHART 4
EFFICIENT FRONTIER ANALYSIS: SAMPLE RUN–OPTIMAL ALLOCATIONS



Let's say our client considers itself moderate risktakers. Perhaps this combination of portfolios might be best for them. From our perspective in evaluating the diversification value of a new fund or of an asset class, notice that there are six different funds that come into play in this analysis. There are seven funds we considered in the process. What this tells us is there is one fund that has no diversification value in terms of optimizing your risk/return performance.

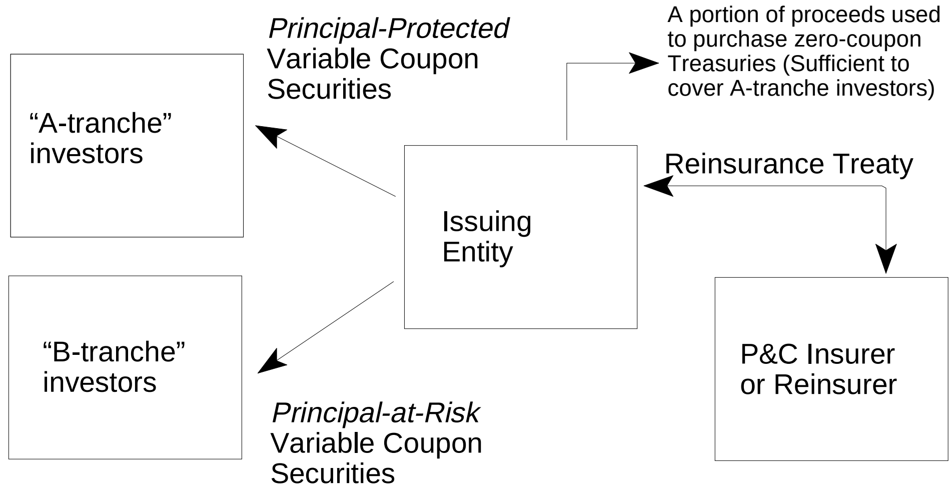
So if we look at this type of analysis for various measures of risk, for various time periods, for various sets of constraints, we can make some decisions and come to some conclusions about how we might want to structure our portfolio or how we might want to help our clients structure their individual portfolios. Now again, this example is in the form of mutual funds. We can extend it to general account risk assets, and I would submit we can extend it one step further to the general account, fixed-income portfolios that are matched to product segments. The same type of approach and the same type of methodology that I put in the financial engineering camp has future applications for how we structure the portfolios behind our fixed-income products.

The second example I'd like to look at are catastrophe bonds. I define catastrophe bonds as debt securities issued by some type of an entity, trust, or special purpose corporation, that have as their purpose, providing additional capital to the property and casualty (P&C) industry. I say it is in the form of excess-of-loss co-insurance. Those two words don't normally go together. It is excess-of-loss type insurance in a quota share arrangement beyond the trigger points. So it's really sort of a sharing of experience, but only of an excess loss level with the experience of the issuer or the reinsurer shared by investors in a bond. Typically, this type of structure would include both the principal protected and the principal at risk tranched for investors to participate in. Now let me give you a little schematic to show how this works.

In the middle of Chart 5, we have an issuing entity, this is a specially created trust or corporation. It enters into a reinsurance treaty with a P&C insurer or reinsurer. It raises funds in the capital market from A tranche investors and B tranche investors. The difference is A tranche investors are guaranteed to receive their investment back, 100% of their principal is protected. The B tranche investors are not. They have principal at risk. There's a credit element if you will as well as what both investors have which is a variable return element. The issuing entity in addition to entering into the reinsurance treaty uses a portion of the proceeds it raises to buy zero-coupon Treasury bonds. It is those bonds that provide the ultimate guarantee of return of principal to the A tranche investors. The rest of the capital goes to support the reinsurance treaty. Over time, the performance of this reinsurance treaty ultimately passes through to the A and B tranche investors. What we've done is securitize property & casualty risk and put it into the capital markets.

There are several considerations in structuring this kind of investment. First is the type of loss suffered. Is it restricted to earthquakes? Is it earthquake, hurricane, fire, and wind? What is the excess loss level, in other words, what is the retention level before the excess loss kicks in, and what is the quota share arrangement and the co-insurance percentage about that? Is it a particular segment of the underlying reinsurer's business? Is it bicoastal? Is it a particular pro rata share of its business? Is it old business? Is it new business? There are many considerations. At the heart of this analysis is a stochastic catastrophe model. It is similar to the life business. We're looking at stochastic interest rate models. In this type of business, we're looking at a stochastic catastrophe model which is provided by third party providers. We are looking at historical experience and very significantly not only the extent of potential losses, but the timing because they influence the return to the investors.

CHART 5
UNDERWRITING CATASTROPHE BONDS



Now if we step back from this a moment we should realize what this is. This is an investor. In our case, we're a bond operation looking to possibly buy one of these types of securities and we're trying to analyze the risk. What type of risk is this? This is a property/casualty actuarial analysis of risk. It's an actuarial function embedded in an investment role.

Table 1 would show you using a particular stochastic model, catastrophe model, giving consideration to all of those other elements in the underwriting process. This would be the principal protected tranche. At a minimum, this investment's going to return 0%, but depending upon the experience of that reinsurer or underlying insurer, its range of results will go from 0% up to a little more than 11% in the best case. Our underwriting process is not trying to underwrite the credit worthiness of a corporate issuer, but it is trying to statistically underwrite the probabilities of various returns, the likelihood of those returns, and the variance of those returns. Again, it is a statistical underwriting function in the investment operation. As it happens in our particular shop, this is an analysis that was performed by an actuary that I have on staff who is also now a credit analyst. It fit nicely under his responsibilities.

TABLE 1
UNDERWRITING CATASTROPHE BONDS

Percentile of Results	Base Case Returns	Returns w/Loss Ratio + 10%	Returns w/Loss Ratio – 10%
99%	11.04%	10.83%	11.21%
90%	10.33	10.01	10.69
50%	8.37	7.60	9.16
10%	4.92	3.65	6.37
1%	1.68	0.93	2.68
Mean	7.95	7.20	8.76
Std. Deviation	2.14	2.39	1.80

There are a couple of implications for actuaries. One, this is an actuarial function in investment clothes. It also has current implications. These are the type of assets going into insurers' portfolios. They are financially engineered products that ultimately need to be modeled for cash-flow testing purposes. Therein lies a very significant challenge. This is no longer an interest-rate triggered type of investment.

The final example I'd like to look at is what I will call busted credit cards. As I mentioned, Wall Street has an infinite amount of creativity to securitize and find cash flows it can carve up and distribute to investors. In this particular case, we're looking at the securitization of certain receivables, those receivables being credit cards that have already defaulted, that have been written off by banks and purchased by a specialized collections corporation. The form of this investment is basically fixed interest. We're not quite as concerned about trying to model the ultimate likelihood of receipt of our principal back, although that is an issue. Here we're most concerned about the timing of the return of our investment. It is much more akin say to a CMO-type of analysis.

Let me give a brief example. There is a set of receivables purchased by an insurer which is a specialized collection corporation. It bought these receivables from the banks that have written them off at a cost of roughly 10¢ on the dollar. That entity then turned around, with the assistance of Wall Street, and packaged into those receivables, securitized them, and received roughly 15¢ on the dollar from the markets. This is an instant profit to the issuer. A portion of those proceeds were set aside as a reserve to cover future shortfalls on returns to investors.

As this entity is able to collect, the corrections first cover its expenses, then go to pay the interest on the securities that were issued, then go to pay off principal, and when everything is paid off, the issuer gets to keep the rest. There's a moral risk here you might observe in that the issuer's already pocketed profit up front, but there are two reasons why that issuer will work hard to collect proceeds. One is because it has come to the market several times and wants to keep coming to the market. If it walks away and never collects a dollar, the investors walk away empty handed, and that issuer will never be able to come back to the capital markets. Second, in addition to the profit it can pocket up front, the quicker and more efficiently it can recover and pay off every dollar to the investors after that is pure additional profit for that issuer. Now that's a moral and business type risk that has to be underwritten. Underwriting the issuer's business practices, management, and so forth, is more akin to credit analysis.

The rest of the underwriting, such as trying to determine the timing of receiving cash flows is again a statistical function. There are several considerations, and I'll just run through them. One is the aging of the receivables. Have they been sent out for collection once, twice, or three times? Are they under 180 days? Are they more than 360 days? Another consideration is the distribution of receivable balances. Are they large? Are they small? Are there a lot of large ones or are there a lot of small ones? Most of these deals involve receivables that have been aggregated from several banks, not simply from one. Geographic concentrations and historical experience are statistical factors that can be evaluated in underwriting these securities. The other considerations fall under the traditional credit sense, such as the management practices, incentives, and the business plan.

Table 2 is a piece of output from our analysis on this security. Consider the way that you would take a look at all these different risk factors in the collateral and segment them various ways. Suppose we were to take 90% of the issuer's historical experience, so it's less than their average experience or worse than their average experience. We take a certain assumption about how much they might lose on anything that's restructured. It goes back into paying status, and we stir in some other assumptions. We find out that in this case, we get all of our money back, and we get it back in three years. If we stressed it a little differently, we get all of it back and now it takes four years to get it. This happens to be the stress test that the rating agency required for it to get a single A rating.

We look at a multitude of these, much like we would do multiple scenario analysis on a CMO, and try to assess where the expected likelihood of repayment is. If we're getting a fixed coupon and we're getting our money back, we have two things that are important that are being taken care of. What we're missing is relative value because, if this happens to repay in one year or in seven years, it may be at 15 basis points off Treasuries or it may be at 150 basis points off Treasuries, which makes a big difference in what we can credit on our products. So again, this is an example of a structured product created by the financial engineers on the sell side of the business, which is brought to market for us to reverse engineer, primarily in a statistical sense, to find what kind of fit it might have in our portfolio. Again, what I would say is this is an actuarial type application in an investment clothes with the same current implication for actuaries. This is also the type of investment that needs to be modeled in a cash-flow testing format, and that is quite a challenge to face at present.

TABLE 2
UNDERWRITING "BUSTED" CREDIT CARDS

	Base Case	Stress Test 6
Percent of historical collection level (segmented by aging, balance size, originating bank, and geographical area)	90%	85%
"Haircut" on converted performing loans cumulative static pool default rate credit losses to certificate holders	10% 32% $0	35% 50% $0
Average life and final maturity	2.8 yrs/4.2 yrs	3.9 yrs/7.9 yrs

There are many other things we can touch on, but my main goal was to try to give you a few practical and specific examples of the kinds of things that financial engineers create on the sell side. I would say financial engineers in an insurance company reverse engineer for analysis in our own investment shops to make the point that many of these are actuarial underwriting or actuarial type applications. They also point out that there are some very current actuarial issues involved in them as well.

From the Floor: For the catastrophe bonds, there is a symmetric information problem where the property & casualty people understand the risk much better than the investors. How do investors acquire enough information to evaluate the bonds?

Mr. Boushek: There are a couple of different issues. At the core of the analysis is what I would call due diligence on the catastrophe model. There are providers of the model, and I think an investor has to have a high degree of confidence in what that type of model might predict. It involves a considerable amount of due diligence or underwriting or assessing the capabilities of the model and the modeling entity. In addition, I do think it involves an understanding of the casualty business, an understanding of the types of risk that a casualty actuary might face. We must spend the time to at least get familiar enough with those types of risk, even though they're somewhat different from a life actuary risk. We must be familiar enough with those risks to be confident that the model is addressing them. There is a certain amount of reliance that comes into play.

Mr. Steven P. Miller: One of the things with financial engineering is being out on the forefront of confusing your possible policyholders or investors or whatever. Oftentimes someone tries to make something that looks better than it really is. Does anybody know how one protects the consumer or whether one does protect the consumer, including say the sophisticated consumer on the insurance side who purchases something that was produced by Wall Street, or a policyholder of an insurance company who bought an equity-indexed annuity that maybe looked better than it really was?

Mr. Chalke: I think there are a couple of issues with that. The first is that we, as an industry, have tended to build products for the intermediaries that sell our products rather than for the ultimate consumer. If you start with a clean sheet of paper, you might need the intercession of a human intermediary when the process or the product has a highly consultative or tutorial component to it. There's a lot of explaining to do in very plain terms because of the relationship between the underwriter's intermediaries and the ultimate consumer in our business. Anyone who has built a product knows who you build a product for, at least most of the time. I think we have a tendency toward higher product constellation complexity, but we do have choices as insurers. There's no doubt that what we do is highly complex, but we can make a choice about whether we want to keep the complexity on the underwriter's side or on the consumer's side. I think we build products both ways.

I firmly believe that a trend in the future will be to husband the complexity on the side of the insurer. Just to give you a simple example, suppose you did design an accumulation vehicle that was just inflation indexed; it is as simple as that. Just use the traditional index for inflation in the consumer price index and just offer a product like that. That would involve an inordinate degree of engineering complexity in order to make that product fly, but you could husband that complexity on the side of the insurer and keep that wrapped behind the curtains. Or you could put products out to the consumers that make our job as financial engineers a little more possible. We try to match the risks, and we try to match the expenses and push the complexity out to the consumer. I think we can do either, and I think the trend will be toward more consumer simplicity.

Mr. Boushek: I think there are two separate questions there. One has to do with our ultimate client or consumer, and one has to deal with us standing in the middle and evaluating this. I can't address the former but I can the latter. I do think that the onus is on insurers or other sophisticated institutional investors to develop or acquire the expertise necessary to address these kinds of things because I think the market is going to become more populated, and not less populated by them. Also important would be acquiring or building the systems necessary to be able to evaluate and stay on top of these things. What is at the root of your question might be if we go back to sort of the earlier financial engineering efforts, primarily in CMOs. We know of some of the sophisticated institutional investors who were burned badly. Part of that was caused by inordinate or excessive risk taking. Part of it was ignorance in fully understanding what they're dealing with. Another part of it was not fully understanding what they're dealing with and a lack of the necessary systems that truly evaluate the risk they were taking. I think a combination of those three things is essential for investors in this type of product.

Mr. Ho: I would like to point out that financial engineering is really creating derivatives to satisfy needs. So if the consumers don't have a specific need, and just want the basic part of the commodity type of products, I think the capital market works through competition. So competition creates the right price, and it will be a fair price for the consumer. What if the consumer doesn't want a basic product; what if the consumer wants something else? Financial engineering creates the right needs and the pricing on the consumer side. Either you pay for that special customized need or product or you shop for a competitive price.

Mr. Paul LeFevre: We're creating products that companies want to sell. We are not creating products that people want to buy. We have another aspect of financial engineering that revolves around either taking advantage of or reacting to arcane financial reporting concepts. Our chief investment officer thought that when our company became part of a public company, the world and the investor would realize the wonderful aspects of ALM. That is not so. The result is if you had been longer, you would have made more money. In addition, the bulk of the rating agency people are looking for much simpler answers, and they are very much afraid of and almost allergic to any type of explanation of the types of things that we're talking about here. I think it's tough but we're going to have to crack through this. I mean more people spend more money trying to figure out how to manipulate *FAS No. 97* than how to create a product that's built right for the consumer. I don't know if that's a question, a comment, or an opinion.

Mr. Chalke: But it was a good one.

Mr. Ho: I mean financial engineering is really to fulfill the role of the intermediaries of any discrepancy we deal with. Maybe there's a social goal somewhere and the regulators try to do something, but if the regulation doesn't make economic sense, someone should try to do something about that.

Mr. Chalke: Equity-indexed annuities, in their infancy, which is what they are in right now, have created many different functions, many of which are driven not by economic value, not by what the customer is going to get, but by making them look better to the distributor. We're going to make them better to the customer.