Prudential

INTEGRATED MODELING

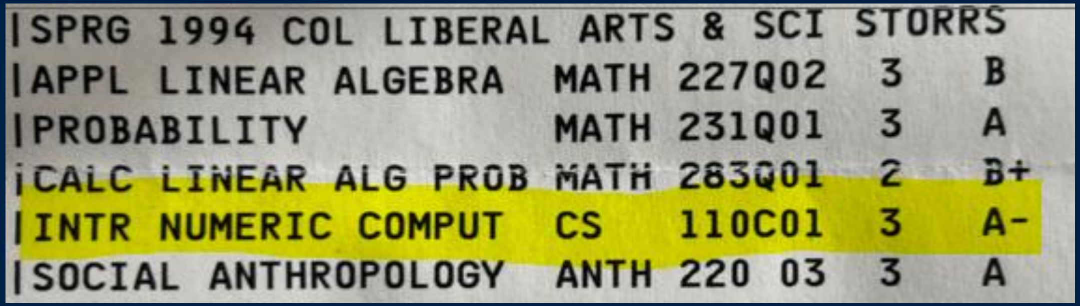
Actuaries Club of Hartford and Springfield

November 20th, 2025

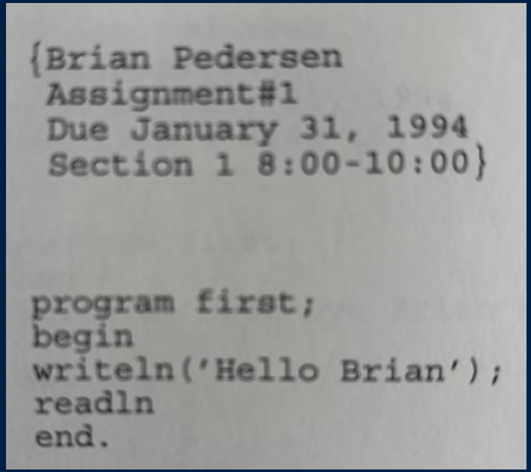
FULL DISCLOSURE

Personal technology limitations

Expertise



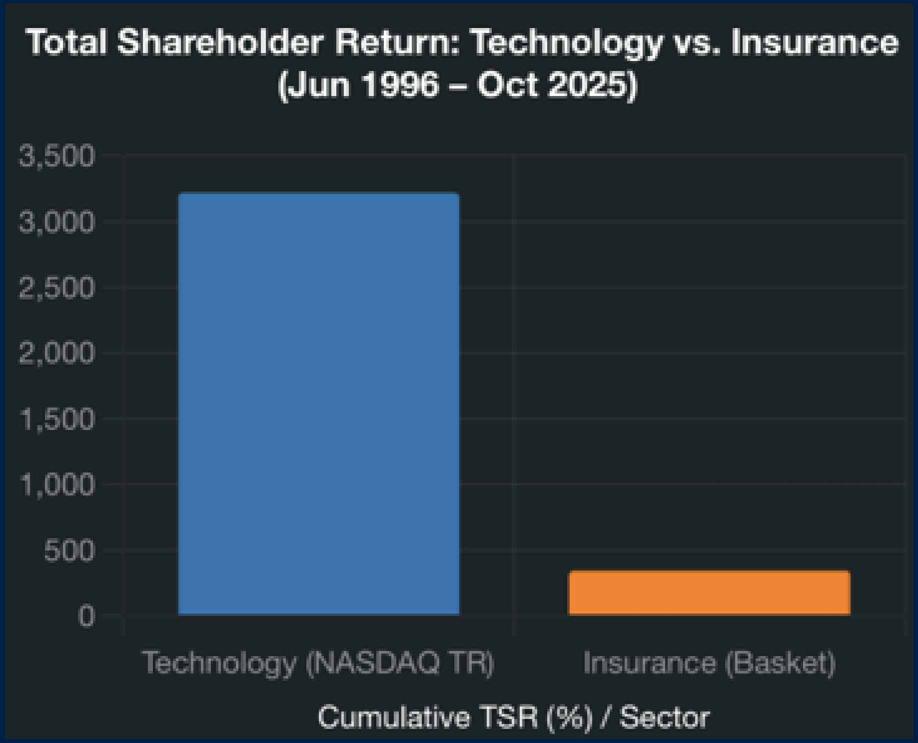
SPRG 1994 COL LIBERAL ARTS & SCI STORRS				
APPL LINEAR ALGEBRA	MATH	227Q02	3	B
PROBABILITY	MATH	231Q01	3	A
CALC LINEAR ALG PROB	MATH	283Q01	2	B+
INTR NUMERIC COMPUT	CS	110C01	3	A-
SOCIAL ANTHROPOLOGY	ANTH	220 03	3	A



```
{Brian Pedersen
 Assignment#1
 Due January 31, 1994
 Section 1 8:00-10:00}


program first;
begin
writeln('Hello Brian');
readln
end.
```

Judgment



Source: Generative AI

INTEGRATED MODELING HEADLINES

Delivering future state integrated liability, asset, and ALM modeling capabilities that:

Increasingly leverage internally developed capabilities like our GPU-based Python liability model (PyVal) and our cloud enabled C# ALM model (ALM 2.0) alongside our use of vendor liability models.

Enable stable, scalable growth by leveraging transformed financial reporting, ALM, forecasting, stress testing, and pricing capabilities.

Enable rapid delivery of methodology enhancements better reflecting actual liability, asset, and ALM management actions for over $150B business subject to Principles-Based Reserves in the US.

Those integrated modeling capabilities enable partners to deliver impactful business outcomes including:

Identify management opportunities to optimize capital.

Support growth by enabling viability of new product launches.

Enhance competitive positioning.

AGENDA

VISION

STRATEGIC CHOICES

- ❑ NON-TECHNICAL
- ❑ TECHNOLOGY

EXECUTION

- ❑ OUTCOMES AND VALUE DELIVERY
- ❑ CHALLENGES
- ❑ FUTURE OPPORTUNITIES

Q&A

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VISION

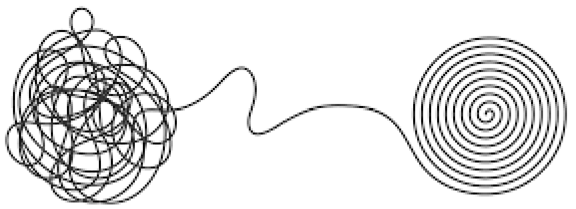
VISION

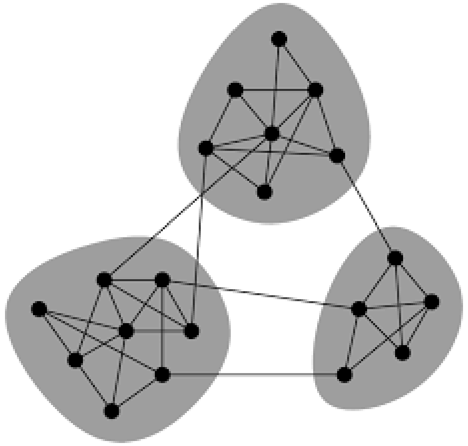
Integrated Modeling

Simplified
Code things once

Modular
<u>Not</u> a single supermodel

Integrated
Bring together





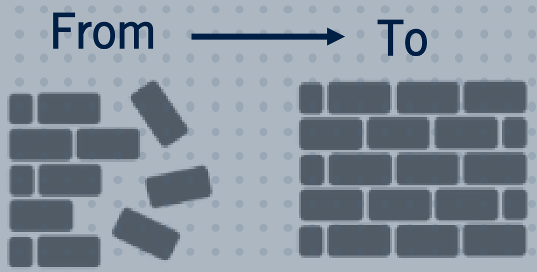
Eureka!
Any end use, any jurisdiction

SIMPLIFIED

Our Valuation foundation is core to our vision to code things once

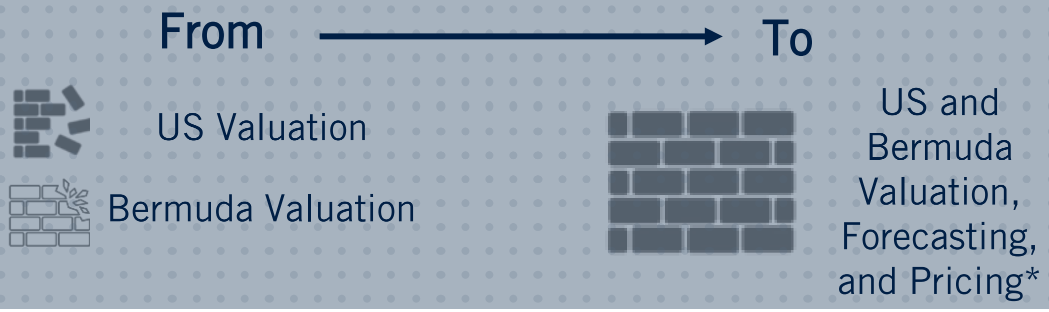
Strong Valuation foundation

We established a new vision with our US Valuation customers in 2022-2023 to transform foundation for each business



Demonstrated scalability

Since 2024 we've shown ability to stop coding things multiple times for new jurisdictions or end uses

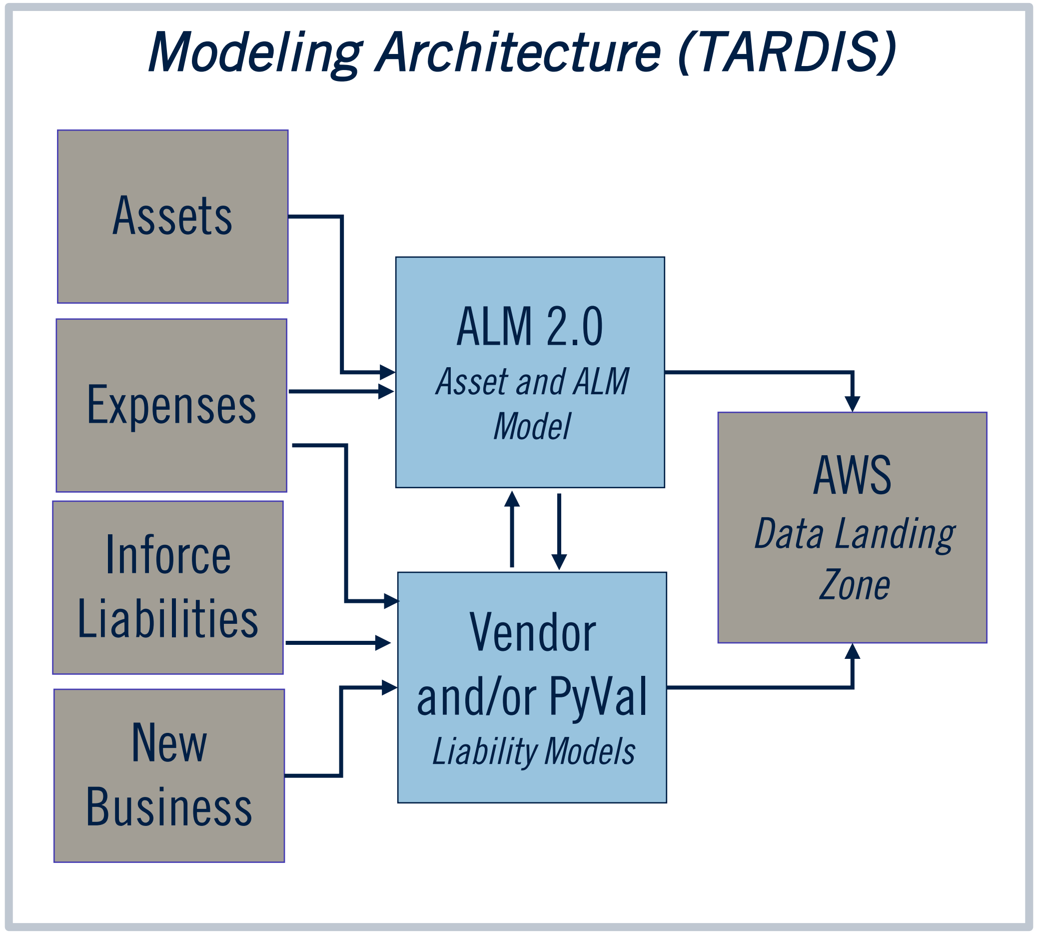


**As we'll discuss we have more to do, but the premise is well established by our outcomes*

MODULAR, INTEGRATED

Scalability comes from bringing together those core components of our foundation

CONCEPT



KEY:

Symbol:	Represents:	Alignment to Vision:
(blue box)	**Core Model Platforms**	**Modular** *<u>Not</u> a single supermodel*
(grey box)	**Data**	
→	**Eureka! application** Data Transformation, Business Logic, or Orchestration	**Integrated** *Bring together*

VISION CASE STUDY

Any end use, any jurisdiction

Business priorities ☑

US and Japan products ☑

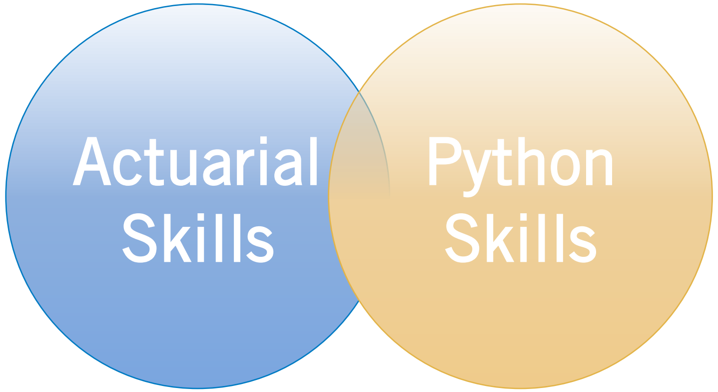
agile delivery in weeks, not months ☑

First principles framework ☑

STRATEGY

KEY INGREDIENTS

Non-technical



TEAM

Skillsets

Large Actuarial population correspondingly enabled us to start with and build on a relatively large number of team members with requisite skillsets

PARTNERS

Mindsets

Key partners with a desire to transform the modeling status quo starting with Valuation but including Technology, Investments, Risk, and beyond

WAYS OF WORKING

Self service

Prior modeling architecture required more full-service technology support whereas modern modeling architecture enables significant self service

KEY INGREDIENTS

Technology

Modeling Architecture	Home Grown Models	Core Vendor Models	Data Architecture

MODELING ARCHITECTURE

History

Local Architecture *Historically*	Finance Architecture *Mid 2010s – 2020s*	ALM Architecture *Today*
Teams leveraged BU tech partners to support modeling architecture needs until changes in governance environment	Senior management preferences for highly controlled modeling and architecture resulted in significant investment in closed, less flexible vendor models in enterprise financial architecture	Home grown TARDIS model architecture platform supporting VA hedging enabled successful Actuarial pilot uses which catalyzed broader investment in home grown modeling capabilities

MODELING ARCHITECTURE
TARDIS

Enables reusable components leveraging unified development approach and AI-enabled development.

MODERN DEVELOPMENT PLATFORM

Tardis

Our platform built originally for the VA hedge powers our broader modeling vision through:

- **Centralized Code Management:** Establishing a unified code repository with full version history for transparency and traceability.
- **Scalable Collaborative Infrastructure:** Automated workflow design, run monitoring, and scaled compute to grid and cloud.

UNIFIED DEVELOPMENT APPROACH

Python

Standardizing on Python as our core programming language drives:

- **Reduced Complexity:** Single language enables consistency, accessibility, and ease of maintenance.
- **Quality Assurance:** Enforcing consistent code review and deployment processes drives high quality and reliable software delivery.
- **Scalable Libraries:** Reusable applications support varying use cases across FM and the globe.

AI-DRIVEN DEVELOPMENT SUPPORT

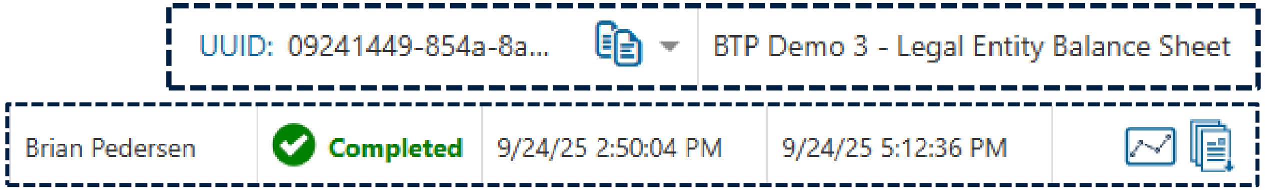
GitHub Copilot

Python development is catalyzed by integrating AI-powered coding tools into development approach which improves:

- **Speed:** Developer productivity boosted by code generation and editing
- **Risk:** Automatic error detection reduces risk of unknowingly accumulating tech debt
- **Upskilling:** Democratized development opportunities for FAC team members with varying degrees of previous coding experience

MODELING ARCHITECTURE

Automated Process Workflow Example



HOME GROWN MODELING

PyVal – Home grown liability projection system

TIMELINE

From VA hedging to RILA Valuation

3-month proof of concept led to eventual STAT and GAAP Valuation

Scaled to other products, jurisdictions, and end uses

Valuation of full individual annuity product suite

Bermuda Valuation, Forecasting, Pricing

US Forecasting

TECHNOLOGY

Python

Well established design principles including Composition

Tensor data structures enabling parallel computing via GPUs

HOME GROWN MODELING

ALM 2.0 - Homegrown Asset and ALM projection system

TIMELINE

Developed in Chief Investment Office

Originally for Strategic Asset Allocations

Actuarial uses

Started with Pension Risk Transfer pricing

Grew significantly over time recently with importance of principles-based frameworks in Bermuda and the US

TECHNOLOGY

C#

Inherent speed of compiled language and ease of refactoring lend well to complexity of ALM modeling

Cloud-native, serverless

Cloud-native ALM application (CALM) enables users to self service spinning up ALM 2.0 in high performance AWS cloud architecture

HOME GROWN MODELING

Eureka! Application - Homegrown model orchestration system

TIMELINE

Bermuda POC to MVP to Product

Initial POCs drove choice for internal capabilities

Went live with Bermuda forecast MVP in 3q24

Expanding to all Bermuda end uses as well as US reporting and forecasting

TECHNOLOGY

Python

Using same principles as PyVal

APIs

Leveraging clear, distinct interfaces with core modular components

User Experience

Exposing certain choices on inforce and assumptions to users via UI

VENDOR MODELING

Multiple vendor liability, asset and ALM projection systems

HOME GROWN OR VENDOR?

Proprietary Costs vs. Benefits of:

Modeling Products or Balances

Process for:

- ❑ Extract Transform Load
- ❑ Version Control
- ❑ Cloud enablement
- ❑ Interfaces

WHICH VENDORS?

Customer considerations

Transformation vs. maintenance priorities

Local talent

DATA LAKE

Amazon Web Services

VISION AND TIMELINE

Model Landing Zone part of overall vision for democratized single source of truth for accessible, governed, scalable data via Data Lake

Replaces legacy silos with modular, tech-forward architecture

TECHNOLOGY

Amazon Web Services

Part of broader multi-cloud strategy

Leveraging Lamda and Glue for ETL and workflow orchestration

Supports BI and AI/ML

Consistent data management and governance

EXECUTION

OUTCOMES AND VALUE

Transformed integrated modeling capabilities drive better decisions faster and at lower cost and risk

BETTER DECISIONS

Leveraging our best asset or liability capabilities developed across Investment and Actuarial teams enables better insights to drive actions

As covered earlier, those actions enable us to optimize capital while also supporting growth and competitive positioning

INCREASED SPEED

Concentrating modeling and customer resources on fewer platforms accelerates development as well as runtime of capabilities

PyVal roughly 30x runtime vs. previous vendor platform

Core vendor platform runtimes roughly 10x vs. vendor platforms in maintenance mode

Development of home grown and core vendor platforms measured in weeks, not years

REDUCED COST AND RISK

Eliminating duplicative coding reduces risk of error and enables organizational efficiencies.

For example, at one point we were coding more than 100 products up to 6 times

Fewer platforms reduces licensing, consulting, and cloud costs

Cloud and license cumulative saves to date of ~$4m annually

CHALLENGES AND OPPORTUNITIES

CHALLENGES

Complexity

Liabilities, assets, and valuation frameworks growing in complexity along with our mandate

Competing Priorities

Various partners pulled in many directions

Architecture and Process

Aligning on vision for FP&A consolidation architecture and process is key to unlocking power of forecasting modeling

OPPORTUNITIES

Valuation End Use – Finalize foundation

Complete in 2026

New End Uses – Expand execution

Many remaining opportunities to code things once in the US

New Jurisdiction – Align on vision

Early stage of exploring transformation partnership opportunities

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QUESTIONS?