

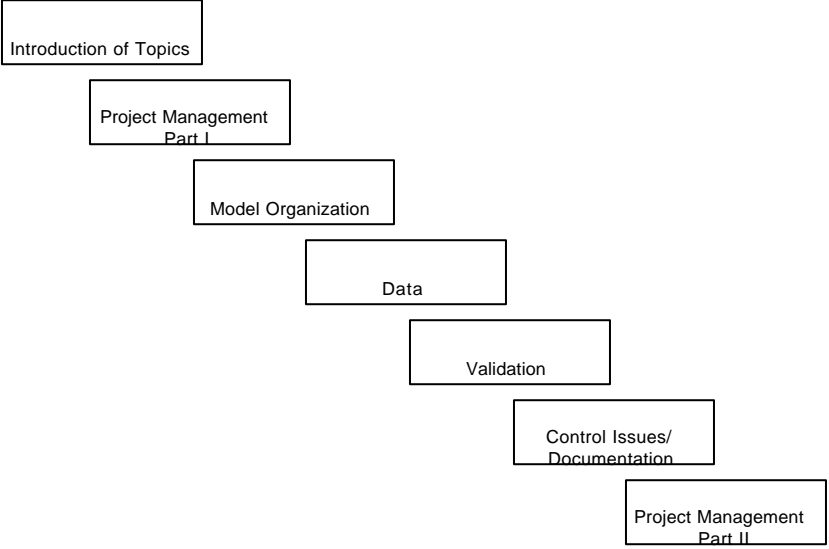
Session 16 PD  
General Modeling Techniques

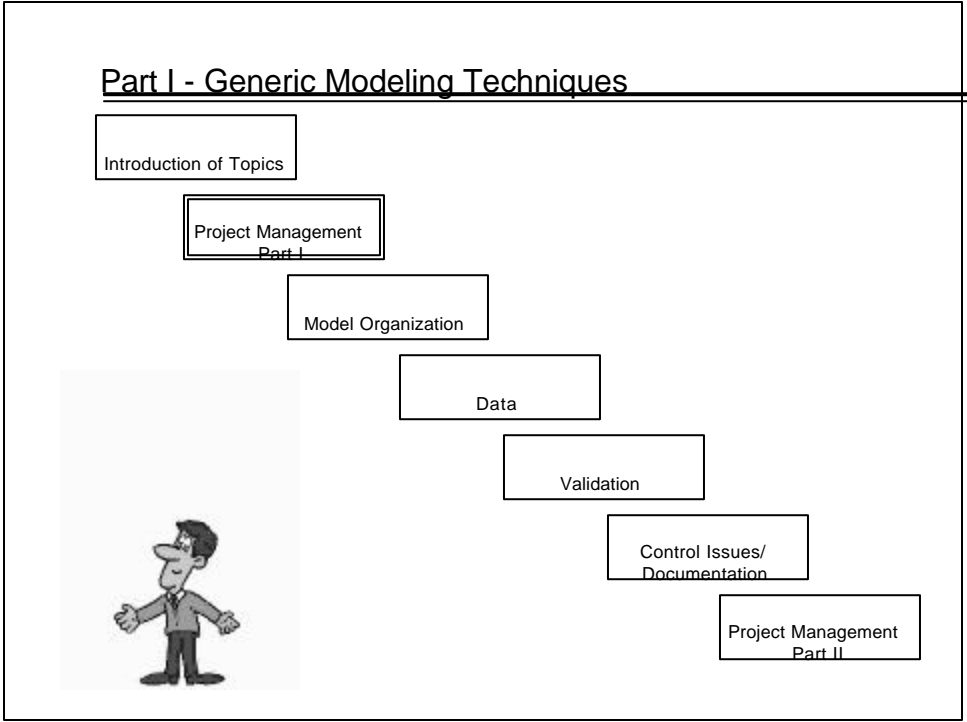
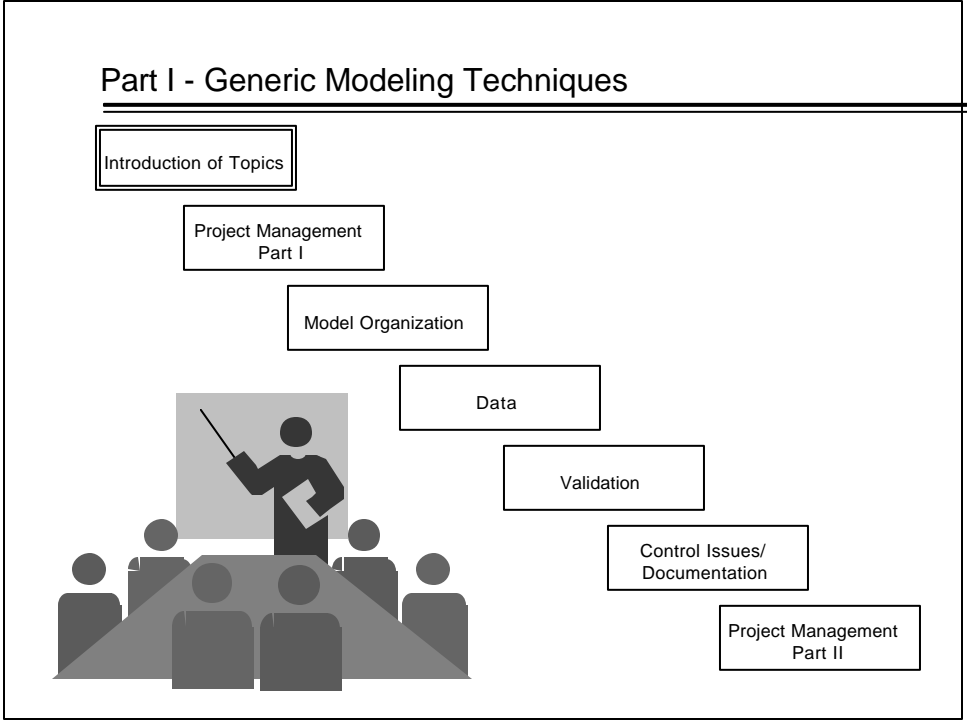
**2002 Valuation Actuary Symposium**

**David Ricci, FSA, MAAA**  
**Scott Kane, ASA, MAAA**  
**Rebecca Burton, FSA, MAAA**

**September 19, 2002**

Part I - Generic Modeling Techniques





## Project Management - Part 1

**What are the  
issues?**

**What are the  
objectives?**

**Constraints/  
Limitations**

### Issues

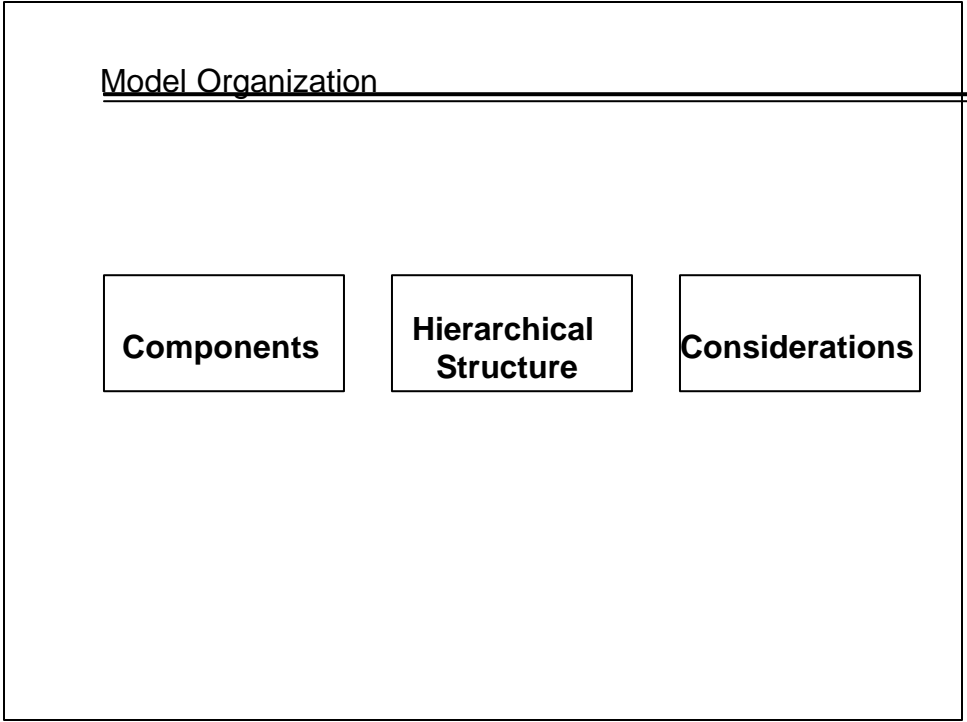
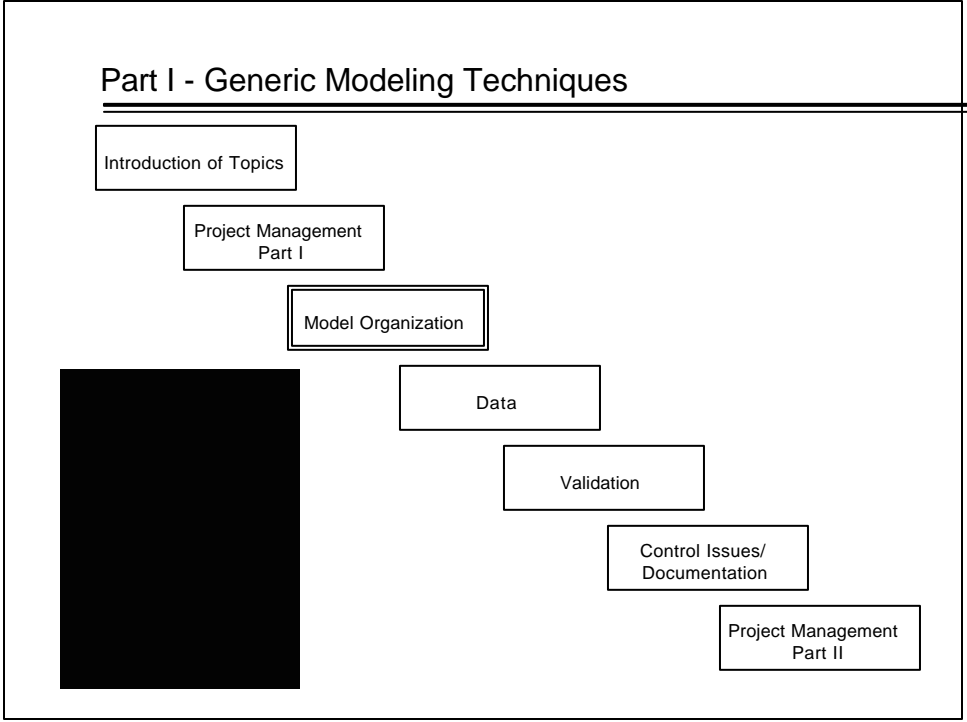
- Profitability
- Assumptions
- Distribution
- Model Structure
- Acceptable Changes

### Objectives

- Measure Risk
- Maintain Profitability
- Establish Control
- It must sell
- Mitigation
- Incentives

### Constraints/Limitations

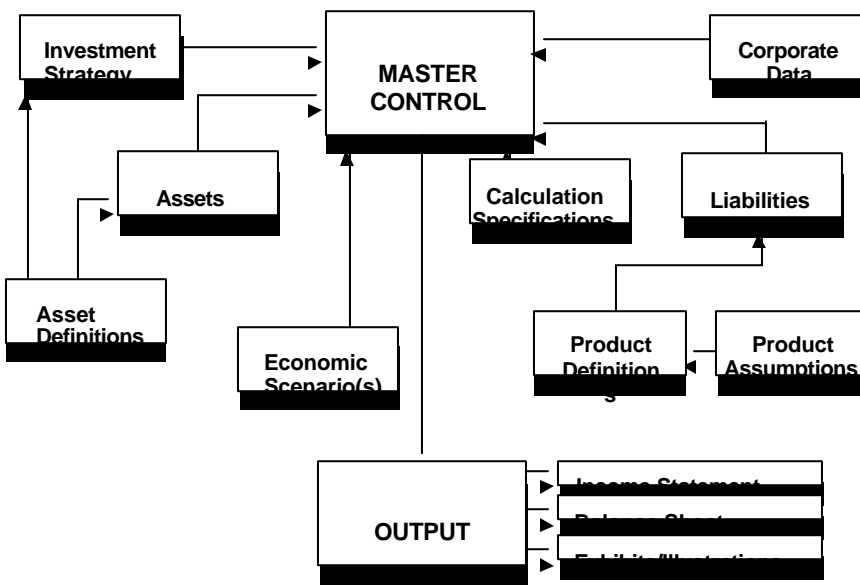
- Variable annuities
- Old product vs. new approach
- If it ain't broke...
- Profitability vs. risk control
- Reserve and interest requirements
- Distribution



### Component pieces of model

- Data - assets and liabilities
- Product definitions and assumptions
- Asset definitions
- Investment strategy
- Economic scenario(s)
- Software
  - “Master” that links all of these items together
  - Engine to process with calculation specifications
- Output generation facility

### Generic hierarchical structure



### Model considerations

- Benefits of component structure
- Automate processes, for example
  - Model point generation
  - Table making/altering
  - Report generation
- Allow for more than one set of hands
  - Tables
  - Data
  - Specs and assumptions

### Model considerations (cont'd)

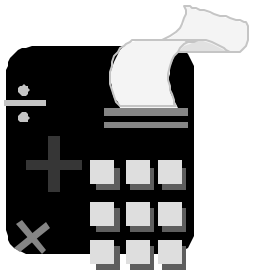
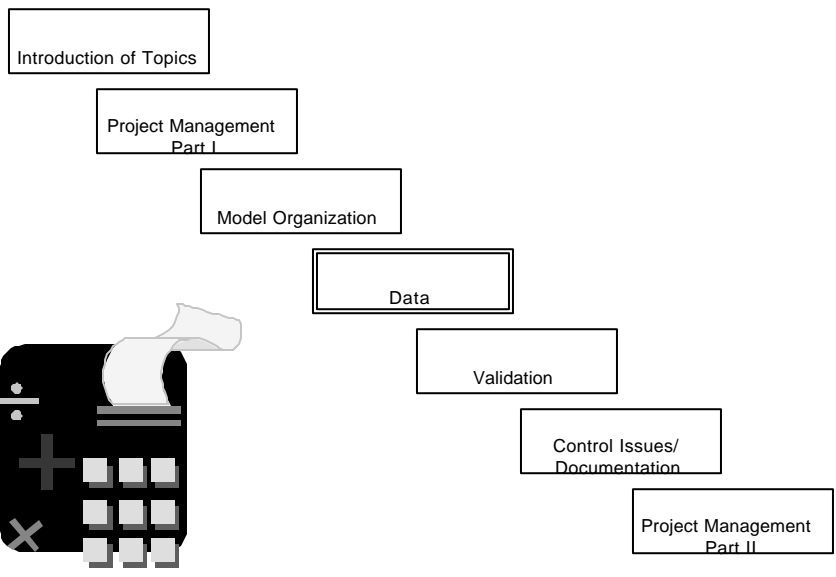
- Allow for expansion of/additions to model
  - Products/plans of same type of product
  - Additional data files
- Be able to divorce yourself from the model
- Do not hard code
- Output organization — compilation spreadsheets

Housekeeping considerations

- Centralized model storage
- Keep directory structure organized
- Sample directory structure
- Archive models
- Documentation



Part I - Generic Modeling Techniques



## Data

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**Data Sources/  
Structure**

**Integrity**

## Data sources

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- In-force policy extracts from
  - Valuation system
  - Administration system
- Data elements
  - Required by your model
  - Necessary in order to group into model points
- Statutory annual statements and exhibits
- Actuarial memorandums
- Experience studies
- Bloomberg

### Data structure

- Seriatim data or model points
  - Maximize accuracy under constraints of time/budget
  - Group smaller model points with larger model points
- Analyze data using ACCESS or another database facility
- New business
  - Forecasts of future sales production and distribution
  - Consider past sales trends (amount and distribution)
  - Bear in mind changes to current or recent sales environment
  - Model points typical

### Data structure (cont'd)

- Assets
  - Seriatim data typical
  - Data elements include:
    - book value, par value, market value
    - coupon rate, separate account index
    - maturity
    - options embedded and/or explicit

### Data integrity — problems with data collection

- Not according to specifications
- Duplicates/blanks/null fields
- Inappropriate text instead of numbers
- Do not understand what you have
- Incorrect data
- Critical elements missing
- Bias in data
- Not consistent and/or reasonable
- Communication breakdown

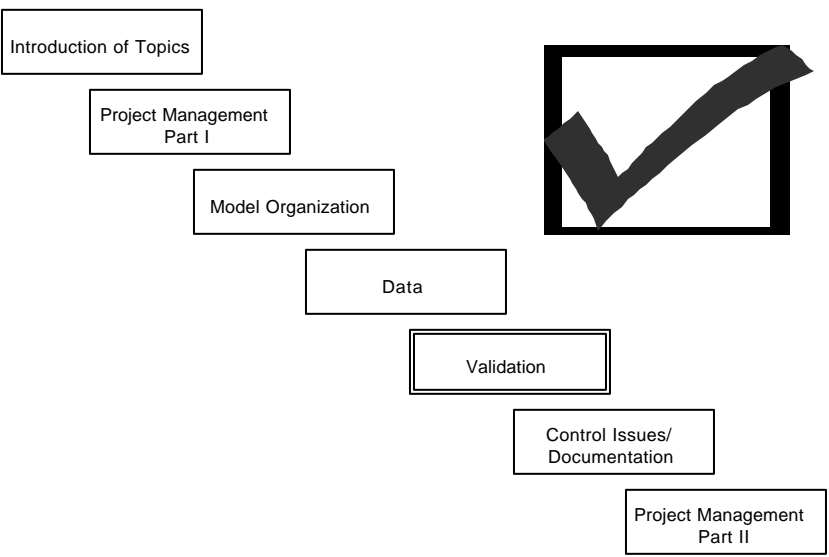


### Data integrity — understanding data/resolving problems

- Make sure you understand it
  - Where did the data originate? Why?
  - Inquire about definition of critical items
- Reconcile! Tie to published information
- Reasonableness checks
  - Print and examine several records
  - Check for duplicates/blanks
  - Have expectation for distribution of data
- Speak with source of data
- Never enough time spent with data

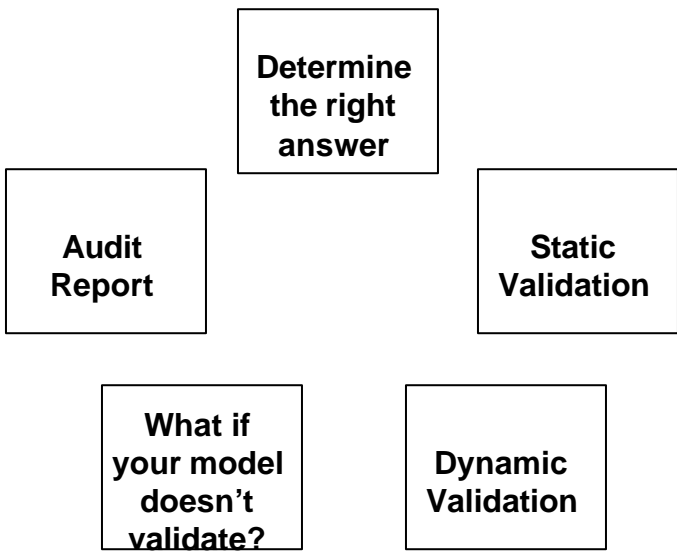
### Part I - Generic Modeling Techniques

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### The Validation Process

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### Determine the Right Answer

- Establish sources of information
  - Policy administrative systems
  - Valuation reports
  - Quarterly financial reports
  - Other models
- Establish margins of deviation
  - Specific, not general

### Static Validation

- Starting balances
  - Policy counts, account balances, reserves
  - Book value, market value, accrued interest, unrealized capital gains
- Other policy and asset specific items
  - Premiums, policy charges
  - Coupon payments, maturities

### Dynamic Validation

- Is the progression of income statement items across several periods of time (actual and projected) reasonable?
- Does a change in assumptions have the expected result?
- For example, change interest rates...
  - Market value of bonds
  - Mortgage prepayment rates
  - Policyholder lapse rates (if dynamic)
  - Account value growth

### Back Testing

- Start with a previous model (last year's)
- Set the assumptions to reflect actual experience
  - Interest rates and equity returns
  - New business volume
  - Expenses
- Run the model and see how close model results are to actual
  - Investment income and asset prepayments
  - Premiums and policy charges
  - Policy benefits
  - Income statement and balance sheet

### What if your model doesn't validate?

- Does it need refinement or is it a systemic problem?
- How do you tell?
  - Go back to single data point
  - Check detailed calculations
  - Get help



### Audit Report

- At the end of the model cycle there should be sufficient documentation for another actuary to review what was done and to reproduce the results
- The report should contain
  - Data sources
  - Listing of assumptions
  - Validation documents
  - Explanations of any differences
  - Run log
  - Detailed output

## Part I - Generic Modeling Techniques

Introduction of Topics

Project Management  
Part I

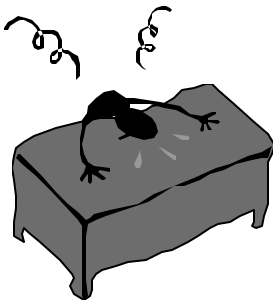
Model Organization

Data

Validation

Control Issues/  
Documentation

Project Management  
Part II



## How do you deal with model components outside your area of expertise?

- Examples
  - Economic scenario generators
  - Mortgage prepayment models
- There is no ASOP for Life and Health actuaries



### Model components outside your area of expertise

- You need to know enough to be able to pass judgment
  - Is the model appropriate for the proposed use?
  - Understand the model inputs
  - Validate outputs for reasonableness
  - Reliance on experts

### Model Documentation

- Detailed technical documentation of the model should exist
  - Necessary inputs and required format of assumptions
    - COI rates: annual or monthly
    - Interest rates: 4 or .04
  - Data file formats
  - Organization of assumptions (inheritance)
  - Actuarial calculations

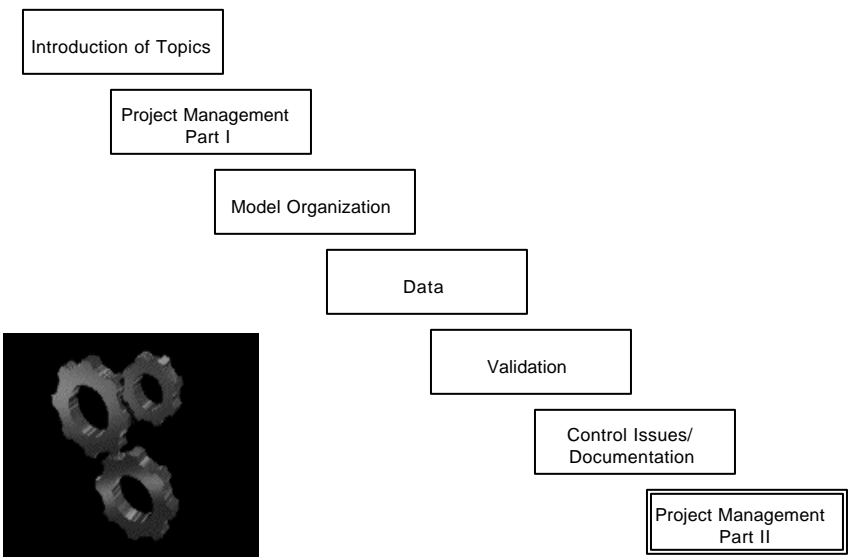
### How Good is Good Enough?

- No model is perfect
- Tolerances should be established at the beginning of the project
- Tolerances depend on what the model is used for
- Need to balance cost, run time

### Model Integrity

- Model Control
- Who can make changes
- Audit trail of changes
- Lock down of final model

Part I - Generic Modeling Techniques



Project Management - Part II



### Alternative Development

- Reinsurance
- Policy Limitations
- Current Business
- New Product
- Guarantees
- Interest Bonus

### Resolution

- Profitability threshold
- Attractiveness to market / distribution
- Current Business
- Regulation limitations
- Time to develop and launch

## Application

- Filling the void
- Getting the word out
- Team Approach
- Monitor and control
- Update models
- Planned continued improvements

## Part II - Case Study

**Introduction of  
Issue**

**Best Modeling  
Techniques**

**Communicating the  
Results**

## Part II - Case Study

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**Introduction of Issue**

**Best Modeling  
Techniques**

**Communicating the  
Results**



In today's economic environment, downside risk in variable annuity secondary guarantees has increased

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- Secondary guarantees include GMDB, GMIB, GMAB and GMWB
- More and more of these secondary guarantees are “in-the-money”
- Consider a “worst-case scenario” which causes your VA issue in year 2000 to experience an average 50% loss over the next 20 years
- For the GMDB alone, would asset charges cover this cost?
- Using 100 randomly-generated scenarios, there is a high probability that under some of the scenarios even a “trivial” GMDB could cause the VA block to be insolvent
- Imagine “non-trivial” GMDBs that are coupled with other secondary guarantees

Who cares about this risk and that it is properly analyzed?

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- The Valuation Actuary
- Corporate Management
- Board of Directors
- Regulators
- Rating Agencies
- Stockholders
- Class Action Lawyers



Part II - Case Study

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**Introduction of Issue**

**Best Modeling Techniques**

**Communicating the Results**

### How should you group your in-force data?

- By guarantee type
- Fund allocation
- Ratio of current fund value to the guaranteed benefit (how in or out of the money it is)

### Guarantee provisions

- Do not separate the benefits from the base policy
  - A policy with GMIB and GMDB cannot collect on both
- Do not oversimplify
  - A 3-year reset and a 5-year reset GMDB should not be grouped into the same model point

## Fund Allocation

- The model should project fund types with different risk characteristics separately
  - General account
  - Bond funds
  - Balanced funds
  - Large cap equity funds
  - International/small cap equity funds
  - Money market funds
- Also group policies by fund allocation
  - Diversified allocation is different than 100% equity

## Current Exposure

- Too much grouping can hide risk exposure
  - The actuary with one foot in a fire and the other in a snowbank is on average just right
- Break into groups according to ratio of current AV to guaranteed benefit. For example,
  - GB < 90% of AV (way out of the money)
  - GB is 90 to 100% of AV (out of the money)
  - GB is 100% to 110% of AV (in the money)
  - GB > 110% of AV (way in the money)



## What is the difference between Deterministic and Stochastic?

### **One Scenario**

(e.g. interest level at 7%)

vs.

### **Multiple Scenarios**

Deterministic & Static  
go hand-in-hand



Stochastic & Dynamic  
go hand-in-hand



## Stochastic modeling is the best way to go

- A good scenario generator is crucial to getting meaningful results
- Need a sufficient number of scenarios
- Scenarios should have returns for each of the funds modeled
  - The mean and standard deviation should be appropriate for the fund type
  - The returns should be correlated among the funds

### What information do we need out of our model?

- Balance Sheet
  - Current fund value
  - Current GMDB
  - GMDB reserve
- Income Statement
  - GMDB claims
  - GMDB fees
  - GMDB reinsurance cash flows

### Other Analytics

- PVDE over all scenarios
- Value at Risk
- Conditional Tail Expectation (CTE) of claims

## Part II - Case Study

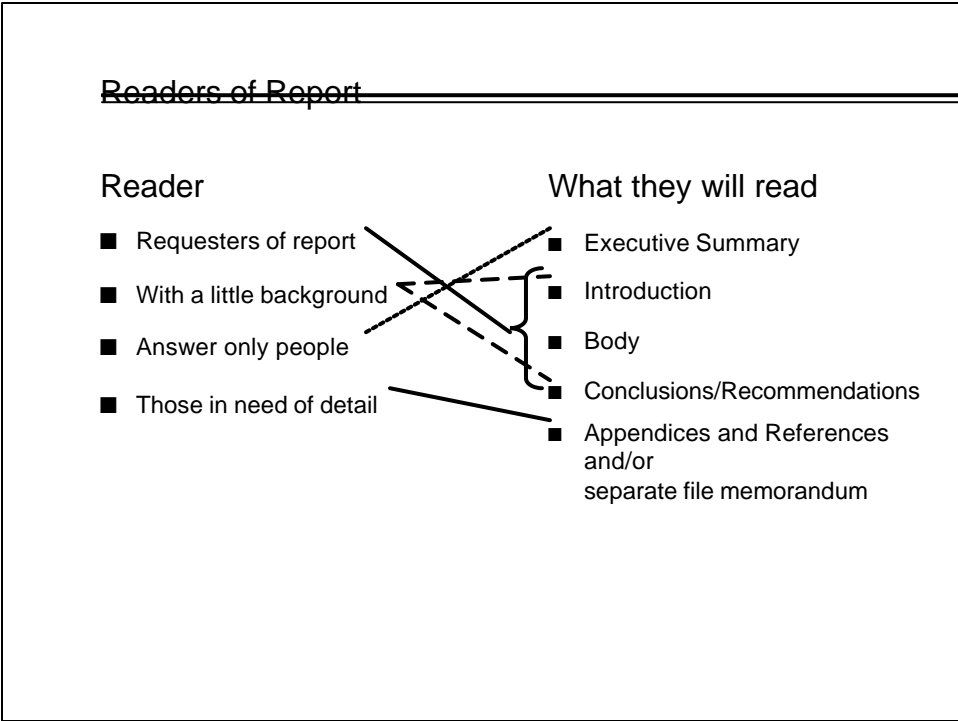
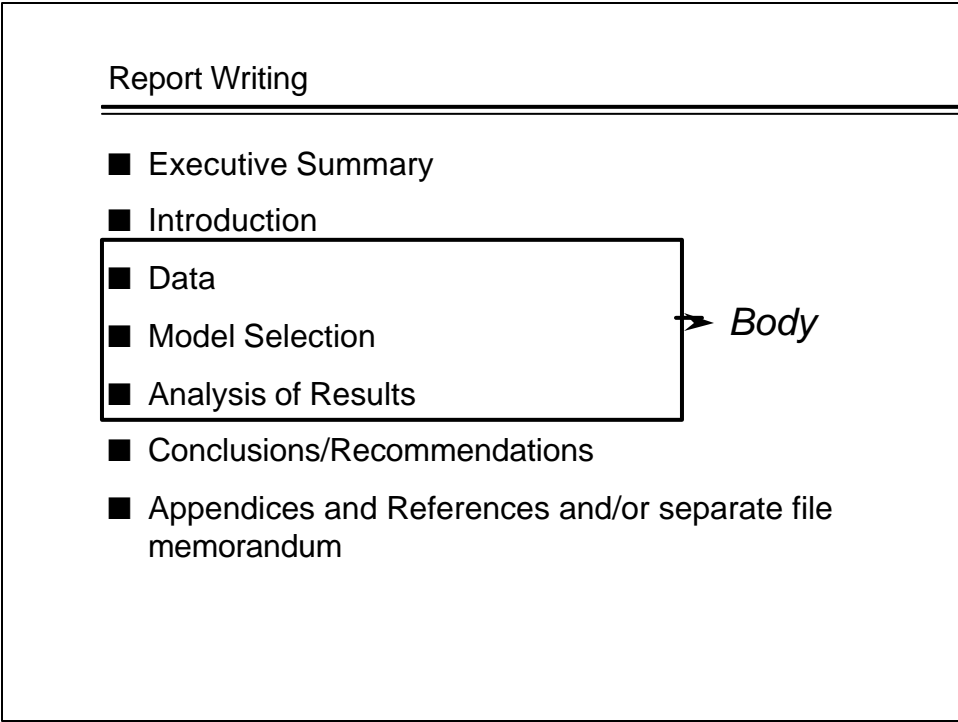
**Introduction of Issue**

**Best Modeling  
Techniques**

**Communicating the  
Results**

After analyzing your VA block of business, how best should you communicate the results?

- Convey the message/motivate action
- Make it easy to read/understand
- Charts are helpful
  - clear
  - concise
  - use of color



## How to Go About It

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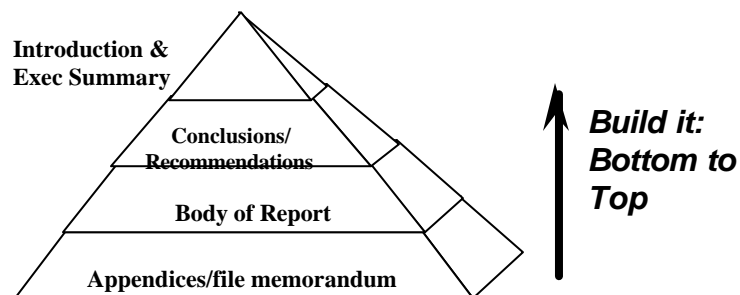
- Plan the finish
  - “If you don’t know where you are going, how do you know when you get there?”
- Plan your route
  - Know who your audience is
- Peer Review
- What order should we write it?

## Writing the Report

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- Keep finish line in focus
- Start with foundation, and build
- Don’t write in the order it will be read



### Professional Standards of Written Report

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- Document all major assumptions
- Detailed enough for other actuary  
(or other professional) to verify results
- Acknowledge responsibility

### Formatting the Report

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- Do it last
  - write it first
  - make it look nice later
- Fonts
  - save the fancy fonts for a purpose
  - don't distract from the message
- Size
  - font sizes between 10 and 12 are easy to read
- Margins
  - how will the document be bound?
  - very little white space is intimidating

## Oral Presentation

- Differences
- Do's and Don'ts

## Part III - Questions



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