According to ASOP 56, what are the three core components of every model?

Source: LTAM Chapter 1: Introduction to Modeling

1. **Information Inputs:** Data, assumptions, and parameters
2. **Processing:** The calculation engine that applies mathematical formulae/algorithms
3. **Results:** Outputs transformed into useful business intelligence

Describe the three interconnected building blocks of actuarial liability models.

Source: LTAM Chapter 1: Introduction to Modeling

1. **Modeling Rates and Decrements:** Models populations/states and transitions (mortality, morbidity, lapse rates)
2. **Undecremented Flows:** Models cash flows from the *policyholder's perspective*, assuming policies remain in force
3. **Decremented Flows:** Models the *insurer's perspective*, adjusting undecremented flows for the number of policies actually remaining in force

What are the most common levels of an organization for which model results are aggregated?

Source: LTAM Chapter 1: Introduction to Modeling

- **Lines of Business (LOBs) / Business Segments:** Broad groupings of products/markets (e.g., Life vs. P&C)
- **Blocks of Business / Portfolios:** Subsets of an LOB by specific market/product type (e.g., Whole Life)
- **Cohorts:** Subdivisions of a block sharing a common characteristic (e.g., issue year)
- **Seriatim:** Modeling the entire business one policy at a time (often required for regulatory/accounting rules)

Define the following model attributes: Usefulness, Complexity, Fidelity, Accuracy, and Precision.

Source: LTAM Chapter 1: Introduction to Modeling

- **Usefulness:** Degree to which a model serves the user's purpose (functionality, ease of use)
- **Complexity:** Simplicity/complexity of structure (architecture, number of parts, relationships)
- **Fidelity:** Degree to which a model accurately reproduces the item it represents
- **Accuracy:** Degree to which outputs match actual values being modeled
- **Precision:** Ability of a measurement to be consistently reproduced (level of detail)

Define the following model attributes: Speed, Granularity, Robustness, Flexibility, and Stability.

Source: LTAM Chapter 1: Introduction to Modeling

- **Speed:** Time to run from start to finish (must be weighed against usefulness)
- **Granularity:** Level of detail (number of factors/variables); higher granularity often lowers speed
- **Robustness:** Degree to which a model supports a wide range of purposes/products
- **Flexibility:** Ease with which a model and its components can be adapted/changed
- **Stability:** Ability to produce consistent/reliable results over time without breaking

What is the ‘Principle of No Foresight’ in modeling dynamic behavior?

Source: LTAM Chapter 1: Introduction to Modeling

- At each projected model timestep, only conditions and events that have happened *up to that point in time* can be used to project decision-making behavior
- Models can distinguish between proactive actions and reactions to projected conditions

What five items should be assessed when evaluating model efficiency?

Source: LTAM Chapter 1: Introduction to Modeling

1. **Computing power utilization:** Optimizing speed, parallel processing, and using proxy models
2. **Scalability:** Ability to handle large calculation volumes and future changes without overhaul
3. **Memory management:** Efficient data storage/retrieval (e.g., avoiding nested loops)
4. **Integration with other systems:** Seamless connection to reporting tools/dashboards
5. **Modeling asset-liability interdependencies:** Handling the interactions between newly invested assets, excess cash flows, and liability crediting rates

How do excess liability cash flows impact asset-liability interactions?

- Creates the need for borrowing cash, leading to a drag on projected net earned rates
- May force the sale of assets, impacting future projected book values and investment income
- Newly invested assets affect portfolio yield, impacting liability crediting rates

Compare Explicit vs. Iterative approaches for modeling asset-liability interactions.

- **Explicit Projection:**
  - Runs liability and asset models in tandem one time-step at a time
  - Highly memory intensive; makes parallel processing difficult/impossible
- **Iterative Projection:**
  - Runs asset and liability models multiple times, feeding outputs of one as inputs to the other
  - Continues until results converge to a specific tolerance level
  - Requires larger volume of less intensive runs
  - Generally preferable in practice

What is a ‘proxy model’ (light model)?

Source: LTAM Chapter 1: Introduction to Modeling

- A model intended to replicate the output of a fully detailed (‘heavy’) model
- Provides faster run times with an acceptable reduction in accuracy
- Accuracy is assessed and improved by comparing its output to the heavy model

State the formula for Gross Premium Valuation (GPV).

Source: LTAM Chapter 3: Principle-Based Projections

$$\text{Gross Premium Reserve} = \text{PV(benefits)} + \text{PV(expenses)} - \text{PV(gross premiums)}$$

Distinguish between Deterministic and Stochastic GPV calculations.

Source: LTAM Chapter 3: Principle-Based Projections

- **Deterministic:**
  - Projected using a fixed set of inputs
  - Produces a single, predictable output
  - Usually best estimate along a single scenario
- **Stochastic:**
  - Incorporates randomness/uncertainty using a range of inputs
  - Produces a distribution of potential liability outcomes (e.g. 1,000 scenarios)
  - Allows reserves to be set at a specified VaR or CTE level
  - VaR: A specific percentile on the liability distribution
  - CTE: The average of all reserve outcomes beyond a specific percentile

Describe the three categories of assumptions used in valuation.

Source: LTAM Chapter 3: Principle-Based Projections

1. **Anticipated/Best-estimate:** Neutral; not intentionally conservative or aggressive
2. **Prudent:** Adds risk margins to best estimates to reflect the cost of bearing risk/uncertainty
3. **Regulatory Prescribed:** Mandated by regulators, usually to introduce conservatism for specific requirements

In principle-based frameworks, how do assumptions differ between the income statement and reserve calculations?

Source: LTAM Chapter 3: Principle-Based Projections

- **Income statement projections** typically follow best-estimate assumptions.
- **Reserve calculations** incorporate margins or prescribed conservatism.

How should risk margins be applied to insurance death benefits vs. living benefits?

Source: LTAM Chapter 3: Principle-Based Projections

- **Death Benefits:** Margins should increase the mortality rate and decrease mortality improvement.
- **Living Benefits:** Margins should decrease the mortality rate and increase mortality improvement.

State the relationships for Revenue, Cost, Net Income, and Distributable Profit

Source: LTAM Chapter 3: Principle-Based Projections

- Revenue $=$ Investment income $+$ Premiums
- Cost $=$ Benefits Paid $+$ Expenses $+$ Increase in reserves
- Net Income $=$ (Revenue $-$ Cost) $\times$ (1 $-$ Tax Rate)
- Distributable Profit $=$ Net Income $+$ Decrease in capital held

What is a Nested Model for projection?

- A projection where a calculated quantity within the main projection requires its own full valuation model
- **Outer Loop:**
  - The primary projection path that describes how the environment evolves
  - Usually involves projections using best-estimate assumptions
- **Inner Loop:**
  - A sub-projection performed at each re-valuation date within the projection to re-measure the liability
  - Usually involves projections using conservative/prescribed assumptions

How does the starting state of an inner-loop projection differ from the outer-loop?

Source: LTAM Chapter 3: Principle-Based Projections

- The inner-loop does *not* restart from the original $T = 0$ assumptions
- It begins from the projected state generated by the outer-loop as of the specific future valuation date
- The in-force population reflects those who survived up to that date
- Market conditions reflect the outer loop state at that date

What are the key projection considerations for nested models regarding run time and assumptions?

- **Model Run Time:**
  - Inner-loops are computationally intensive, especially if asset projections are modeled
  - Modelers must use judgment to limit the number of inner loop calculations
- **Assumption Management:**
  - Modelers must decide which assumptions are dynamically re-determined at each time step versus kept at initial valuation date values based on materiality