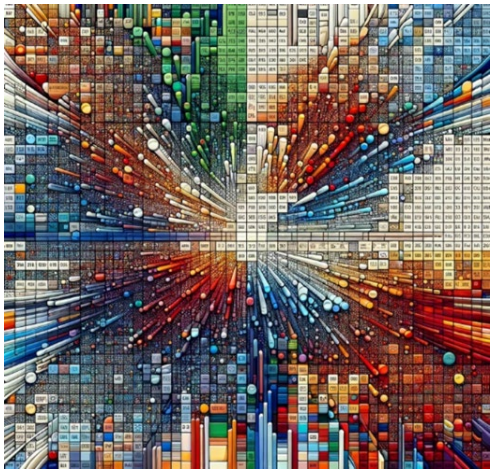
The Life Product Model

Manual



Life Product Model, Model worksheet as visualized by DALL-E, a generative AI model, and integrated within a ChatGPT context

The Life Product Model is an Excel-based financial projection tool designed for various life insurance calculations, including pricing, financial analysis, actuarial tasks, and product evaluations. It calculates IRR using Statutory Reserves, calculates Target Capital, generates illustrations, solves premiums, and applies mortality decrement to cash flows. It emphasizes clarity and modularity, incorporating keyboard shortcuts for efficient navigation and formatting. The model adheres to Excel financial modeling standards, ensuring high-quality, standardized development, and serves as both an educational resource and a practical tool for students of life insurance.

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The Life Product Model workbook is a standalone Excel file that does not require any external dependencies. You may save it anywhere on your computer that is convenient for you. To access all of the workbook's features, you must modify your Excel security settings to allow macros. Please note that this workbook has been tested exclusively on Windows PCs.

Introduction

When I started the Life Product Model in October last year, I never imagined it would evolve into what it is today.

I needed the ability to price mortality-based cash flows that reflect capital and statutory reserves. I briefly considered licensing a commercially available actuarial pricing tool, but the cost was prohibitive, especially since I only needed a fraction of its capabilities. Moreover, I wasn't particularly interested in learning a new tool that I may only ever use to *estimate* changes in premium or profit resulting from changes in such things as mortality or compensation.

Thus began the long-forgotten working title of what is now the Life Product Model. Initially, the sole objective was personal use. However, from the outset, I was determined to build a sustainable tool that I could expand upon in the future, integrating all the Excel best practices I have learned.

During the holiday season, several things converged:

- I began to see early results from using ChatGPT for VBA coding assistance. The first utility I developed was a tool to quickly apply the formatting standards I had established for the model. Its efficiency could, over time, recoup the entire effort of building the Life Product Model.

- While I was confident that I could perform the basic analysis I needed once completed, I knew I could notably expand the tool's utility with a little more sophistication and peer review. Ultimately that led to the ‘free review’ strategy. Or simply stated, I aim to develop content interesting enough to warrant a ‘free review’, and the feedback I hope goes with that.

- I also recognized the scarcity of public domain resources for building the underlying life insurance calculations. This scarcity encouraged increased my confidence in the 'free review' strategy, if I can find the right audiences.

- Lastly, it was fun, and I was excited about the possibilities with the spreadsheet. My limit with VBA had always been how much time I was willing to invest in developing macros beyond basic functionality. However, with ChatGPT's help, I started to see new possibilities that would have been far out of reach previously.

These confluences led to the development of the Life Product Model in its current form. A highly functional, effective, and dynamic tool. The environment developed far exceeded my expectations, such that even if the life insurance calculations are not of interest, the tools developed warrant a look.

But regardless of what is of interest, hopefully, it warrants a ‘free review.’ And I consider your feedback invaluable.

Opportunity will ultimately dictate the future of the Life Product Model and whether it extends beyond my personal use. In fact, I'm uncertain about Excel's long-term future. For now, it remains an invaluable tool for

visualizing and conceptualizing various modeling efforts. However, even in the short term, I perceive a decline in some of its basic utility as a data analysis tool, given the progression of generative AI tools to simplify such tasks.

In the long run, even I, a longtime spreadsheet enthusiast, see the emergence of large language models, machine learning techniques, and other innovations that will transform modeling into an activity directed by plain English directions or even voice. Maybe this will be in Excel, or maybe not.

But until then, enjoy!
Rod

Your thoughts, critiques, and corrections are invaluable. Let's make this even better together!

LIFE PRODUCT MODEL

The Life Product Model is an Excel-based financial Projection Model designed for various life insurance calculations and projections, including pricing, financial analysis, actuarial tasks, mortality assessments, and product evaluations. It delivers functionality such as:

- Calculates the IRR of monthly distributable earnings using Statutory Reserves and Target Capital.
- Determines Statutory Reserves as Net Premium Reserves using VM-A and VM-C (or existing UL CRVM reserving).
- Calculates Target Capital as a multiple of 100% NAIC Risk-Based Capital (RBC) with covariance adjustment.
- Generates guaranteed and non-guaranteed illustrations, solves for premiums (e.g., to carry the policy to age 105), and calculates Section 7702 premiums (including Guideline Single, Level, and Modified Endowment Premiums), accurately replicating insurer values.
- Projects a survival cohort, calculates future life expectancy and generally provides the ability to apply mortality and persistency decrement to all life insurance cash flows, including commissions, expenses, etc.

The environment for the Life Product Model is highly functional, effective, and dynamic and delivers the following:

- Emphasizes consistent design across all model aspects, including worksheet structure, work areas, calculations, and the VBA environment. This focus enhances the tool's quality, accuracy, efficiency, and intelligibility.
- Includes extensive functionality through well-defined user interfaces accessible via easy-to-remember keyboard shortcuts. For example, you can quickly apply one of over 15 defined formatting standards to indicate cell purpose.
- Enhances navigation and speed of use through various techniques, focusing on keyboard operation and shortcuts. For example, you can quickly jump to any model calculation or navigate to any worksheet.
- Prioritizes educational clarity and intelligibility, striving to make the tool as ‘self-documenting’ as possible through techniques such as descriptive Named Ranges, clear labeling, consistent formatting standards, and visual formatting techniques. Additionally, calculations are divided into manageable components.
- Includes custom views to streamline use by providing quick access to relevant data and minimizing navigation through non-essential information. For example, you can easily switch between editing and modifying the underlying model.
- Utilizes a dynamic system to manage various Structural Elements, enhancing the model's organization, navigation, and usage. These elements form a foundation that ensures consistency, flexibility, and the ability to extend functionalities easily.

Moreover, the Life Product Model, or tool, adheres to Excel financial modeling best practices and techniques I have learned or developed over the years and intend to write about separately. These standards aim to maximize control and efficiency.

This document is the **tool's** user manual and describes the working environment and the Projection Model. The underlying workbook is the primary documentation for the model and has been designed to be as self-documenting as possible.

The remainder of this section includes a discussion of:

- Objectives of the **Life Product Model**
- Audiences for the **Life Product Model**
- User Expectations
- Orientation
- Excel Settings
- Lexicon for the **Life Product Model** and this manual
- 'Free Review' Strategy & Future Development
- Disclaimer
- Retained Rights

And

A Table of Contents for Manual

OBJECTIVES

The Life Product Model has several objectives:

The *most important* of these is to provide a tool for my research and analysis or to calculate 'things' such as life expectancy or Section 7702 premiums. The Life Product Model has already accomplished that objective.

The second is to serve as an *educational tool* for life insurance students, including myself, facilitating a deeper understanding of the product, its profitability drivers, and various relationships by interacting with them in an Excel-friendly environment.

The third objective is to generate enough interest in the content to result in critical feedback, technical peer review, and potentially even future development assistance. In this regard, it is a key component of a 'Free Review' Strategy that I am executing, as discussed below.

The fourth demonstrates how I organize a relatively complex task, such as building an actuarial pricing model.

AUDIENCES

Currently, I see three key audiences for the Life Product Model:

STUDENTS OF LIFE INSURANCE

Actuarial and financial students or anyone interested in exploring, learning, or modeling various insurance topics, such as new regulatory requirements or capital frameworks that can leverage the pre-built calculations to suit their needs.

Students of life insurance who seek to understand the dynamics driving profitability, including the relative impact of changes in assumptions such as mortality, expenses, and compensation.

Life insurance distributors who may want to analyze compensation or assess business value, considering not only interest but mortality and persistency decrements. Or may need to generate illustrated results for planning purposes or even engage in product design, considering factors such as Section 7702 premiums.

STUDENTS OF EXCEL MODELING

Any individual who regularly constructs models in Excel and seeks best practices and techniques to enhance the quantity and quality of the models they develop. While the primary focus is on Excel, the principles discussed are applicable to general modeling practices.

STUDENTS OF EXCEL

Although I anticipate the primary audience is in the insurance or financial services industries, the techniques demonstrated by the model are universally applicable to any Excel development project. Therefore, the model is a valuable resource for anyone aiming to improve their Excel skills, providing insights into advanced Excel functionalities and modeling methodologies that can be adapted across various applications.

As mentioned above, I also view potential work prospects as an audience interested in understanding how I build a solution to a task of the magnitude of the tool.

USER EXPECTATIONS

The user expectations are straightforward: This manual and the design of the Life Product Model have been constructed to facilitate an understanding of the tool's structure and design. Users are presumed to have the necessary skills, whether in Excel, VBA, actuarial science, or finance, to utilize the tool as they see fit.

ORIENTATION

The Life Product Model is orientated first vertically from top to bottom, then horizontally from left to right, and finally diagonally from the upper left to the lower right.

Time is typically organized vertically, from the beginning to the end. However, there are exceptions, such as the orientation of the Proforma worksheet and the input of the compensation scales, both of which commonly present time running horizontally.

EXCEL SETTINGS

The Life Product Model default settings include *Auto-Save turned off* and *manual calculation*.

LEXICON

The following is a lexicon for the Life Product Model and this manual.

TERMINOLOGY AND FINANCIAL NOTATION

Efforts have been made to use accurate, common, generic, and descriptive terminology throughout the Life Product Model and this manual.

The Current Assumption Universal Life section defines the specific life insurance terminology used.

For financial notation, native Excel formatting features such as superscripts and subscripts are utilized to present formulas as accurately as possible.

Headings are designed to be descriptive rather than abbreviated for space efficiency and employ 'Shrink to Fit' formatting. To adjust the cell width automatically to fit its content, double-click the boundary to the right of the column header. This action expands the column to fit its widest entry. For instance, as shown in the example below, this method allows the heading 'Premium Expense Charge' to be fully displayed, comparing the default column widths with the expanded view necessary.

Default Columns Widths

	Guaranteed Policy Values | Current Illustration	
year	$Premium_t^{guar}$	$Premium\ Expense\ Charge_t^{guar}$
1	22,455	2,807
2	22,455	2,807
3	22,455	2,807
4	22,455	2,807

Expanded View

	Guaranteed Policy Values | Current Illustration	
year	$Premium_t^{guar}$	$Premium\ Expense\ Charge_t^{guar}$
1	22,455	2,807
2	22,455	2,807
3	22,455	2,807
4	22,455	2,807

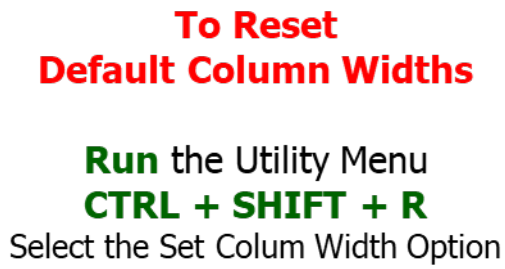
To Reset
Default Column Widths

Run the Utility Menu
CTRL + SHIFT + R
Select the Set Colum Width Option

Excel and VBA terminology strictly adhere to Microsoft's language to ensure clarity and precision.

MANUAL

Keyboard shortcuts are shown in **dark, bold green**, with the word containing the key letter also highlighted. For example, for the **Run** Utility menu, **Run** is highlighted in the shortcut **CTRL + SHIFT + R**. This notation is shown in the example below.



Capitalized words, such as Cash Surrender Value, have specific definitions. In this case, it is defined within the product description included in the Current Assumption Universal Life discussion.

Tables, areas, and arrays are considered multi-dimensional (e.g., 4 x 4), whereas vectors are considered one-dimensional (e.g., 1 x 4 or 4 x 1).

No distinction is made between assumptions and parameters in the model. 'Assumptions' is used generically to refer to parameters, inputs, etc.

Assumption values are **bolded**.

I use '*As an aside*' to indicate a discussion of a topic that is tangentially related to the purpose of the manual.

'Free Review' Strategy & Future Development

I consider the 'free review' strategy essential for increasing the success of the advisory services business I am developing. This strategy aims to develop content that generates enough interest to warrant a 'free review,' which serves two critical purposes:

First and most importantly, I find diversity of perspective absolutely critical for optimal problem-solving, and any feedback received will only improve the tool.

Second, if the content warrants more than a 'free review' and leads to technical review and even developmental help, all the better.

Seeking Assistance

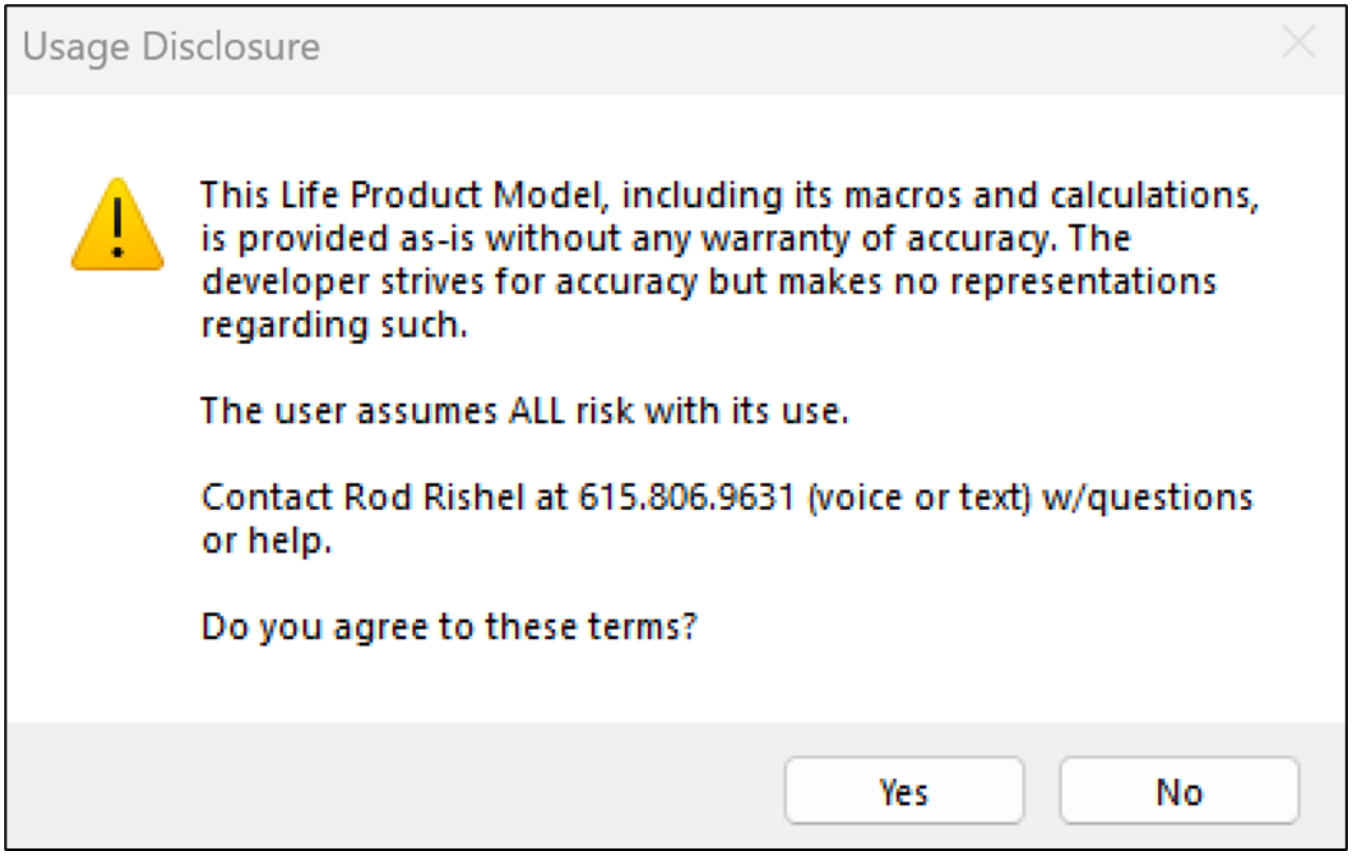
For clarity!! I will take any help someone is willing to provide, but two items from the Life Product Model that I would specifically ask for help on:

- While the Life Product Model Statutory Reserves functionality Module reproduces various examples from "Statutory Valuation of Individual Life and Annuity Contracts, Fifth Edition," authored by D. Clarie, L. Lombardi, and S. Summers and copyrighted in 2023 by ACTEX Learning, it is an area in which I am seeking assistance, or more specifically calculation review.
- Feedback or alternatives on handling capital excesses and shortfalls outside the monthly asset true-up.

Future Development

I initially considered documenting potential areas for future development. However, I realized this could become a never-ending task, so I chose to omit such discussions from this guide. Ultimately, any and all future development will be driven by need.

DISCLAIMER



The Life Product Model is a personal work product designed for educational use. It has been reviewed for its approach and the reasonableness of results but has not undergone a formal technical peer review.

Accuracy and completeness were key objectives in its development but there are no representations as such.

The user assumes ALL responsibility for downloading and usage.

Retained Rights

The Life Product Model is provided as a freely available resource intended for educational purposes. Users are encouraged to utilize any or all parts of it, adopting what proves useful and omitting what does not meet their needs.

I do retain the following rights:

Copyright Ownership

I retain the copyright on the Life Product Model. This copyright includes any original content, the structure of the model, and any derivative works unless explicitly stated otherwise.

Moral Rights

As the author of this model, I retain moral rights, which are legally recognized rights in certain jurisdictions. These rights include the right to be credited in any adaptations or publications that incorporate my work, to object to any derogatory treatment of the model, and to insist on the integrity of the work. I also ask to be sourced as the originator when the model or its elements are used.

Modification and Commercialization

I reserve the right to modify, update, or commercialize the Life Product Model at my discretion. Users do not have the right to sell or redistribute the model for commercial purposes without my explicit permission.

Withdrawal of Use

I reserve the right to withdraw this model from public use or alter the terms of its availability at any time.

Other Rights

I retain any other reasonable rights to maintain control over the use and distribution of my work.

TABLE OF CONTENTS FOR MANUAL

The manual has been designed to use the bookmarks in Adobe View; however, a table of contents for the manual is included below.

Quickly return to this section using the link in the footer.

Life Product Model (above)

Environment

The Environment discussion details the design objectives of the **Life Product Model** and is divided into the following two sections:

> The Workbook Structure section covers the workbook and worksheet structure and design.
>
> The Design Techniques section explains the functionality available organized by the techniques used to create the environment.

Projection Model

The Current Assumption Universal Life discussion outlines the modeled product and establishes the insurance lexicon used throughout this manual and the **tool**.

The subsequent sections are Input, Calculations, and Output:

> Inputs: Discusses the input assumptions for the Projection Model and is organized by the general types of inputs and their locations.
>
> Calculations: Discusses the 12 functionality Modules that comprise the calculation engine for the Projection Model.
>
> Outputs: Discusses the types of outputs for the Projection Model and their locations.

Analyses

This section demonstrates the Life Product Model's functionality through several analyses.

Methodology Notes

"Methodology Notes" details investigations like UL CRVM calculations used in the development of the tool.

ENVIRONMENT

The design objectives for the Life Product Model can be summarized as follows:

- **Consistency:** Ensuring structured layouts, consistent formatting, and adhering to standardization practices to maintain uniformity across the workbook.
- **Efficiency and Usability:** Optimizing the model with keyboard shortcuts, intuitive interfaces, custom views, and ensuring it is easy to update and modify without disrupting functionalities.
- **Educational Clarity and Intelligibility:** Prioritizing educational clarity and intelligibility by using descriptive Named Ranges and headers, consistent formatting standards, structured formula organization, and shallow formula depth, striving for the workbook to be as self-documenting as possible.
- **Accuracy, Reliability, and Maintenance:** Implementing data validation, thorough testing, version control, and maintaining consistency in design to ensure dependability and ease of maintenance.

The resulting Excel environment for the tool far exceeded my initial objectives, evolving into a highly functional, effective, and dynamic environment. It can perform premium solves and quickly apply formatting standards. It establishes a level of consistency in design that I consider one of the most essential best practices in building financial models in Excel. This environment has now become the default for any spreadsheet work I do. As outlined in the VBA Environment discussion, this was only possible with the help of my coding partner, ChatGPT.

This discussion of that environment occurs in the following two sections:

The Workbook Structure section covers the workbook and worksheet structure and design.

The Design Techniques section explains the functionality available organized by the techniques used to create the environment.

WORKBOOK STRUCTURE

The discussion of the workbook and worksheet structure and design is organized into the following subsections:

The Control Worksheet is the hub for all essential workbook documentation, design elements, and navigation utilities. It encompasses details on workbook information, Projection Model functionality Modules, Macro utilities and shortcuts, formatting standards, validation lists, and other relevant information.

The Model Worksheet contains the Input, Calculations, and first-order Output for the Projection Model. It is the heart of the model, and all other worksheets are oriented to the Model worksheet.

Worksheets in the Output ==> Section provide reports of calculations performed in the Model Area, including the following:

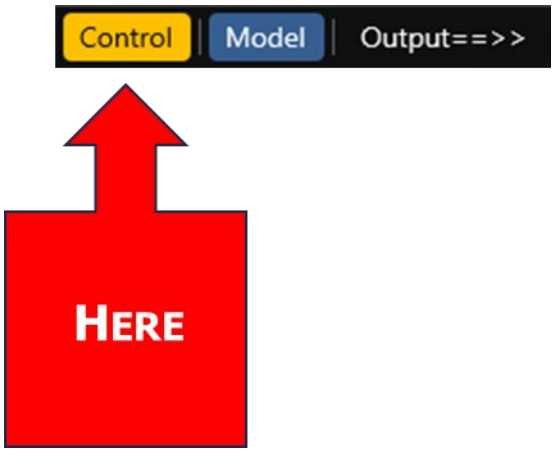
- The Profit Summary worksheet streamlines testing model inputs by including current and previous model results, with the ability to highlight differences.
- The Illustrations worksheet displays current and guaranteed illustrations and provides the template for vertical report presentation.
- The Proforma worksheet presents income statement results and provides the template for horizontal report presentation.

Worksheets in the Input Sheets==> Section contain assumptions or parameters loaded into the Calculations Area, including the following:

- The Vector Data worksheet contains COI, mortality, and other vectors.
- The Load Designs and Commission Scales worksheets contain arrays selectable in the Input Area.

The Housekeeping Module centralizes configurations and manages structural elements for improved efficiency. It consolidates default settings like colors and font sizes, simplifying maintenance and reducing computational load. Additionally, it handles structural elements dynamically, integrating named ranges for seamless functionality throughout the workbook.

CONTROL WORKSHEET



The Control worksheet contains all essential workbook documentation, worksheet structure, design elements, various infrastructure management tools, and navigation utilities.

The information in the Control worksheet is discussed below in the order that it is organized on the worksheet, moving from left to right.

LIFE PRODUCT MODEL WORKBOOK INFORMATION & CURRENT VERSION

This includes details such as developer information, file name, environment & workbook settings, and version history, as depicted below.

Life Product Model | Control | The Life Product Model v0.0.0.xlsm | April 27, 2024

Life Product Model Workbook Information

Developer & Contact Information	
name	Rod Rishel
phone or text	615.806.9631
email	rod@rodrishel.com
phone or text	615.806.9631
website	www.rodrishel.com

Life Product Model File Name and Version	
FileName / Version	The Life Product Model v0.0.0.xlsm

Life Product Model Enviroment Information
AutoSave is turned **OFF**
Calculation Method is set to **Manual** (F9)

Workbook Settings	
Workbook Zoom Default	75
User Agreement on OR off at open	off
directory to store running archive	C:\Life Product Model Archives

Current Version						
ID	Version	date	IRR	Profit Margin	VONB	note
1	The Life Product Model v0.0.0.xlsm	04/27/2024	8.20%	10.86%	1.18%	

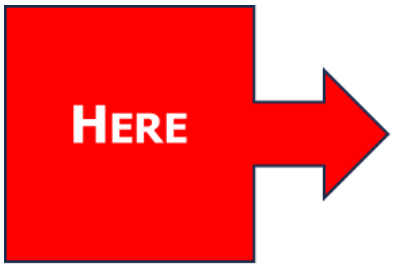
Archived Versions						
ID	Version	date	IRR	ProfitMargin	VONB	note

Projection Model Functionality Modules & Worksheet Structure

You can quickly navigate to the Control worksheet using the CTRL + SHIFT + C shortcut, which takes you to the Workbook Navigator, as shown below.

You can navigate quickly to any functionality Module or worksheet from the Workbook Navigator.

The functionality Modules, which are sequentially built upon each other, generate the Output of the Projection Model.



Projection Model Functionality Modules & Worksheet Structure		
Workbook Navigator	ID	Functionality Module or Worksheet Name
Model		
	1	Survival Model
	2	Current Illustration
	3	Section 7702
	4	Guaranteed Illustration
	5	Statutory Reserves
	6	Commission Calculations
	7	Expenses
	8	Capital Development
	9	Assets & Investment Income
	10	Statutory Income Statement
	11	Surplus Account & Balance Sheet
Output==>>		
	a	Profit Summary
	b	Illustrations
	c	Proforma
	d	Premium Pie
Input Sheets==>>		
	a	Vector Data
	b	Load Designs
	c	Commission Scales
Other==>>		
	a	Target Capital
Hidden==>>		
	a	User Agreement

Macro Utilities and VBA Environment

This area of the Control worksheet includes all Macro utilities and their corresponding keyboard shortcuts, as seen below.

Life Product Model Control Worksheet | Macro Utilities & VBA Environment

General			
Macro Name	CTRL + SHIFT +	VBA Module	Description
ShowAvailableMacros()	A	SHORTCUT_A_ShowAvailableMacros	Displays all Macros and their respective keyboard shortcuts

Workbook Navigation and Viewing			
Macro Name	CTRL + SHIFT +	VBA Module	Description
GoToControlNavigator()	C	SHORTCUT_C_GoToControlNavigator	Returns user to the Control worksheet
JumpToModule()	J	SHORTCUT_J_JumpToModule	Goes to the Module selected by the user
VisibilityModuleToggle()	V	SHORTCUT_V_ModuleVisibility	Toggles visibility of Modules
ToggleWorkAreas()	T	SHORTCUT_T_ToggleWorkAreas	Toggles visibility of Work Areas

Editing and Input			
Macro Name	CTRL + SHIFT +	VBA Module	Description
SetMode()	M	SHORTCUT_M_SetMode	Toggles between Edit/Use and Input modes
FormatCells()	F	SHORTCUT_F_FormatCells	Applies Formatting Standards

Utilities and Management			
Macro Name	CTRL + SHIFT +	VBA Module	Description
RunUtilities()	R	SHORTCUT_R_RunUtilities	Utilities for workbook and Projection Model efficiency
CopyProfitOutputRow()	P	SHORTCUT_R_RunUtilities	Copies Profit Output Row for paste

Personal Productivity			
Macro Name	CTRL + SHIFT +	VBA Module	Description
NotePad()	N	SHORTCUT_N_NotePad	Captures notes and stores on Control worksheet

The Macro functionalities mentioned above are discussed throughout this manual in the relevant sections.

FORMATTING STANDARDS

The Control worksheet contains the Formatting Standards used throughout the workbook.

VALIDATION LISTS

Validation lists serve as a data control mechanism within the workbook, ensuring accuracy and consistency in input and calculations.

As illustrated in the redacted image below, these lists serve various purposes. They can function as basic toggles, such as "yes" or "no" (see A). Additionally, they govern all Data Vector Types employed in the Calculations Area for accessing specific mortality or COI tables (see B).

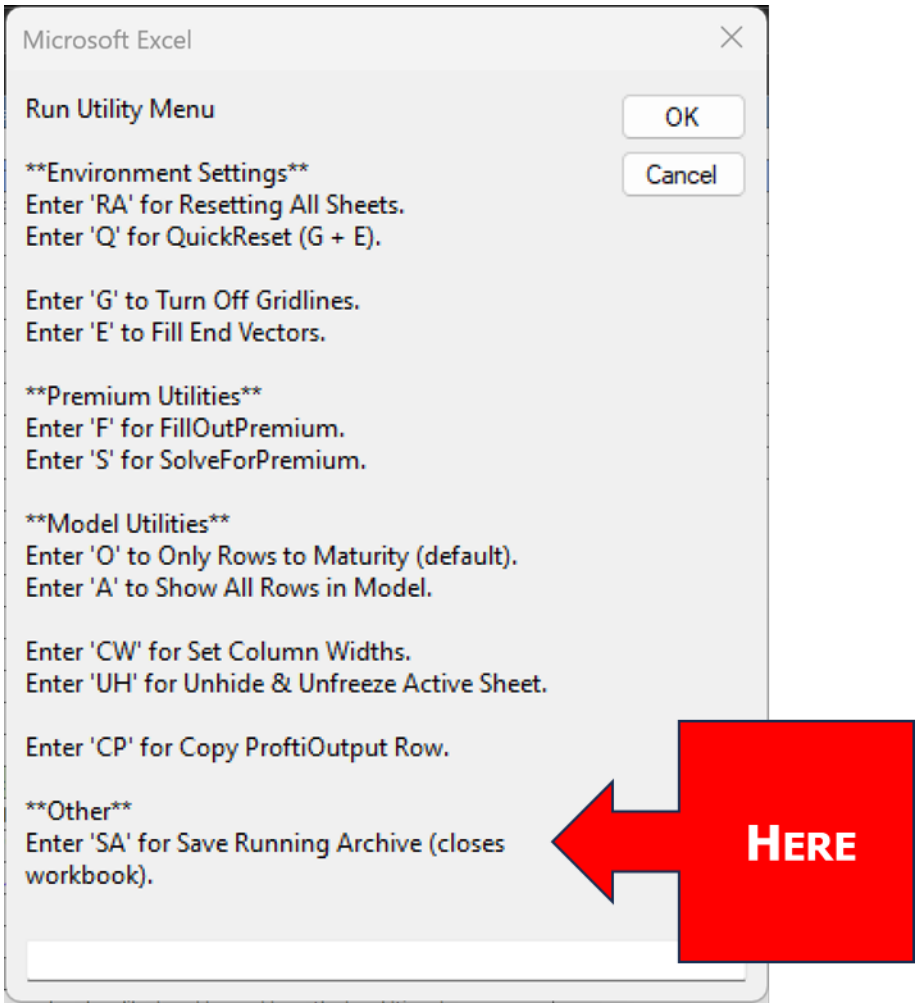
A

Validation Lists					
yesORno	Data_Vector_Type	Reserve_Type	Premium_Basis_Type	PaymentMode_Type	COI_Uses
yes	MortalityVector	CSV	current	annual	vector
no	COIVector	CRVM	guaranteed	semi-annual	calculated
	GuarCOIVector			quarterly	
	StatqxVector			monthly	
	S7702COIVector				

B

SAVE RUNNING ARCHIVE

The Save Running Archive Macro, accessed through the Run Utility menu by pressing CTRL + SHIFT + R and entering SA, saves a timestamped version of the workbook to the directory specified in the named range Running Archive Directory at the beginning of the Control worksheet. Additionally, it logs user comments describing the archive.



The Macro closes the current version of the tool and leaves the Running Archive version open. It also reminds the user to close the archive.

The versions and their corresponding user notes can be viewed below:

Save Running Archive | CTRL + SHIFT + R: Selection SA		
Version	note	date
The Life Product Model v0.0.0_2024-03-21_1944.xlsm	demonstration	03/21/2024
The Life Product Model v0.0.0_2024-04-16_2255.xlsm	prior to packaging (part ?)	04/16/2024
The Life Product Model v0.0.0_2024-04-19_1912.xlsm	RST results	04/19/2024

Remainder of Control Worksheet

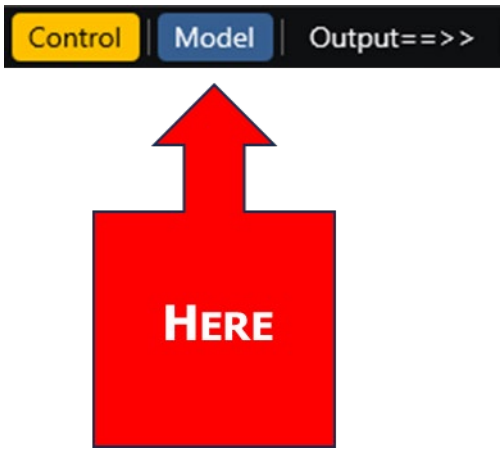
The Control worksheet includes the NotePad notes repository, Corridor Factors, and an under-construction internal error dashboard.

Note Pad		
ID	Description	Date
1	test	3/21/2024
2	test2	3/21/2024
3	Double check calculation XYZ	3/21/2024
4	Follow up with John regarding roofing estimate	3/21/2024
5	Adjust worksheet structure pending decision on approach.	3/30/2024
6	call about dinner reservations	4/2/2024
7	be able point to where the formuloa breaqks down or disagree with	5/9/2024
8	include in the lexicon and standards i have attempted to use the baseline runs, however, this eremay be some descrepanceies.	5/11/2024

Corridor Factors for 7702	
corridor_age	corridor_factor
0	2.50
40	2.50
41	2.43
42	2.36
43	2.29
44	2.22
45	2.15
46	2.09

Error Checks | <<under construction>>				
check list	Worksheet	Cell	status	description
check_A	Model	GZ273	error	
LapseCheck	Model	BN274	Lapse-Ok	

MODEL WORKSHEET



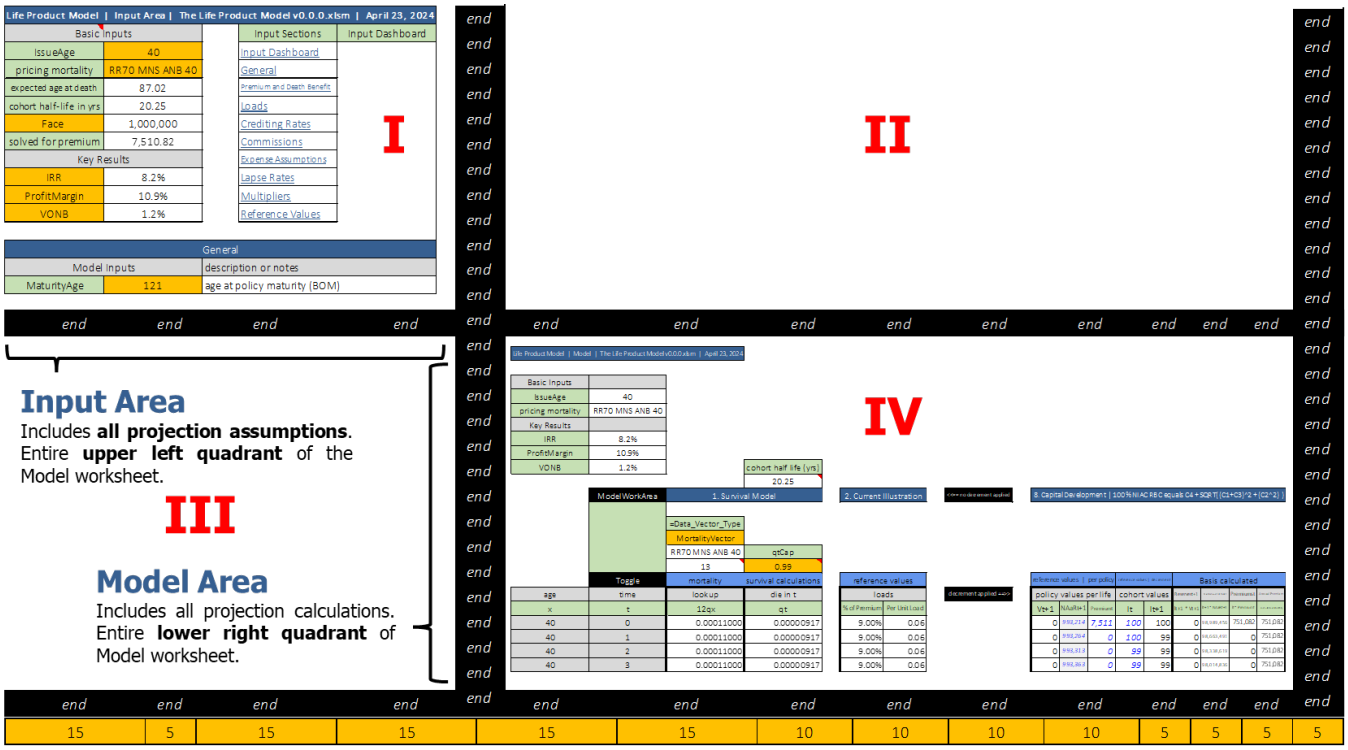
The Model worksheet contains the Input, Calculations, and first-order Output for the Projection Model. It is the heart of the model, and all other worksheets are oriented to the Model worksheet.

The Model worksheet was developed to achieve several key objectives:

- It was designed such that a formulas-only version would fully define the model.
- It includes no cross-sheet references, enhancing formula clarity. For example, rather than using ='Commission Scales'!E5, all formulas reference the same sheet or a Named Range.
- It adheres to the best practice of separating Inputs, Calculations, and Outputs.
- The diagonally organized layout enables quick insertion of rows and columns without affecting adjacent calculations.
- The worksheet is optimized for ease of use in 'Input' and 'Edit' modes and multiple screens.

ORIENTATION

The Model worksheet is divided into 4 quadrants, as visualized below:



QUADRANT I & IV: INPUT AREA & MODEL AREA

The Input Area contains projection assumptions, while the Model Area is the calculation engine of the Life Product Model.

Both the Input Area and the Model Area are discussed further below.

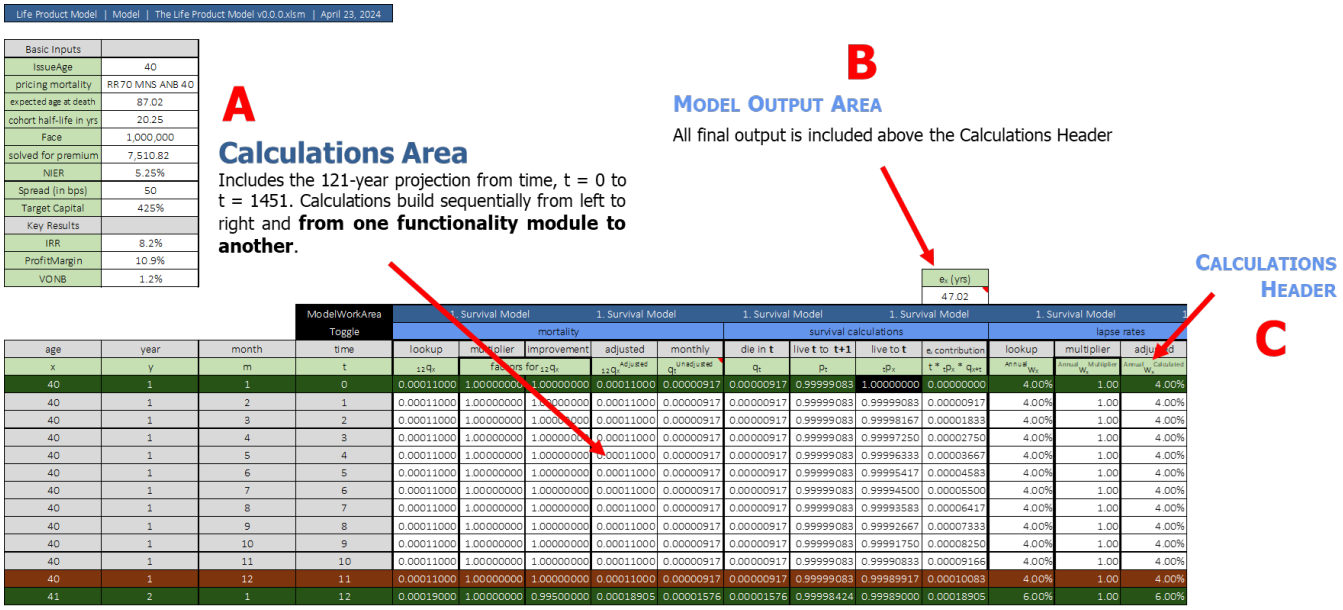
The viewing mode can be changed between 'Edit/Use' or 'Input' Mode by running the Set Mode Macro: CTRL + SHIFT + M.

QUADRANT II & III: EMPTY CELLS

These quadrants are intentionally left blank to facilitate adding rows or columns to the Input or Model Areas without disrupting calculations elsewhere.

MODEL AREA

The Model Area includes the calculations of the Life Product Model and is structured as seen below:



Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,510.82
NIER	5.25%
Spread (in bps)	50
Target Capital	425%
Key Results	
IRR	8.2%
ProfitMargin	10.9%
VONB	1.2%

e_x (yrs)
47.02

ModelWorkArea Toggle				1. Survival Model	1. Survival Model				1. Survival Model		1. Survival Model	1. Survival Model				
				mortality					survival calculations				lapse rates			
age	year	month	time	lookup	multiplier	improvement	adjusted	monthly	die in **t**	live **t** to **t+1**	live to **t**	e.contribution	lookup	multiplier	adjusted	
x	y	m	t	$_{12}q_x$	factors for $_{12}q_x$		$_{12}q_x^{Adjusted}$	$q_t^{Unadjusted}$	q_t	p_t	$_tp_x$	$t * {}_tp_x * q_{x+t}$	Annual W_x	Annual Multiplier W_x	Annual W_x Calculated	
40	1	1	0	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	1.00000000	0.00000000	4.00%	1.00	4.00%	
40	1	2	1	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99999083	0.00000917	4.00%	1.00	4.00%	
40	1	3	2	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99998167	0.00001833	4.00%	1.00	4.00%	
40	1	4	3	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99997250	0.00002750	4.00%	1.00	4.00%	
40	1	5	4	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99996333	0.00003667	4.00%	1.00	4.00%	
40	1	6	5	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99995417	0.00004583	4.00%	1.00	4.00%	
40	1	7	6	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99994500	0.00005500	4.00%	1.00	4.00%	
40	1	8	7	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99993583	0.00006417	4.00%	1.00	4.00%	
40	1	9	8	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99992667	0.00007333	4.00%	1.00	4.00%	
40	1	10	9	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99991750	0.00008250	4.00%	1.00	4.00%	
40	1	11	10	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99990833	0.00009166	4.00%	1.00	4.00%	
40	1	12	11	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99989917	0.00010083	4.00%	1.00	4.00%	
41	2	1	12	0.00019000	1.00000000	0.99500000	0.00018905	0.00001576	0.00001576	0.99998424	0.99989000	0.00018905	6.00%	1.00	6.00%	

REFERENCE A

The Calculations Area is the model's engine, performing a **121-year** projection from time t = 0 to t = 1451.

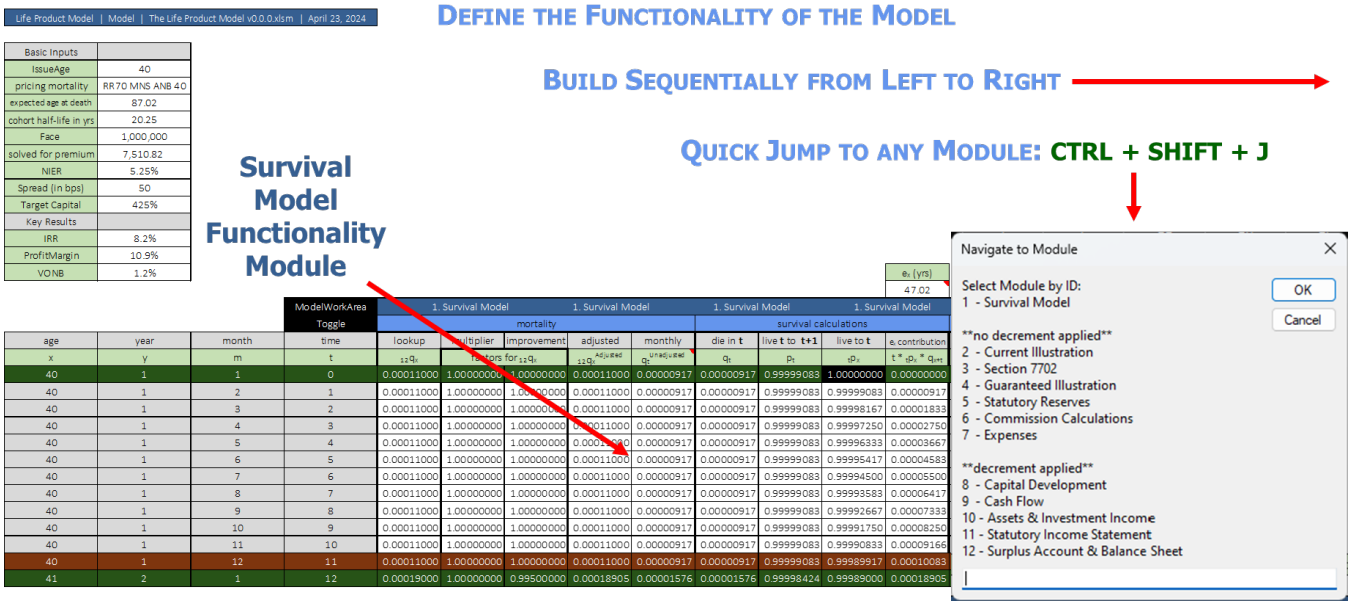
REFERENCE B

Direct output from the projection is included above the Calculations Header in the Model Area.

REFERENCE C

The Calculations Header lists the column names of the Calculations Area and is used for the Dynamic Aggregation Strutrucal Element to generate various reports, as discussed in the Dynamic Aggregation section.

Calculations build sequentially from left to right and from one functionality Module to another. The functionality Modules are discussed in the Calculations section.



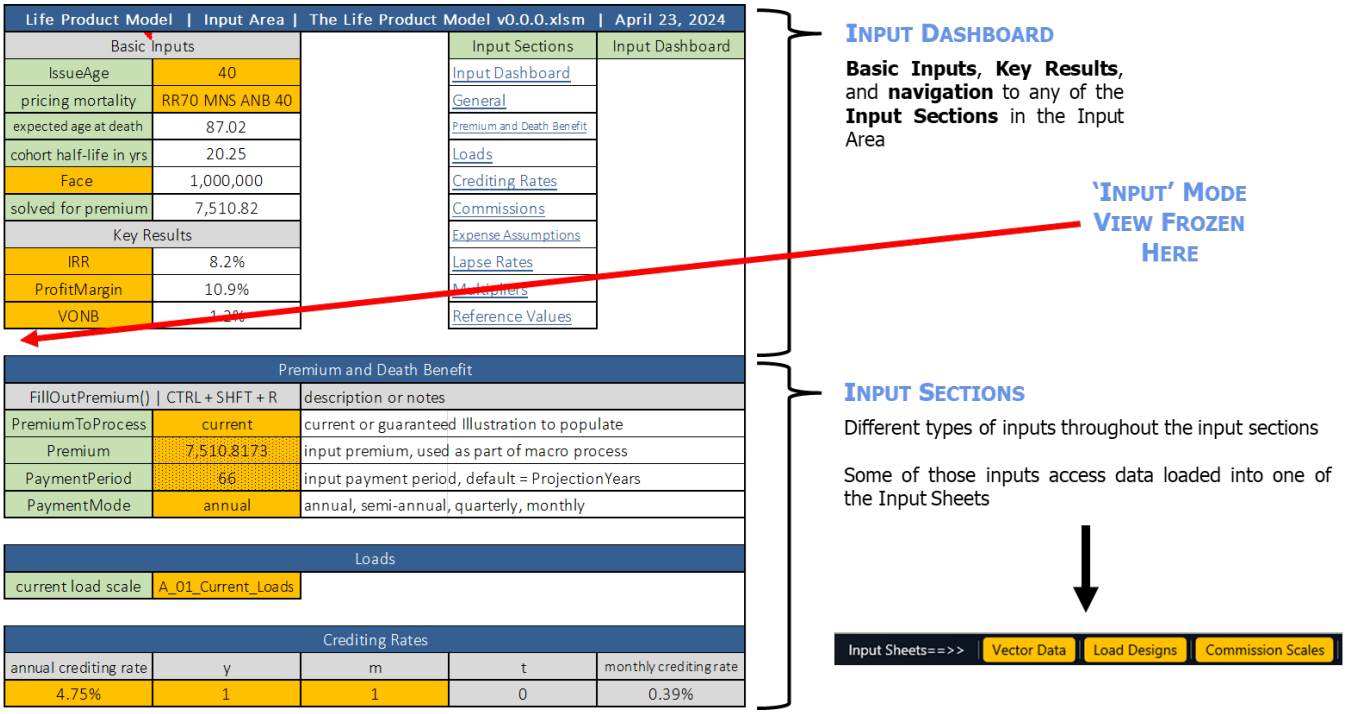
Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,510.82
NIER	5.25%
Spread (in bps)	50
Target Capital	425%
Key Results	
IRR	8.2%
ProfitMargin	10.9%
VONB	1.2%

e_x (yrs)
47.02

ModelWorkArea Toggle				1. Survival Model	1. Survival Model				1. Survival Model			1. Survival Model
				mortality					survival calculations			
age	year	month	time	lookup	multiplier	improvement	adjusted	monthly	die in **t**	live **t** to **t+1**	live to **t**	e_x contribution
x	y	m	t	${}_{12}q_x$	factors for ${}_{12}q_x$		${}_{12}Q_x^{adjusted}$	$q_t^{unadjusted}$	q_t	p_t	${}_tp_x$	$t * {}_tp_x * q_{x+t}$
40	1	1	0	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	1.00000000	0.00000000
40	1	2	1	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99999083	0.00000917
40	1	3	2	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99998167	0.00001833
40	1	4	3	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99997250	0.00002750
40	1	5	4	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99996333	0.00003667
40	1	6	5	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99995417	0.00004583
40	1	7	6	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99994500	0.00005500
40	1	8	7	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99993583	0.00006417
40	1	9	8	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99992667	0.00007333
40	1	10	9	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99991750	0.00008250
40	1	11	10	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99990833	0.00009166
40	1	12	11	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99989917	0.00010083
41	2	1	12	0.00019000	1.00000000	0.99500000	0.00018905	0.00001576	0.00001576	0.99998424	0.99989000	0.00018905

INPUT AREA

The Input Area contains projection assumptions and is shown below:



Life Product Model | Input Area | The Life Product Model v0.0.0.xlsm | April 23, 2024				
Basic Inputs			Input Sections	Input Dashboard
IssueAge	40		Input Dashboard	
pricing mortality	RR70 MNS ANB 40		General	
expected age at death	87.02		Premium and Death Benefit	
cohort half-life in yrs	20.25		Loads	
Face	1,000,000		Crediting Rates	
solved for premium	7,510.82		Commissions	
Key Results			Expense Assumptions	
IRR	8.2%		Lapse Rates	
ProfitMargin	10.9%		M...ipliers	
VONB	1.3%		Reference Values	

Premium and Death Benefit		
FillOutPremium() | CTRL + SHFT + R		description or notes
PremiumToProcess	current	current or guaranteed Illustration to populate
Premium	7,510.8173	input premium, used as part of macro process
PaymentPeriod	66	input payment period, default = ProjectionYears
PaymentMode	annual	annual, semi-annual, quarterly, monthly

Loads	
current load scale	A_01_Current_Loads

Crediting Rates				
annual crediting rate	y	m	t	monthly crediting rate
4.75%	1	1	0	0.39%

INPUT DASHBOARD

Basic Inputs, **Key Results**, and **navigation** to any of the **Input Sections** in the Input Area

'INPUT' MODE VIEW FROZEN HERE

INPUT SECTIONS

Different types of inputs throughout the input sections

Some of those inputs access data loaded into one of the Input Sheets

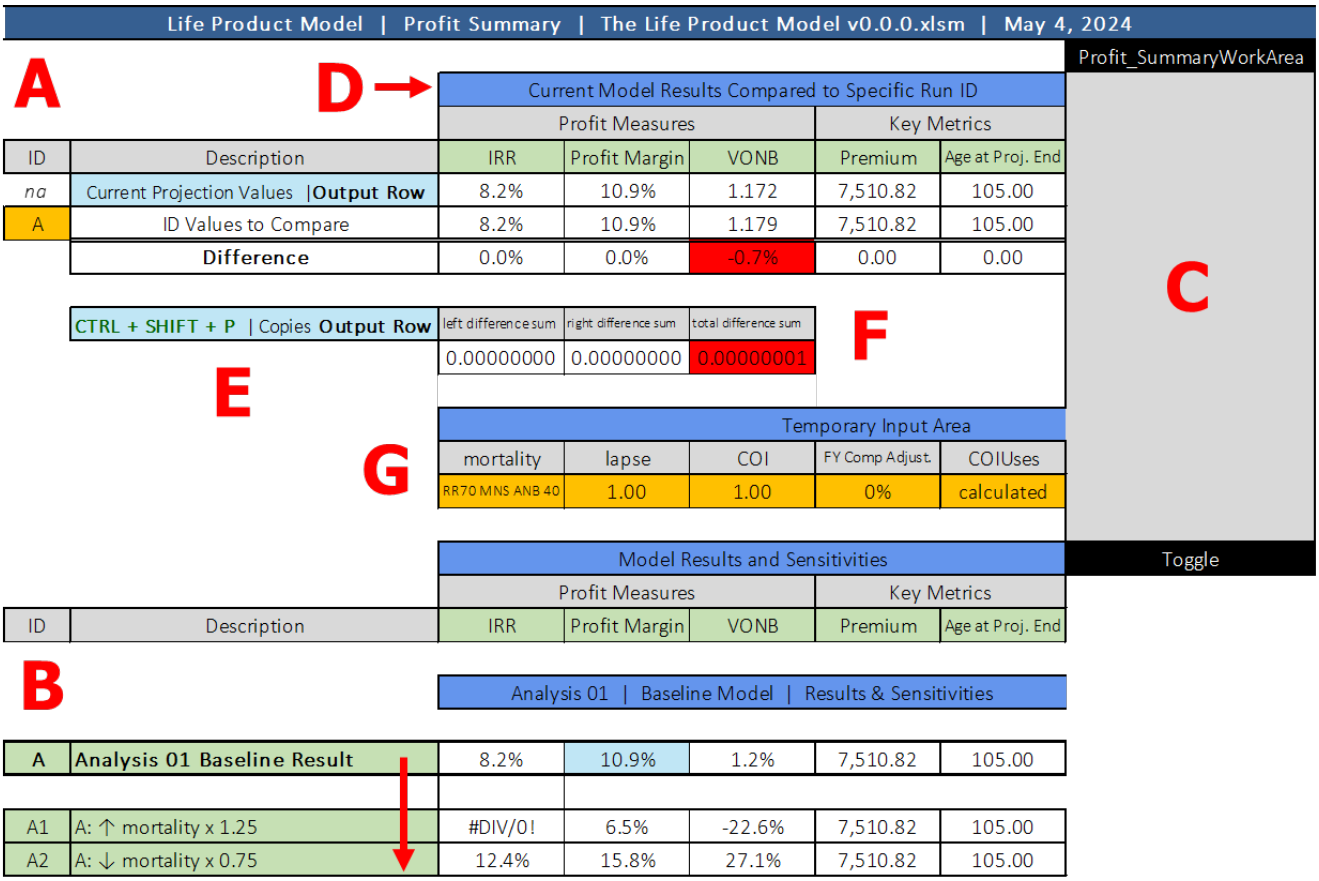
Input Sheets==>> | Vector Data | Load Designs | Commission Scales

OUTPUT==> SECTION

Each worksheet in the Output==> section contains a report of the calculations performed in the Model Area.

PROFIT SUMMARY WORKSHEET

The Profit Summary worksheet will continue to mature with usage, as it is one of the most utilized worksheets once the model is completed. It contains several items designed to streamline the process of testing model inputs, aka "pricing the cash flow," as efficiently as possible. These items are discussed below.



REFERENCE A

The current model results, indicated by the "na" ID, are included in the **Output Row**. These results are compared to the previous model results, as identified in the ID input, with the outcome of that comparison in the **Difference** row. Any difference that does not equal the comparison is conditionally formatted to highlight the cell red.

REFERENCE B

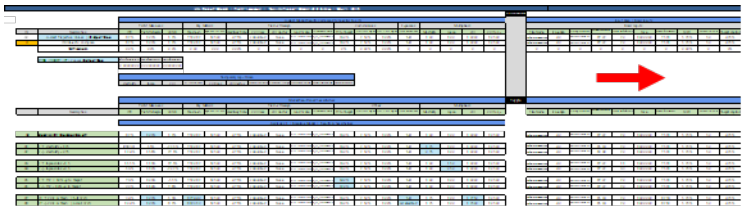
Previous model results are arranged vertically down the sheet, each with a unique ID to facilitate comparison, as discussed above.

REFERENCE C

The grey area is a Work Area that can be **toggled** to be visible or hidden using **CTRL + SHIFT + T**. Work Areas are further discussed in their dedicated section.

REFERENCE D

The **Output Row** includes the current model results and extends horizontally across the worksheet, as seen below. It includes all of the inputs in the Input Area. As a result, each row fully documents the model results, as well as the majority of outputs and many interim calculations. I will continue to add outputs and interim calculations as I have realized the efficiency of comparing results in the Work Area, as described.



REFERENCE E

I created a 'hack' to expedite moving the Output Row to the results area, as discussed in Reference B. Previously, this process required a mouse action followed by three END + RIGHT keystrokes. Now, with the shortcut **CTRL + SHIFT + P** (**P** for **Profit**), the Output Row is selected and copied, ready to paste into the results without leaving the keyboard and in one keyboard action. Interestingly, I have written this macro hundreds of times and began writing it *without* ChatGPT. However, about two steps in, I realized there were a few considerations, such as ensuring it could run from another worksheet. I added some comments to the code I'd written, and my coding partner created the version in use today with no further edits.

REFERENCE F

The differences discussed in Reference A are summed on both sides of the Work Area and then totaled. Conditional formatting highlights any column that doesn't meet the comparison criteria.

When adding a new column to the Output Row and creating the comparison for the difference calculation, the comparison must yield a numerical result, such as zero or non-zero.

REFERENCE G

Often, when 'pricing the cash flows,' it is efficient to have the inputs directly available, and when so, I move or link the inputs from the Input Area to the 'temporary input' area shown in Reference G.

ILLUSTRATIONS WORKSHEET

The Illustrations worksheet contains current and guaranteed illustrations, as shown below.

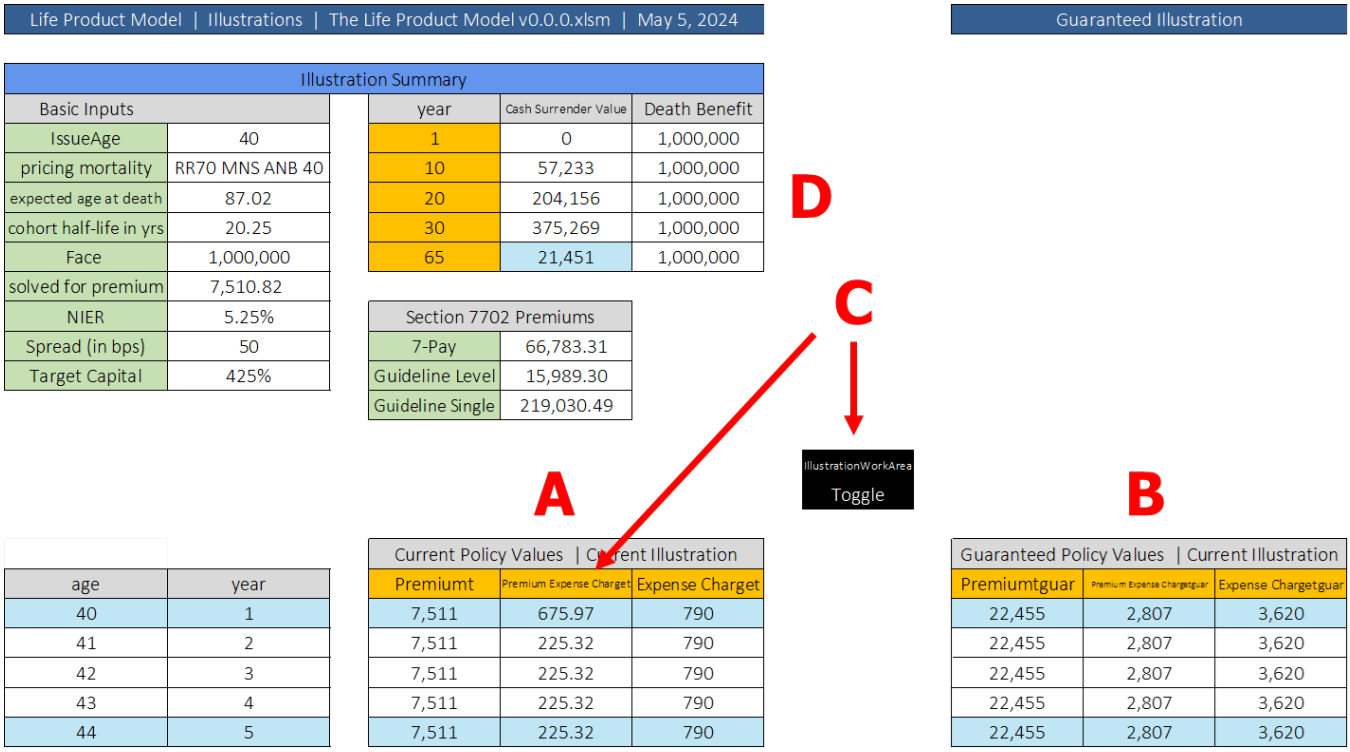


Illustration Summary	
Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,510.82
NIER	5.25%
Spread (in bps)	50
Target Capital	425%

year	Cash Surrender Value	Death Benefit
1	0	1,000,000
10	57,233	1,000,000
20	204,156	1,000,000
30	375,269	1,000,000
65	21,451	1,000,000

Section 7702 Premiums	
7-Pay	66,783.31
Guideline Level	15,989.30
Guideline Single	219,030.49

age	year
40	1
41	2
42	3
43	4
44	5

Current Policy Values | Current Illustration		
Premiumt	Premium Expense Charget	Expense Charget
7,511	675.97	790
7,511	225.32	790
7,511	225.32	790
7,511	225.32	790
7,511	225.32	790

Guaranteed Policy Values | Current Illustration		
Premiumtguar	Premium Expense Chargetguar	Expense Chargetguar
22,455	2,807	3,620
22,455	2,807	3,620
22,455	2,807	3,620
22,455	2,807	3,620
22,455	2,807	3,620

REFERENCE A AND B

A is the current ledger of projected values, and B is the guaranteed ledger.

REFERENCE C

The *annual values* in the ledger are returned using a technique called Dynamic Aggregation, as detailed in that section. This method involves entering the Calculations Header of the desired column in the Illustration header and updating the infrastructure settings in the work area.

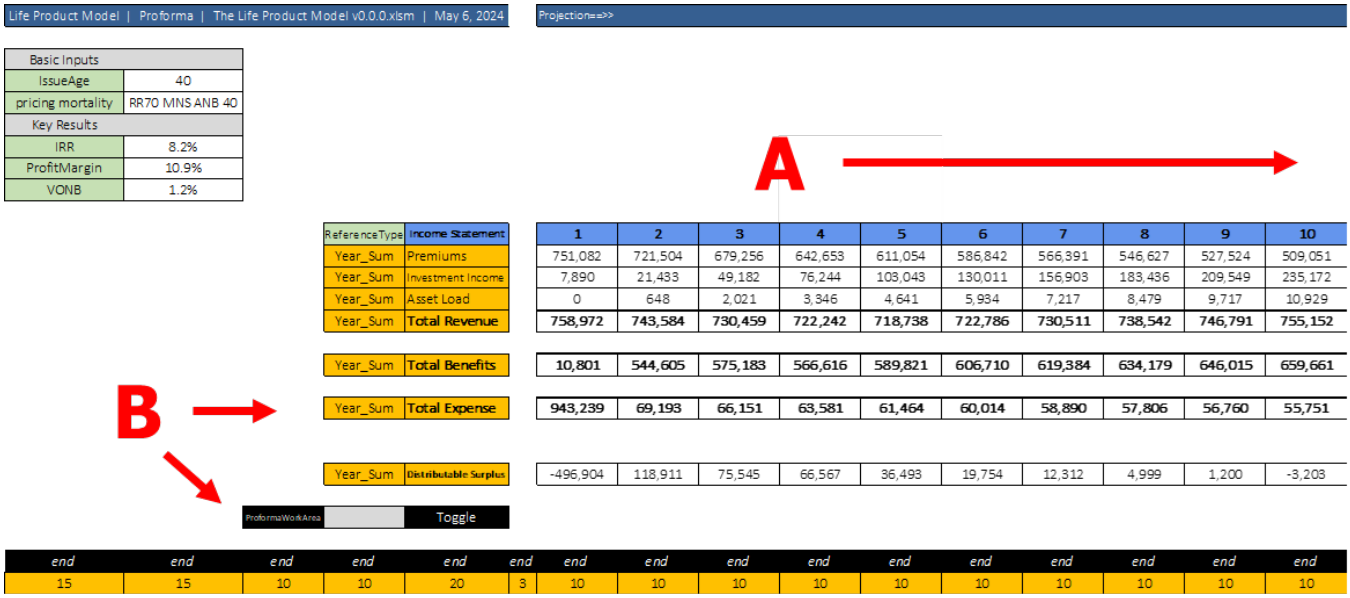
Dynamic aggregation streamlines the process of transforming monthly data from the Calculations Area into an annual summary, enabling efficient copying and customization of data presented.

REFERENCE D

The illustration summary provides the Cash Surrender Value and Death Benefit values according to the specified input year. Although the headers are not inputs, the XLOOKUP function used to retrieve these values can be easily adjusted to reference the desired column.

PROFORMA WORKSHEET

The Proforma worksheet displays annual results chronologically, aligned with the standard financial format of an income statement.



Life Product Model | Proforma | The Life Product Model v0.0.0.xlsm | May 6, 2024 — Projection==>>

Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
Key Results	
IRR	8.2%
ProfitMargin	10.9%
VONB	1.2%

A

ReferenceType	Income Statement	1	2	3	4	5	6	7	8	9	10
Year_Sum	Premiums	751,082	721,504	679,256	642,653	611,054	586,842	566,391	546,627	527,524	509,051
Year_Sum	Investment Income	7,890	21,433	49,182	76,244	103,043	130,011	156,903	183,436	209,549	235,172
Year_Sum	Asset Load	0	648	2,021	3,346	4,641	5,934	7,217	8,479	9,717	10,929
Year_Sum	**Total Revenue**	**758,972**	**743,584**	**730,459**	**722,242**	**718,738**	**722,786**	**730,511**	**738,542**	**746,791**	**755,152**
Year_Sum	**Total Benefits**	**10,801**	**544,605**	**575,183**	**566,616**	**589,821**	**606,710**	**619,384**	**634,179**	**646,015**	**659,661**
Year_Sum	**Total Expense**	**943,239**	**69,193**	**66,151**	**63,581**	**61,464**	**60,014**	**58,890**	**57,806**	**56,760**	**55,751**
Year_Sum	**Distributable Surplus**	-496,904	118,911	75,545	66,567	36,493	19,754	12,312	4,999	1,200	-3,208

B

ProformaWorkArea — Toggle

end	end	end	end	end	end	end	end	end	end	end	end	end	end	end	end
15	15	10	10	20	3	10	10	10	10	10	10	10	10	10	10

REFERENCE A

Time runs horizontally and continues running to the right of the spreadsheet.

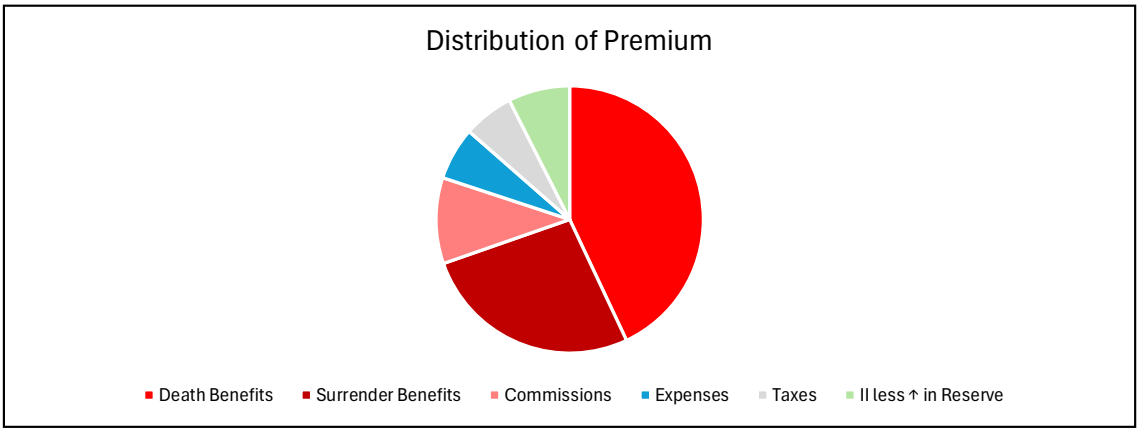
REFERENCE B

The annual values in the ledger are returned using a technique called Dynamic Aggregation, which is detailed in that section and discussed in the Illustration Worksheet.

PREMIUM PIE WORKSHEET

While accurate for how it is developed, the Premium Pie worksheet is still under construction.

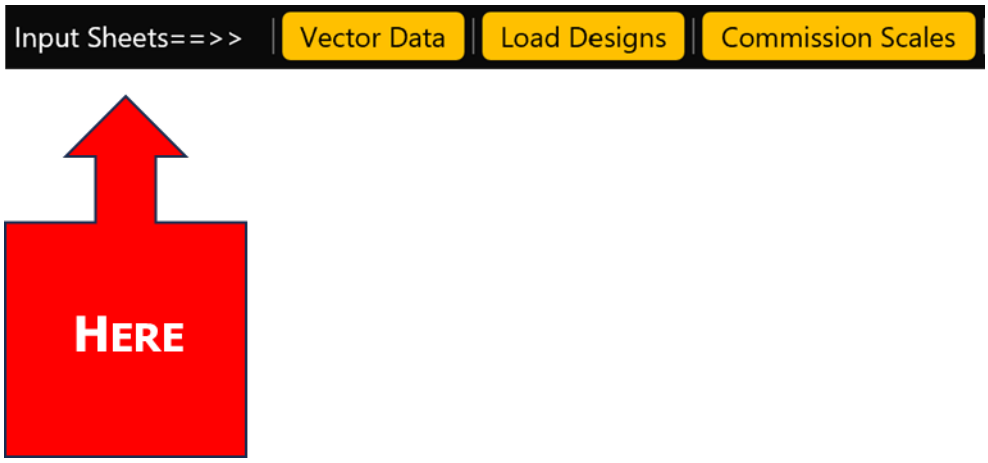
Premium Pie



	Premiums	Death Benefits	Surrender Benefits	Commissions	Expenses	Taxes	Il less ↑ in Reserve	After-Tax Income
% of Premiums	**100.0%**	-45.1%	-27.9%	-10.9%	-6.7%	-6.4%	7.8%	10.9%
NPV @ NIER	**8,818,011**	(3,972,899)	(2,462,115)	(961,720)	(589,669)	(563,079)	688,684	957,212

As a side note, I find it insightful to consider how premiums are allocated across various profit drivers. This analysis aids in prioritizing efforts, assessing differences between product designs, understanding their relative impacts, and recognizing the benefits returned to the policy owner.

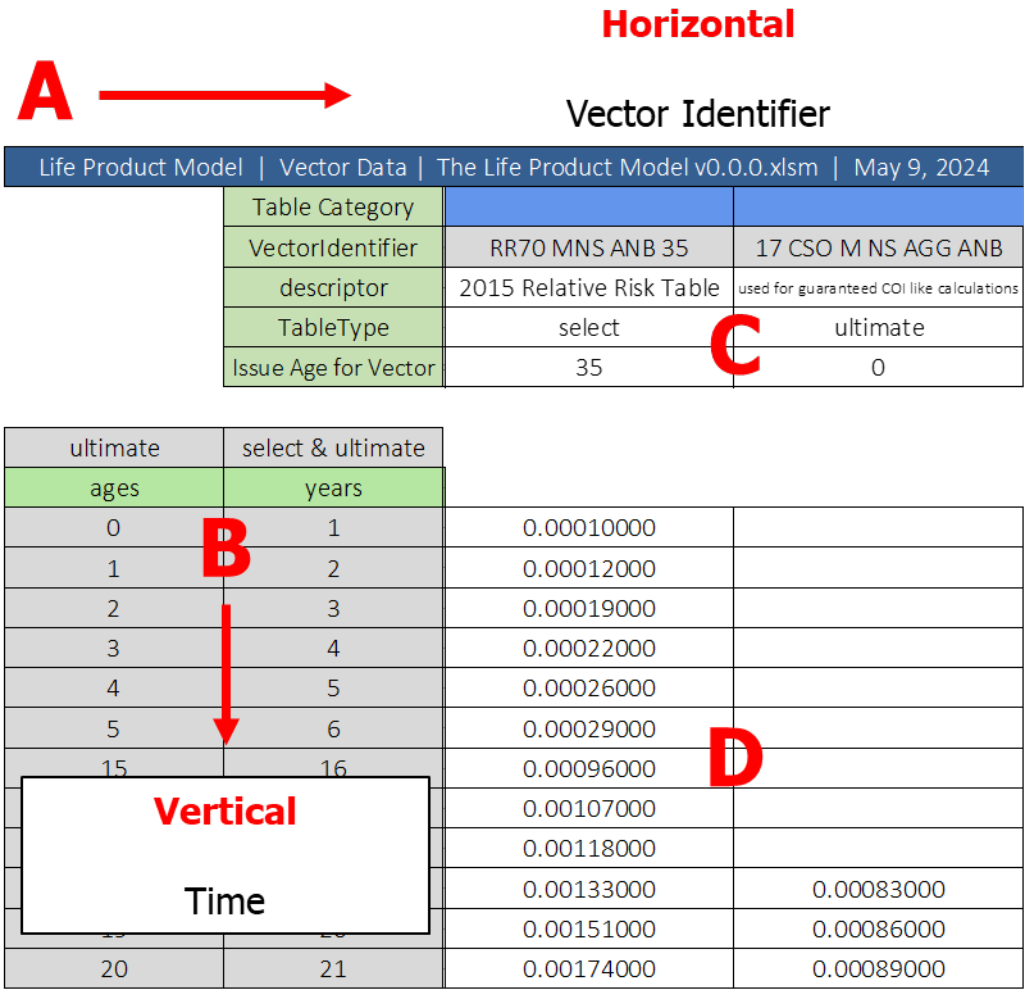
INPUT SHEETS==> SECTION



The Input Sheets contain assumptions or parameters that are loaded into the Calculations Area as arrays selected in the Input Area.

VECTOR DATA WORKSHEET

The Vector Data worksheet has been designed to return COI, mortality, and other vectors, as discussed in the Vector Data Retrieval section.



Life Product Model | Vector Data | The Life Product Model v0.0.0.xlsm | May 9, 2024			
	Table Category		
	VectorIdentifier	RR70 MNS ANB 35	17 CSO M NS AGG ANB
	descriptor	2015 Relative Risk Table	used for guaranteed COI like calculations
	TableType	select	ultimate
	Issue Age for Vector	35	0
ultimate	select & ultimate		
ages	years		
0	1	0.00010000	
1	2	0.00012000	
2	3	0.00019000	
3	4	0.00022000	
4	5	0.00026000	
5	6	0.00029000	
15	16	0.00096000	
		0.00107000	
		0.00118000	
		0.00133000	0.00083000
		0.00151000	0.00086000
20	21	0.00174000	0.00089000

REFERENCE A

The Vector Identifier runs horizontally on the worksheet.

REFERENCE B

Time runs vertically and uses *ages* for 'ultimate' Table Types and *years* for 'select' Table Types.

REFERENCE C

The Table Type is loaded into the Calculations Area and is either a select or ultimate table.

REFERENCE D

The COI and mortality vectors are loaded as values per dollar ($1.00) of Death Benefit.

Load Designs and Commission Scales Worksheets

Both worksheets contain arrays that can be selected in the Input Area. Below are examples of input for each sheet.

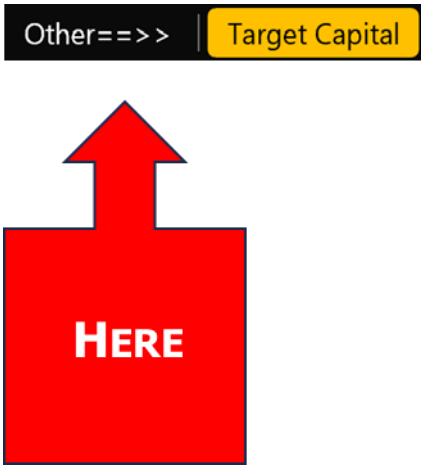
Life Product Model | Load Designs | The Life Product Model v0.0.0 | May 9, 2024							
Identifiers for Validation	Load Design Input Area						
LoadDesignIndentifiers	Load Design Identifier			A_01_Current_Loads			
A_01_Current_Loads	y	m	t	% of Premium	AnnualPer Unit Load	AnnualAV Load in bps	Monthly Fee
A_01_Guaranteed_Loads	1	1	0	9.00%	0.72	0	6.00
RST_Loads	2	1	12	3.00%	0.72	0	6.00
UVW_Loads	3	1	24	3.00%	0.72	0	6.00
XYZ_Loads	4	1	36	3.00%	0.72	0	6.00
ABC_Loads	5	1	48	3.00%	0.72	0	6.00
DEF_Loads	6	1	60	3.00%	0.72	0	6.00
GHI_Loads	7	1	72	3.00%	0.72	0	6.00
	8	1	84	3.00%	0.72	0	6.00
	9	1	96	3.00%	0.72	0	6.00
	10	1	108	3.00%	0.72	0	6.00
	11	1	120	3.00%	0.00	0	6.00
	16	1	180	3.00%	0.00	0	6.00
	21	1	240	3.00%	0.00	0	6.00

Life Product Model | Commission Scales | The Life Product Model v0.0.0 | May 9, 2024						
Identifiers for Validation	Commission Scale as a % of Premium					
CommissionDataIndentifiers	Commission Data Identifier	A_01_Commissions				
A_01_Commissions	Starting Year	1	2	6	7	11	21
RST_Commissions	% to Target	130.00%	2.50%	2.50%	2.50%	1.00%	0.50%
ABC_Commissions	Excess %	5.00%	2.50%	2.50%	2.50%	1.00%	0.50%
DEF_Commissions							
GHI_Commissions							

Commission Target Identifier	Targets
A_01_Commissions	6,500.00

OTHER>==> SECTION

This includes other sheets, such as the Target Capital worksheet, which serves as an input sheet and a Target Capital factor calculator.



TARGET CAIPTAL WORKSHEET

The Target Capital worksheet in the Other==> section includes the calculations used to develop the 100% NAIC RBC in the Capital Development Module and reproduces the values included in the 'Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions,' published in July 2023 by the SOA Research Institute, Ben Leiser, et al. Available at: https://www.soa.org/resources/research-reports/2023/regulatory-capital-adequacy-four-jurisdictions/

It is shown below:

NAIC RBC Factor Development					
NAIC RBC C1 - Asset Risk | Factor Development					
Asset	Class	Factor	Allocation		Contribution
Fixed Income	NAIC 1.G	0.0102	80.00%		0.0082
Mortgages	CM2	0.0175	15.00%		0.0026
Real Estate	*assumed*	0.1500	3.50%		0.0053
Equities	*assumed*	0.3000	1.50%		0.0045
		sum	100.00%	C1 Pre Tax - Asset Value	0.0205
				Reserve / Asset	1.00
CorporateTaxRate	21%			C1 Pre Tax - Reserve Value	0.0205
				$^{RBC}C1_{factor}$	**0.0162**

100% of NAIC RBC Calculation & Assumptions					
Sample Calculation					
Risk Category	Risk	Factors	Basis	Value	RBC Amount
C1	Asset	0.0232	Reserve	14,243,016	330,438
C2	Underwriting & Pricing	0.0012	NAaR	167,881,984	201,458
C3	Interest	0.0122	Reserve	14,243,016	173,765
C4	Business Risk	0.0243	Premium	1,609,546	39,112
				sum	744,773
RBC Formula | C4 + SQRT($(C1+C3)^2 + (C2^2)$)					
				Total RBC with Covariance	582,072

NAIC RBC C2 - Underwriting & Pricing Risk | Factor Development					
NAaR lower	NAaR higher	Factor	NAaR per category		weighted factor
0	500,000,000	0.00223	500,000,000		0.0000000
500,000,000	5,000,000,000	0.00146	4,500,000,000		0.0000000
5,000,000,000	25,000,000,000	0.00116	20,000,000,000		0.0000000
25,000,000,000	999,999,999,999,999	0.00087	999,974,999,999,999		0.0008700
	Net Amount at Risk	999,999,999,999,999	999,999,999,999,999	$C2\ Pre\ Tax^{Calculated}$	0.0008700
$C2\ Pre\ Tax^{Input}$	0.00087	RBC C2 uses	Input	$^{RBC}C2_{factor}$	**0.0006873**

NAIC RBC C3 - Interest Rate Risk | Factor Development			
Product Type	Factor	C3 Pre Tax	0.006300
Life - Low Risk	0.0063	tax	0.0013
		$^{RBC}C3_{factor}$	**0.0049770**

NAIC RBC C4 - Business Rate Risk | Factor Development			
Product Category	Factor	C4 Pre Tax	0.025300
Life & Annuity Premium	0.0253	tax	0.0053
		$^{RBC}C4_{factor}$	**0.0199870**

NAIC RBC Component After Tax Factors	
$^{RBC}C1_{factor}$	0.0162
$^{RBC}C2_{factor}$	0.00069
$^{RBC}C3_{factor}$	0.0050
$^{RBC}C4_{factor}$	0.0200

sources
1.) Regulatory Capital Adequacy for Life Insurance Companies A Comparison of Four Jurisdictions published July 2023 by the SOA Research Institute, Ben Leiser, et. al. https://www.soa.org/resources/research-reports/2023/regulatory-capital-adequacy-four-jurisdictions/

sample below from these resources reproduces calculations in Product Model

Risk Category	Risk	Factors	Basis	Value	RBC Amount
C1	Asset	0.0232	Reserve	14,243,016	330,438
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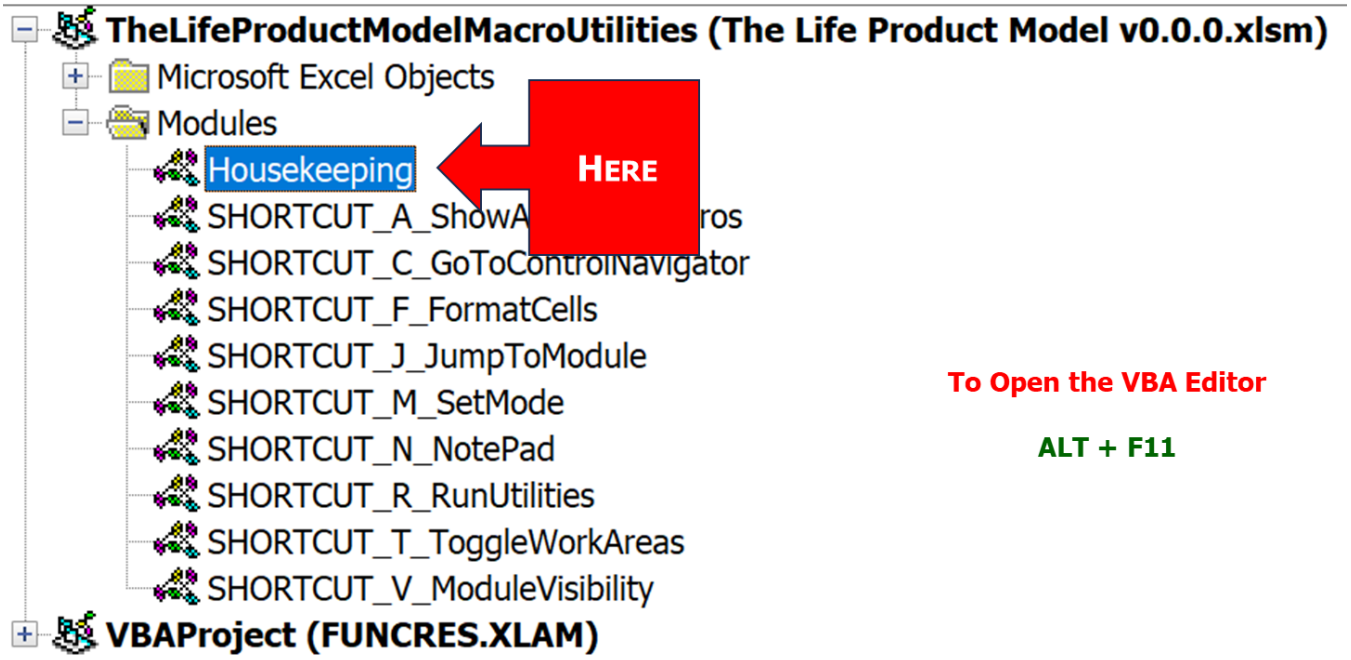
C4	Business Risk	0.0243	Premium	1,609,546	39,112
				sum	744,773
				Total RBC with Covariance	582,072

2.)The Simple Algebra of the Square Root Formula Behind RBC and Solvency II CIPR Newsletter, Volume 1, October, 2011, Tom Herzog

3.)ChatGPT-4, developed by OpenAI, as of April 2023

4.) Risk-Based Capital Forecasting & Instructions, Life and Fraternal NAIC, 2019

HOUSEKEEPING MODULE



The Housekeeping Module centralizes configurations and manages the Structural Elements, ensuring improved efficiency and streamlined operations, including:

CENTRALIZED CONFIGURATION AND IMPROVED EFFICIENCY

The Housekeeping Module centralizes settings like default colors, font sizes, and column widths, ensuring consistency across the Life Product Model. Consolidating these elements in one macro simplifies maintenance and avoids dispersion throughout the VBA code. Additionally, storing these settings internally prevents VBA procedures from needing to access the spreadsheet directly, reducing Excel's computational load.

INFRASTRUCTURE FOR STRUCTURAL ELEMENTS

The Housekeeping Module is essential for dynamically managing and configuring the Structural Elements, as outlined in their dedicated section. Creating named ranges and integrating them into specific lists within the Housekeeping Module guarantees seamless functionality and interaction with the VBA logic throughout the workbook.

Design Techniques

The functionality supporting the Life Product Model is discussed and organized by the design techniques used to create the environment.

Consistency: Ensures uniform formatting, design, and data validation throughout the workbook, enhancing accuracy, efficiency, and ease of use while reducing errors and simplifying auditing.

Navigation: Utilizes keyboard shortcuts, structured worksheet design, and the End Vector Framing technique to facilitate quick and efficient movement within the workbook.

Custom Views: Provides tailored views to streamline data access and minimize navigation through non-essential information, enhancing user efficiency and data clarity.

Educational Clarity and Intelligibility: The tool prioritizes clear labeling, organized formulas, and consistent formatting to make it self-documenting and easy to understand.

Structural Elements: Employs a dynamic system of named ranges and VBA integration to manage workbook structure, enhancing organization, navigation, and presentation capabilities.

Named Ranges: Uses descriptive names to enhance formula clarity and transparency, avoiding abbreviations for easier interpretation and understanding of the workbook.

VBA Environment: Leverages VBA Macros and automation, developed with assistance from ChatGPT, to enhance functionality, maintain consistency, and improve overall productivity and user experience.

CONSISTENCY

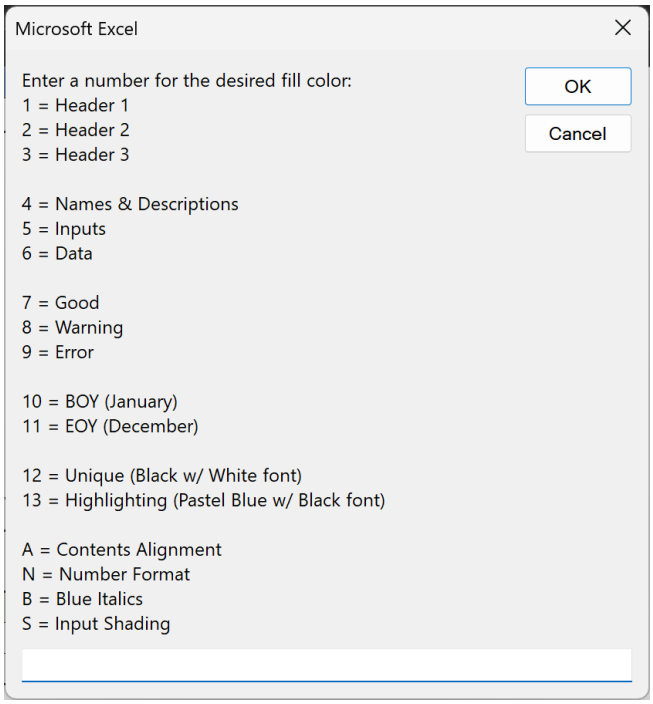
The tool was designed with a strong emphasis on consistency across all elements to enhance its quality, accuracy, efficiency, and intelligibility. I regard overall *consistency* as one of the most important best practices for reducing errors, simplifying auditing, and facilitating understanding. It ensures smoother transitions and handoffs between individuals or over extended periods of time. Consistency not only enhances intelligibility but also promotes scalability and maintainability. Additionally, facilitates efficient documentation and review processes.

The techniques employed to support consistency include:

FORMATTING STANDARDS | CTRL + SHIFT + F

The development of the Formatting Standards used within the Life Product Model, and the keyboard shortcut to quickly apply these Formatting Standards was one of the more significant benefits of developing the tool. As discussed in the Macro and VBA Environment section, outsourcing VBA code development to ChatGPT was a phenomenal decision. It resulted in several tools that have become ingrained in my Excel work.

CTRL + SHIFT + F brings up the following menu:



Which applies one of the following standards:

Formatting Standards | CTRL + SHIFT + F						
ID	cell function	font color	color name	Fill Color R	Fill Color G	Fill Color B
1	Header 1	white	Medium-Dark Blue	54	95	145
2	Header 2	black	Cornflower Blue	100	149	237
3	Header 3	black	Light/Neutral Grey	217	217	217
5	Names & Descriptions	black	Pastel Green	198	224	180
6	Inputs	black	Gold	255	192	0
7	Data	black	White	255	255	255
7	good	black	Green	0	255	0
8	warning	black	Yellow	255	255	0
9	error	white	Red	255	0	0
10	BOY (January)	white	Dark Green	55	86	35
11	EOY (December)	white	Dark Red-Brown	131	60	12
12	Unique	white	Black	0	0	0
13	Highlighting	black	Pastel Blue	192	230	245
		description				
A	Contents Alignment	Center in Cell or Across Cells				
N	Number Format	Decimal = "#,##0.00;[Red]#,##0.00" | Percentage = "0.00%;[Red]-0.00%"				
B	*Blue Italics*	*data sourced from original column and rightward dependencies*				
S	Input Shading	input value currently set to a formula or used by a macro				

Headings 1, 2, and 3 denote hierarchy, with Heading 3 also used for standardized column headers like 'age,' 'years,' 'months,' and 'time.'

Gold denotes Inputs and is the tab color for worksheets that contain inputs. Input Shading indicates an input cell set with a formula or used as part of Macro logic.

The beginning-of-year (BOY, January) and end-of-year (EOY, December) formats are applied via conditional formatting in the Calculations Area of the Model worksheet.

Unique formatting emphasizes a formula different than anticipated or highlights unique model features such as Work Areas.

Blue Italics formatting indicates that data is sourced as an array from another location or shows a rightward dependency in the Model Area. As highlighted in the Array Retrieval and Blue Italics Format discussion, it enhances calculation clarity and maintains data integrity.

Structural Elements | Consistency

Structural Elements, as discussed in their dedicated section, enhance organization, navigation, and presentation capabilities. They form a foundation that ensures consistency and flexibility, facilitating the easy extension of functionalities and scalability.

General Techniques

Other techniques that enhance the consistency of the workbook:

- Consistent worksheet, work area, component, calculation, etc. design.
- Extensive VBA environment and Macro support to provide for consistent operation and use.
- Use of validation lists to control data input and define data structures.
- The formulas retrieve input data in the order of the calculation.
- Use of absolute and relative cell references consistently to avoid errors when copying formulas.

NAVIGATION

The **Life Product Model** was designed to enhance navigation and speed of use through various techniques, focusing on keyboard operation. The following outlines the techniques used in support of this objective.

END VECTOR FRAMING | NAVIGATION

The End Vector Framing technique establishes a physical and visual boundary around the working areas on each sheet. This enhances navigation by facilitating quick movements within these areas using End key shortcuts, like **End + Up**, **End + Down**, **End + Left**, and **End + Right**.

SHORTCUTS

To enhance the speed of their execution, all Macros are accessible via keyboard shortcuts. These macros and their corresponding shortcuts can be seen in the Macro Utilities and VBA Environment section of the Control worksheet:

General		
Macro Name	CTRL + SHIFT +	VBA Module
ShowAvailableMacros()	A	SHORTCUT_A_ShowAvailableMacros

Workbook Navigation and Viewing		
Macro Name	CTRL + SHIFT +	VBA Module
GoToControlNavigator()	C	SHORTCUT_C_GoToControlNavigator
JumpToModule()	J	SHORTCUT_J_JumpToModule
VisibilityModuleToggle()	V	SHORTCUT_V_ModuleVisibility
ToggleWorkAreas()	T	SHORTCUT_T_ToggleWorkAreas

Editing and Input		
Macro Name	CTRL + SHIFT +	VBA Module
SetMode()	M	SHORTCUT_M_SetMode
FormatCells()	F	SHORTCUT_F_FormatCells

Utilities and Management		
Macro Name	CTRL + SHIFT +	VBA Module
RunUtilities()	R	SHORTCUT_R_RunUtilities
CopyProfitOutputRow()	P	SHORTCUT_R_RunUtilities

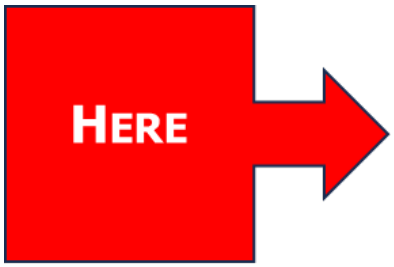
Personal Productivity		
Macro Name	CTRL + SHIFT +	VBA Module
NotePad()	N	SHORTCUT_N_NotePad

WORKBOOK NAVIGATOR

You can quickly navigate to the Control worksheet using the CTRL + SHIFT + C shortcut, which takes you to the Workbook Navigator, as shown below.

You can navigate quickly to any functionality Module or worksheet from the Workbook Navigator.

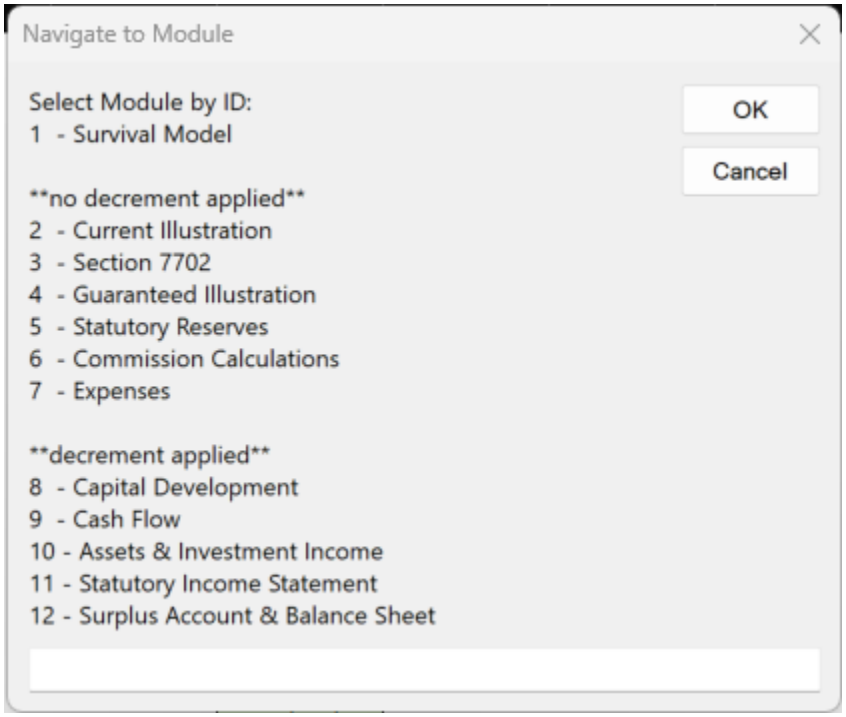
The functionality Modules, which are sequentially built upon each other, generate the Output of the Projection Model.



Projection Model Functionality Modules & Worksheet Structure		
Workbook Navigator	ID	Functionality Module or Worksheet Name
Model		
	1	Survival Model
	2	Current Illustration
	3	Section 7702
	4	Guaranteed Illustration
	5	Statutory Reserves
	6	Commission Calculations
	7	Expenses
	8	Capital Development
	9	Assets & Investment Income
	10	Statutory Income Statement
	11	Surplus Account & Balance Sheet
Output==>>		
	a	Profit Summary
	b	Illustrations
	c	Proforma
	d	Premium Pie
Input Sheets==>>		
	a	Vector Data
	b	Load Designs
	c	Commission Scales
Other==>>		
	a	Target Capital
Hidden==>>		
	a	User Agreement

JUMP TO MODULE

You can quickly jump to any functionality Module with CTRL + SHIFT + J.



CUSTOM VIEWS | NAVIGATION

As outlined in the Custom Views discussion, multiple custom views exist, each discussed in its specific context. These views provide quick access to relevant data and minimize navigation through non-essential information.

GENERAL TECHNIQUES

Other techniques that enhance navigation include:

- The workbook structure and worksheet design are arranged to optimize navigation and efficiency.
- Calculations, modules, and data are organized logically and clearly labeled.
- Links are used throughout the workbook to facilitate navigation to other sheets or external websites, as seen in the discussion of the Projection Model Functionality Modules & Worksheet Structure.
- The workbook employs visual guides through consistent Formatting Standards, which, among other benefits, facilitate easy distinction between input fields and labels.
- The G option on the Run Utility interface, run by pressing CTRL + SHIFT + R, turns the gridlines off, allowing for easy identification of worksheet components.

EDUCATIONAL CLARITY AND INTELLIGIBILITY

In developing the **Life Product Model**, an objective has been to prioritize educational clarity and intelligibility, striving for the tool to be as 'self-documenting' as possible. Techniques used to accomplish this include:

- Utilizing descriptive Named Ranges and clear labeling throughout.
- Consistent Formatting Standards indicating cell purposes.
- Organizing complex formulas in a structured manner and dividing calculations into manageable components, such as designing the functionality Modules and developing calculations within each Module, as outlined in the Calculations discussion.
- Ensuring each functionality Module accesses input values only within its own Module, making formulas easy to follow and inputs conveniently located near the calculations. This technique is facilitated by the Array Retrieval and Blue Italics Format Structural Element.
- Ensuring all cross-sheet references use Named Ranges, which enhances formula clarity and transparency. This practice avoids direct cell references like ='Commission Scales'!E5, making the calculations easier to understand.
- Writing headers to be fully instructive, regardless of their length, and avoiding abbreviations.
- Maintaining a policy where formulas are constrained to one layer of depth wherever possible, with each formula divided into smaller calculation units to enhance clarity. A notable exception is the implementation of Two-Dimensional XLOOKUPs, discussed in detail.
- Incorporating features such as shrink-to-fit formatting in cells ensures headers fit their content. Columns can be easily expanded to view entire headers by double-clicking on the right boundary of the column header. Additionally, the **CW** option on the **Run** Utilities menu, accessible by pressing **CTRL + SHIFT + R**, facilitates quick resetting of **column widths**.
- Overall design consistency contributes to making the tool easier to understand.
- A user manual and Quick Start Guide.

CUSTOM VIEWS

The Life Product Model includes custom views to streamline use by providing quick access to relevant data and minimizing navigation through non-essential information. These views enhance efficiency and effectiveness, ensuring data is presented clearly and specifically for purpose. The custom views help minimize data entry and interpretation errors by reducing on-screen clutter and maintaining consistency.

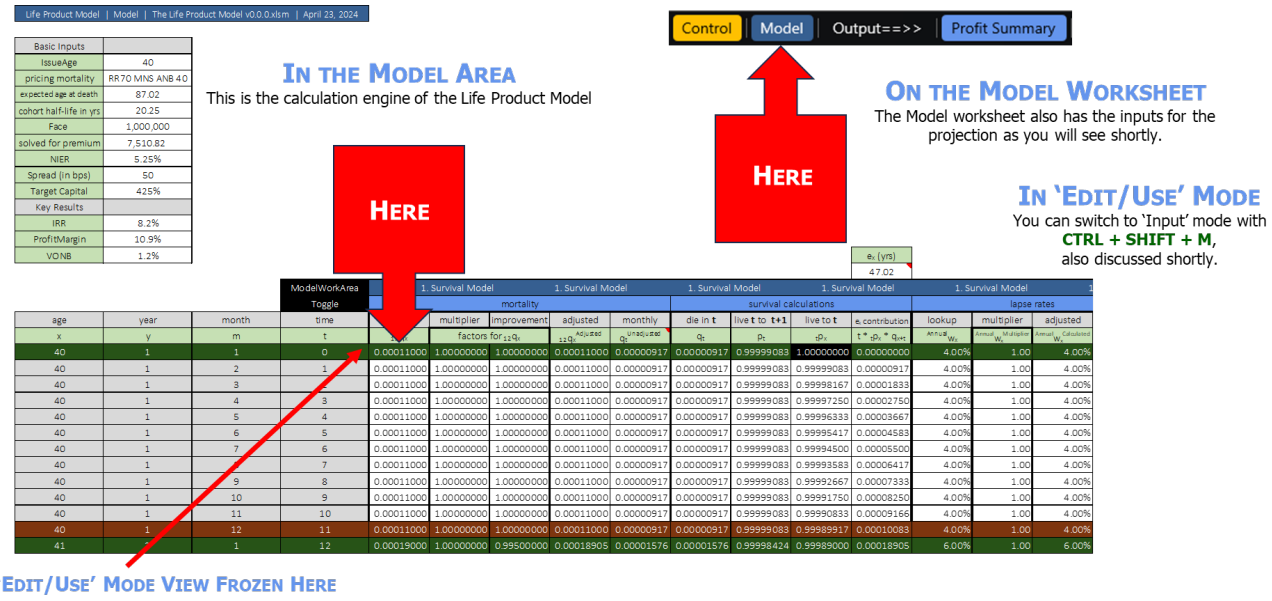
These views include:

'EDIT/USE' OR 'INPUT' MODE

The workbook features two viewing modes:

- Edit/Use Mode: Intended for reviewing, modifying, or extending the underlying calculations in the Model Area.
- Input Mode: Designed for entering Projection Model assumptions.

When you open the workbook, you will be directed to the Model Area on the Model worksheet in 'Edit' mode, as shown below.

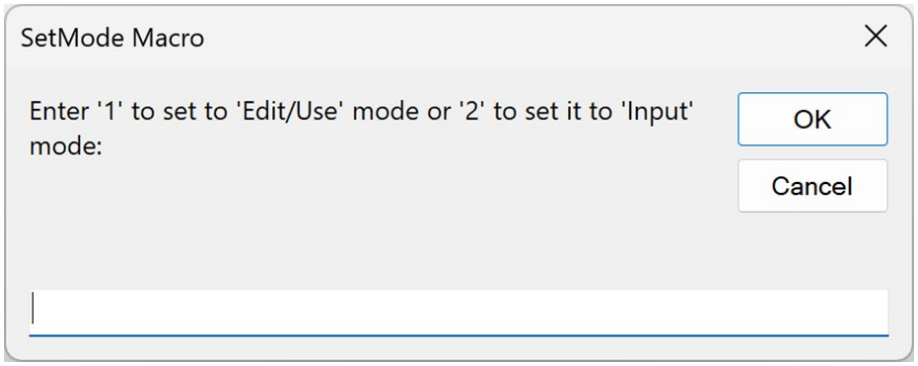


Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,510.82
NIER	5.25%
Spread (in bps)	50
Target Capital	425%
Key Results	
IRR	8.2%
ProfitMargin	10.9%
VONB	1.2%

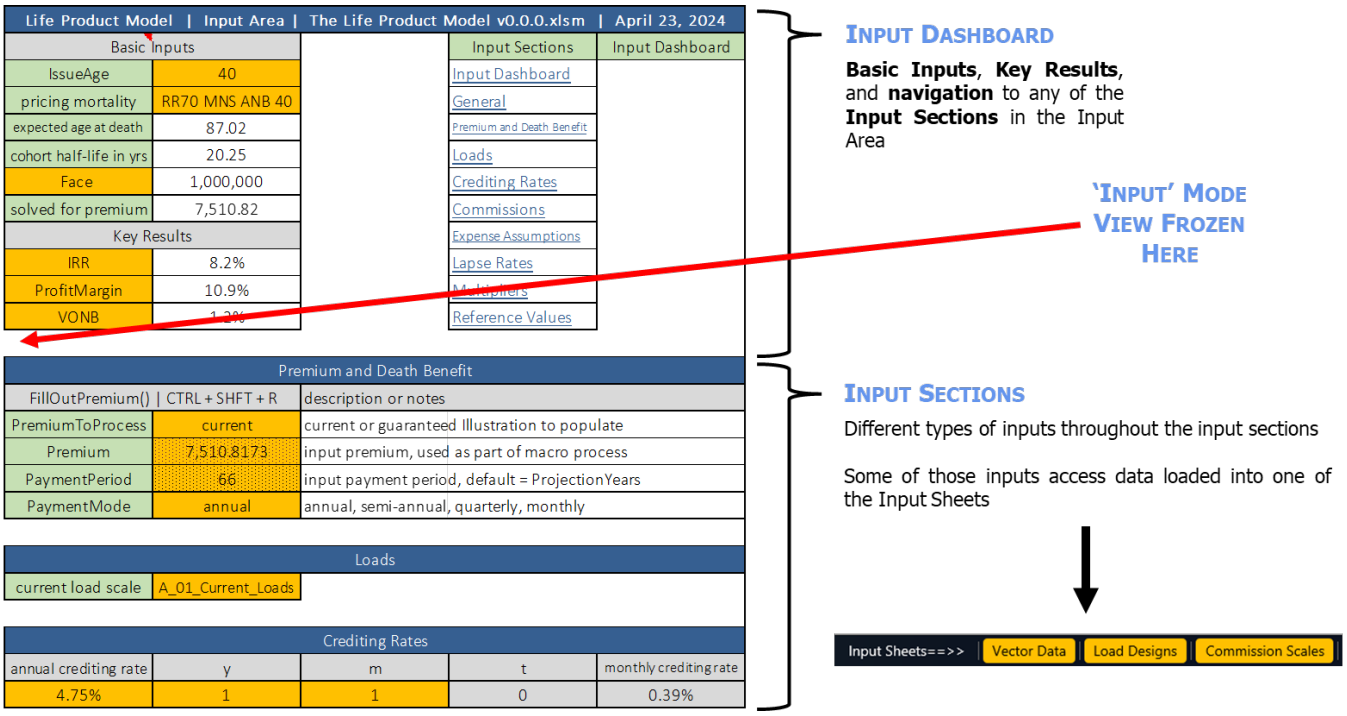
e_x (yrs) 47.02

ModelWorkArea Toggle				1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1. Survival Model	1
				mortality						survival calculations				lapse rates		
age	year	month	time		multiplier	improvement	adjusted	monthly	die in t	live t to t+1	live to t	e_x contribution	lookup	multiplier	adjusted	
x	y	m	t		factors for ${}_{12}q_x$		${}_{12}q_x^{Adjusted}$	$q_x^{Unadjusted}$	q_x	p_x	${}_tp_x$	$t * {}_tp_x * q_{x+t}$	Annual W_0	Annual W_t Multiplier	Annual W_t Calculated	
40	1	1	0	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	1.00000000	0.00000000	4.00%	1.00	4.00%	
40	1	2	1	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99999083	0.00000917	4.00%	1.00	4.00%	
40	1	3	2	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99998167	0.00001833	4.00%	1.00	4.00%	
40	1	4	3	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99997250	0.00002750	4.00%	1.00	4.00%	
40	1	5	4	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99996333	0.00003667	4.00%	1.00	4.00%	
40	1	6	5	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99995417	0.00004583	4.00%	1.00	4.00%	
40	1	7	6	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99994500	0.00005500	4.00%	1.00	4.00%	
40	1	8	7	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99993583	0.00006417	4.00%	1.00	4.00%	
40	1	9	8	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99992667	0.00007333	4.00%	1.00	4.00%	
40	1	10	9	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99991750	0.00008250	4.00%	1.00	4.00%	
40	1	11	10	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99990833	0.00009166	4.00%	1.00	4.00%	
40	1	12	11	0.00011000	1.00000000	1.00000000	0.00011000	0.00000917	0.00000917	0.99999083	0.99989917	0.00010083	4.00%	1.00	4.00%	
41	1	1	12	0.00019000	1.00000000	0.99500000	0.00018905	0.00001576	0.00001576	0.99998424	0.99989000	0.00018905	6.00%	1.00	6.00%	

The Set Mode Macro, CTRL + SHIFT + M, toggles between the 'Input' and 'Edit/Use' modes and freezes the panes.



Enter '2' displays the Input Area, as seen below.



PROFIT SUMMARY WORKSHEET | CUSTOM VIEWS

As outlined in the Profit Summary Worksheet discussion, given its heavy utilization, it has been and will continue to be enhanced.

Frozen Panes

The Illustration, Proforma, Load Designs, and Commission Data worksheets all have default views that are set upon opening the workbook or running the RA option on the Run Utilities interface, using CTRL + SHIFT + R.

As discussed further in the Freeze Pane Reset Structural Element section.

Dual Windows

The 'Input' view functions effectively as a secondary window alongside the primary window or screen, such as the 'Edit/Use' view or Profit Summary worksheet.

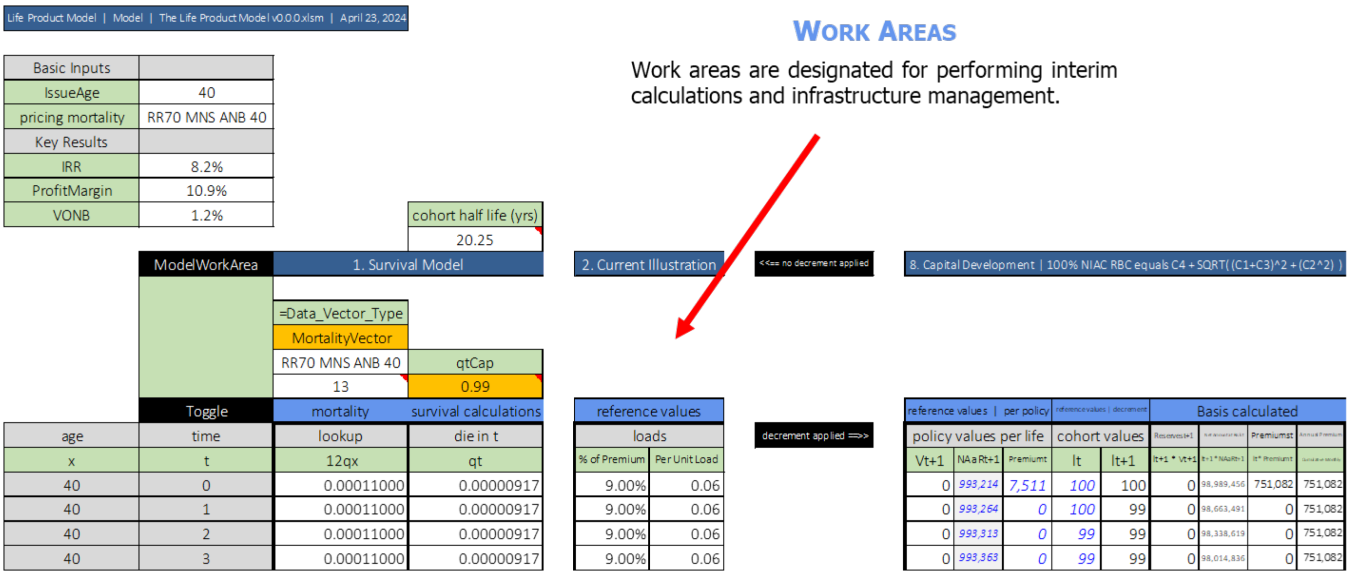
Structural Elements

The Life Product Model utilizes a dynamic system to manage various Structural Elements, enhancing the model's organization, navigation, and presentation capabilities. These elements form a foundation that ensures consistency and flexibility, facilitating the easy extension of the functionalities.

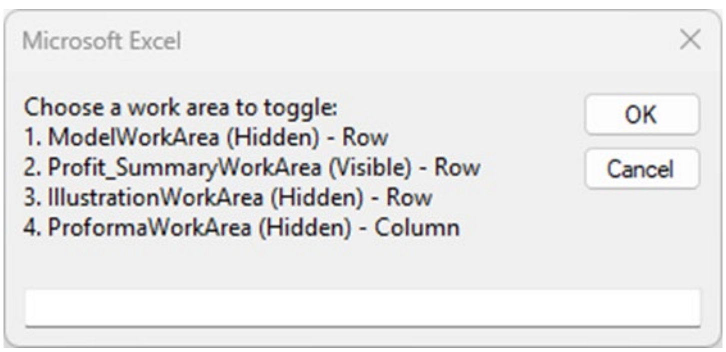
The Structural Elements: Work Areas, Column Width Vectors, End Vector Framing Technique, and Freeze Pane Reset require the creation of Named Ranges within the workbook. These ranges are then integrated into the Housekeeping VBA Module. This systematic approach enables the quick incorporation of these elements into the workbook, facilitating their integration into the VBA environment.

Work Areas

Work areas are designated for performing interim calculations and managing infrastructure and can easily be displayed or hidden, as seen below.



They can be easily **toggled** between visible vs. hidden using **CTRL+SHFT+T**:



TO ADD A WORK AREA

- Define the Named Range to hide the rows or columns comprising the Work Area.
- Enter the Named Range into the Housekeeping configuration:

```
Sub SET_WORK_AREA_LIST()

    WORK_AREA_LIST = Array(     "ModelWorkArea",
                                "Profit_SummaryWorkArea",
                                "IllustrationWorkArea",
                                "ProformaWorkArea")

    WORK_AREA_LIST_ORIENTATION = Array("Row", "Row", "Row", "Column")

End Sub
```

COLUM WIDTH VECTORS

Column Width Vectors are located at the bottom of the working areas in worksheets.

They allow for the quick resetting of column widths to default settings, with the value of each cell in the vector specifying the size to which the column width will reset. Example below:

Life Product Model | Control | The Life Product Model v0.0.0.xlsm | May 7, 2024

Life Product Model Workbook Information

Developer & Contact Information	
name	Rod Rishel
phone or text	615.806.9631
email	rod@rodrishel.com
phone or text	615.806.9631
website	www.rodrishel.com

Life Product Model File Name and Version	
FileName / Version	The Life Product Model v0.0.0.xlsm

Life Product Model Enviroment Information
AutoSave is turned OFF
Calculation Method is set to Manual (F9)

Workbook Settings	
Workbook Zoom Default	75
User Agreement on OR off at open	off
directory to store running archive	

Current Version						
ID	Version	date	IRR	Profit Margin	VONB	note
1	The Life Product Model v0.0.0.xlsm	05/07/2024	8.20%	10.86%	1.18%	

Archived Versions						
ID	Version	date	IRR	ProfitMargin	VONB	note

COLUMN WIDTH VECTORS

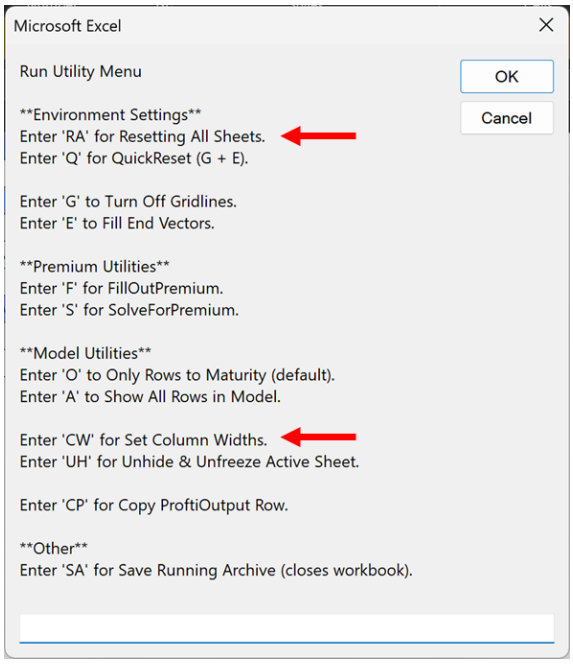
Column Width Vectors are located at the bottom of the working areas in worksheets.

They allow for the quick resetting of column widths to default settings, with the value of each cell in the vector specifying the size to which the column width will reset.

These vectors can easily be added to any worksheet.

end	*end*	*end*	*end*	*end*	*end*	*end*	*end*	*end*	*end*	*end*
30	30	3	5	30	10	10	10	10	10	3

Column Width Vectors are reset on the Run Utility Menu, CTRL + SHIFT + R:



TO ADD A COLUMN WIDTH VECTOR

- Define a horizontal Named Range that specifies the default size for each column's width in the range.
- Apply the input formatting.
- Enter the named range into the Housekeeping configuration:

```
Sub SET_COLUMN_WIDTH_VECTOR_LIST()

    COLUMN_WIDTH_VECTOR_LIST = Array( _
        "ColumnWidth_Vector_Control", _
        "ColumnWidth_Vector_Internal_Control", _
        "ColumnWidth_Vector_Model", _
        "ColumnWidth_Vector_Profit_Summary", _
        "ColumnWidth_Vector_Illustrations", _
        "ColumnWidth_Vector_Proforma", _
        "ColumnWidth_Vector_Premium_Pie", _
        "ColumnWidth_Vector_Vector_Data", _
        "ColumnWidth_Vector_Load_Designs", _
        "ColumnWidth_Vector_Commission_Scales", _
        "ColumnWidth_Vector_Target_Capital", _
        "ColumnWidth_Vector_User_Agreement")

    End Sub
```

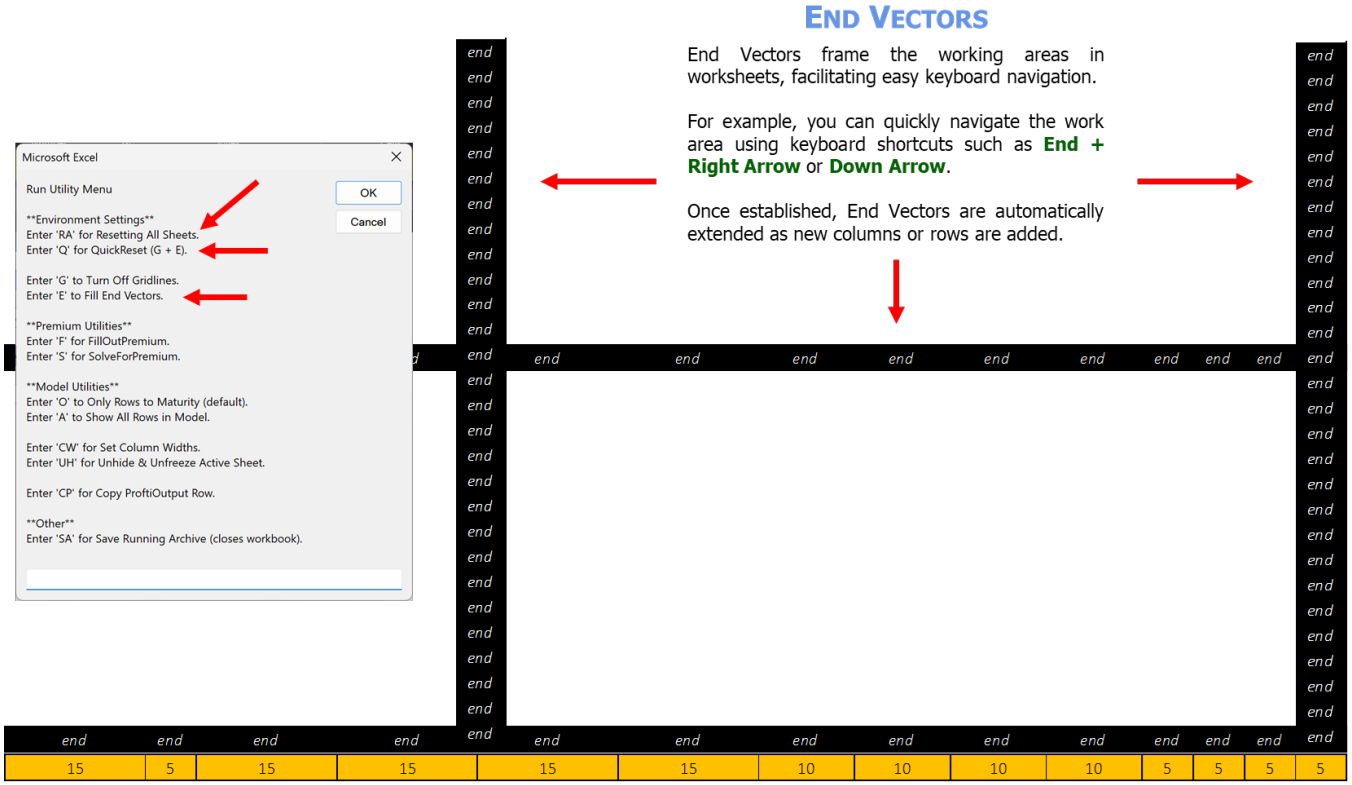
End Vector Framing

The End Vector Framing technique establishes a physical and visual boundary around the working areas on each sheet. As seen below it separates the Model worksheet into four quadrants. This method improves spreadsheet navigation and organization by:

- Utilizing End key shortcuts, like End + arrow keys (End + Up, End + Down, End + Left, End + Right) to speed movement within the working areas.
- Visually organizes sections to allow for identification and separation.

The technique fills each End Vector with the word "end" in designated cell ranges, coupled with a unique black background and white text.

To fill the End Vectors, you can use any of the utilities highlighted in the example below on the Run Utility Menu.



TO ADD AN END VECTOR

- Define the horizontal or vertical Named Range to establish the End Vector(s) that will form the frame.
- Enter the Named Range into the Housekeeping configuration:

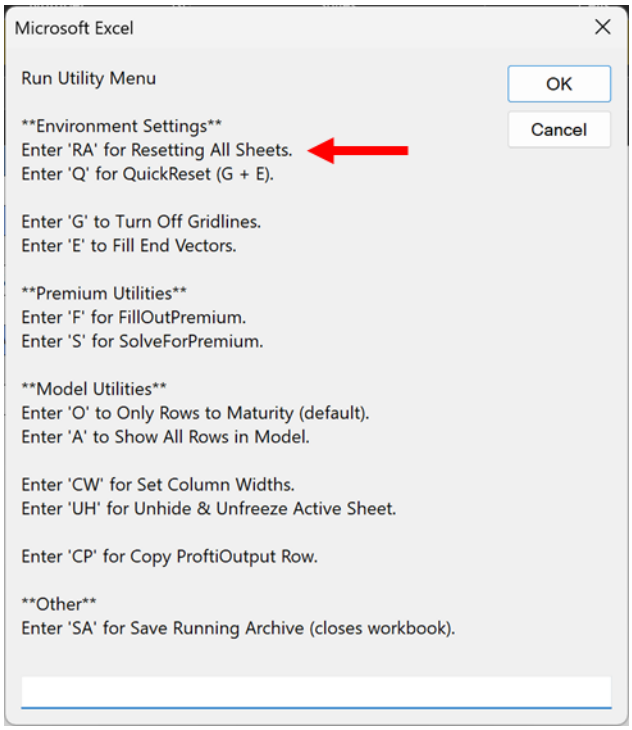
```
Sub SET_END_VECTORS_LIST()

    END_VECTORS = Array( _
"END_VECTOR_Control_Bottom", "END_VECTOR_Control_Right", _
"END_VECTOR_Internal_Control_Bottom", "END_VECTOR_Internal_Control_Right", _
"END_Vector_Model_Horizontal_Middle","END_VECTOR_Model_Vertical_Middle",
"END_VECTOR_Model_Bottom", "END_VECTOR_Model_Right", _
"END_VECTOR_Profit_Summary_Bottom", "END_VECTOR_Profit_Summary_Right", _
"END_VECTOR_Illustrations_Bottom", "END_VECTOR_Illustrations_Right", _
"END_VECTOR_Proforma_Bottom", "END_VECTOR_Proforma_Right", _
"END_VECTOR_Premium_Pie_Bottom", "END_VECTOR_Premium_Pie_Right", _
"END_VECTOR_Vector_Data_Bottom", "END_VECTOR_Vector_Data_Right", _
"END_VECTOR_Load_Designs_Bottom", "END_VECTOR_Load_Designs_Right", _
"END_VECTOR_Commission_Scales_Bottom", "END_VECTOR_Commission_Data_Right",
"END_VECTOR_Target_Capital_Bottom", "END_VECTOR_Target_Capital_Right", _
"END_VECTOR_User_Agreement_Bottom", "END_VECTOR_User_Agreement_Right")

End Sub
```

Freeze Pane Reset

This functionality dynamically freezes panes based on the list of Named Ranges found in the Housekeeping Module. It sets the default frozen pane view to one cell down and one cell to the right of these specified cells:

- IllustrationFreezeCell
- ProformaFreezeCell
- LoadDesignsFreezeCell
- CommissionDataFreezeCell

These default views can be reset on the Run Utility Menu, CTRL + SHIFT + R:



The Set Mode Macro, CTRL + SHIFT + S, toggles between the 'Input' and 'Edit/Use' modes and directly sets the frozen pane views.

TO ADD A FROZEN PANE VIEW

- Name the cell that defines the Frozen Pane view. The frozen pane will be set one cell to the right and one cell down (Offset(1,1)).
- Enter the named range into the Housekeeping configuration:

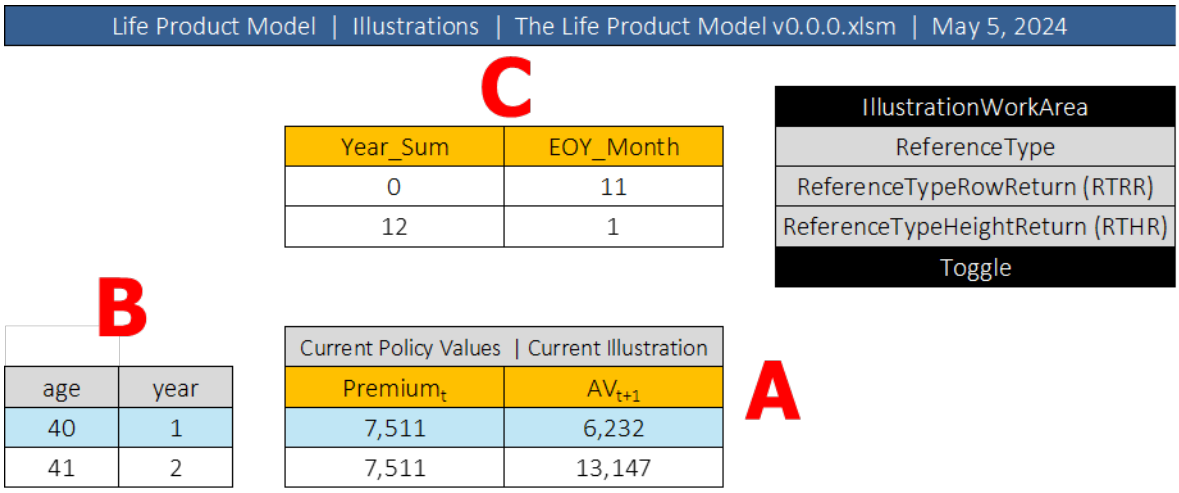
```
Sub SET_FREEZE_PANE_RANGE_LIST()

    FREEZE_PANE_RANGE_LIST = Array(

        "VectorDataFreezeCell",
        "IllustrationFreezeCell",
        "ProformaFreezeCell",
        "LoadDesignsFreezeCell",
        "CommissionDataFreezeCell")

End Sub
```

Dynamic Aggregation

Dynamic Aggregation was developed to present the annual representation of monthly values from the Calculations Area. This functionality exists in the Illustrations and Proforma worksheets, with the primary difference being the orientation. The data is presented vertically in the Illustrations worksheet, while in the Proforma worksheet, it is displayed horizontally.

Dynamic aggregation streamlines the process of transforming monthly data from the Calculations Area into an annual summary, enabling efficient copying and customization of data presented.

See the example from the Illustration worksheet below.



Reference A

The headers in the Illustrations worksheet are the inputs that indicate which column in the Calculations Area you want to retrieve values from.

Reference B

The values are aggregated annually as they extend vertically.

Reference C

The Reference Type indicates whether to sum or retrieve a specific value during the year. The Reference Type Row Return and Reference Type Height Return are set to default values for summing the year's data or returning the final value at year's end. These can be adjusted as needed.

VECTOR DATA RETRIEVAL

The Vector Data retrieval process simplifies the addition of a column in the Calculations Area that retrieves COIs and mortality tables, which are loaded as vector data on the Vector Data worksheet. After copying and inserting the new column, the Data Vector Type specifying the vector to be retrieved is added to the Model Work Area, as illustrated in the example below from the Survival Model functionality Module.

ModelWorkArea	1. Survival Model
	Vector Data Retrieval Reference Values
	=Data_Vector_Type
	MortalityVector
	MortalityVector COIVector GuarCOIVector StatqxVector S7702COIVector
Toggle	mortality
time	lookup
t	12qx
0	=XLOOKUP(P$276,VectorIdentifier,XLOOKUP(INDIRECT(ADDRESS(ROW(),P$279)),INDIRECT(P$278),VectorTable),,0)
1	0.00011000

A

REFERENCE A

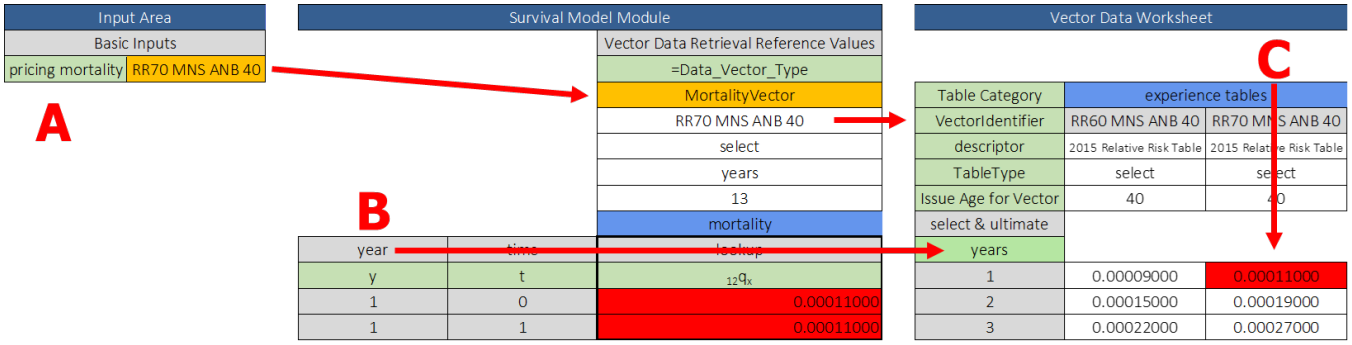
For the Survival Model, the Data Vector Type specifies the Named Range that contains the Vector Identifier. That identifier indicates what Vector to retrieve from the Vector Data worksheet.

To add a new Vector Data Type, include it in the validation list on the Control worksheet and add it as an input in the Input Area.

The formula returns a value from a Two-Dimension XLOOKUP, which is further discussed in its dedicated section where this example continues.

TWO-DIMENSION XLOOKUP

Two-dimensional XLOOKUPs are commonly used in the Life Product Model, as demonstrated by the Vector Data Retrieval example. This example is further expanded upon below.



REFERENCE A

Reference A follows the first XLOOKUP or dimension, which is a horizontal lookup within the Vector Identifier array.

REFERENCE B

Reference B follows the second XLOOKUP or dimension, which is a vertical lookup within the Year's array.

REFERENCE C

Reference C represents the formula's return value, which is the intersection of the two dimensions in the Vector Table's two-dimensional array.

Array Retrieval and Blue Italics Format

Array Retrieval displays input data near its corresponding formula, enhancing the calculation's intelligibility. Using an array reference from the original source data upholds the best practice of a single source of truth, thereby reducing errors and inconsistencies.

The *Blue Italics* format indicates that data in a row or column is sourced as an array from another location or to signify a rightward dependency in the Model Area. This formatting helps identify situations where data is either pulled from an external source or depends on data to the right.

	2. Current Illustration				3. Section 7702			
	reference values				reference values | loads			
time	loads				A loads			
t	% of Premium	Per Unit Load	AV Load in bps	Monthly Fee	% of Premium	Per Unit Load	Policy Fee	$Face_t$
0	9.00%	0.06	6.00	1,000,000.00	*=E22:E1473*	*0.06*	*6.00*	*1,000,000*
1	9.00%	0.06	6.00	1,000,000.00	*9.00%*	*0.06*	*6.00*	*1,000,000*
2	9.00%	0.06	6.00	1,000,000.00	*9.00%*	*0.06*	*6.00*	*1,000,000*
3	9.00%	0.06	6.00	1,000,000.00	*9.00%*	*0.06*	*6.00*	*1,000,000*
4	9.00%	0.06	6.00	1,000,000.00	*9.00%*	*0.06*	*6.00*	*1,000,000*
5	9.00%	0.06	6.00	1,000,000.00	*9.00%*	*0.06*	*6.00*	*1,000,000*

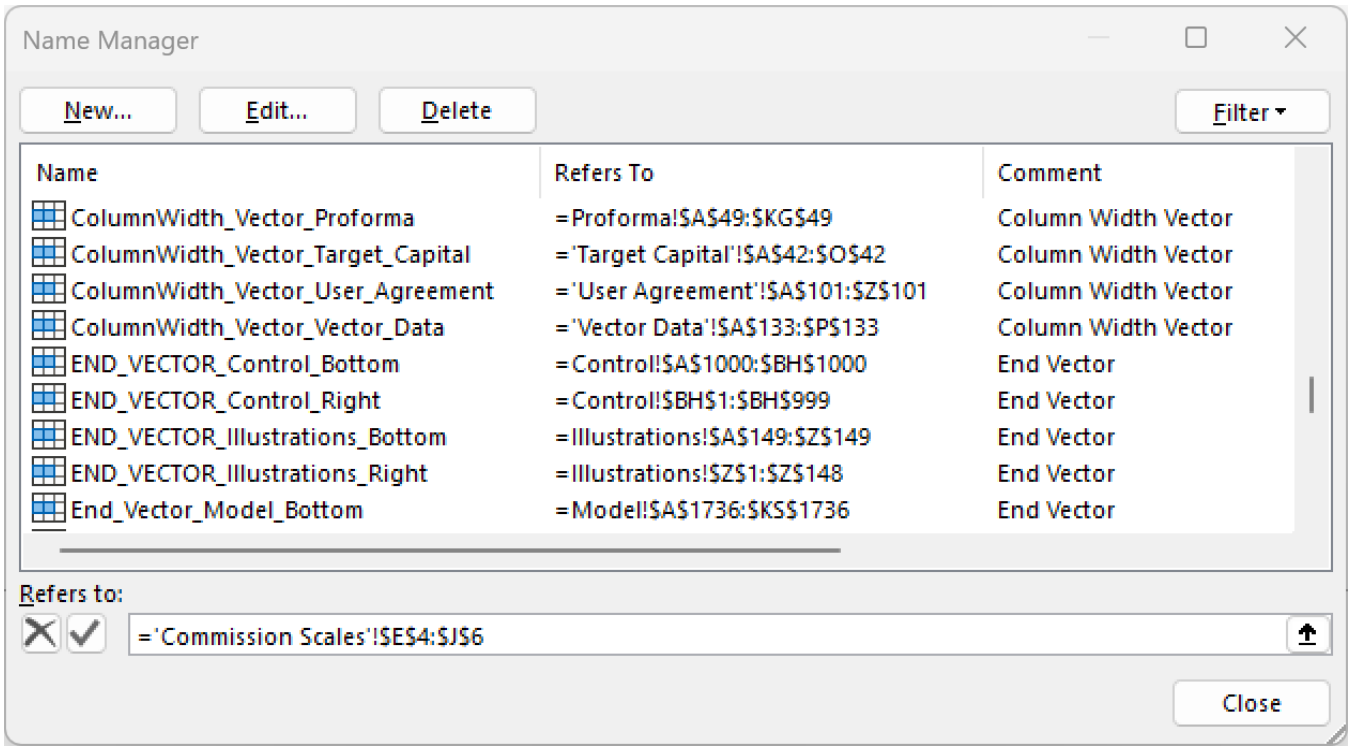
Reference A

Reference A demonstrates the reference values being populated from the original column labeled '% Premium.'

NAMED RANGES

The overarching objective of the Named Ranges in the Life Product Model is to be descriptive. I consciously decided to avoid abbreviations in named ranges, opting instead for as descriptive a name as possible. Although this choice results in longer formulas, the clarity these descriptive names provide significantly enhances the ease of interpreting a formula.

I have recently started using the sortable 'Comment' column in the Name Manager to organize named ranges, as seen below. Early results have been encouraging, particularly in developing the Column Width and End Vector logic. Comment values have been populated in about 10% of the named ranges, which will be expanded over time.



VBA Environment

The VBA Environment in Life Product Model has demonstrated another significant productivity gain I have experienced that is directly attributable to Large Language Models.

This occurred after I asked ChatGPT to 'write a VBA macro in Excel that will...'.

While I consider myself a reasonably accomplished Excel VBA programmer, I quickly realized that I may never write another VBA Macro again. The code I asked it to write was far better than I could have written, providing so much more functionality than I could have accomplished with a level of documentation I would have had difficulty maintaining.

Of course, this was more code-assist than full outsourcing. While it generated about 95% of the code, I needed to massage it in certain areas, collaborate with ChatGPT on debugging, and help solve a few abstract problems. Once we understood our roles, we created a dynamic interface for the tool.

The Macro functionalities developed are discussed throughout this manual in the relevant sections but summarized below.

MACROS

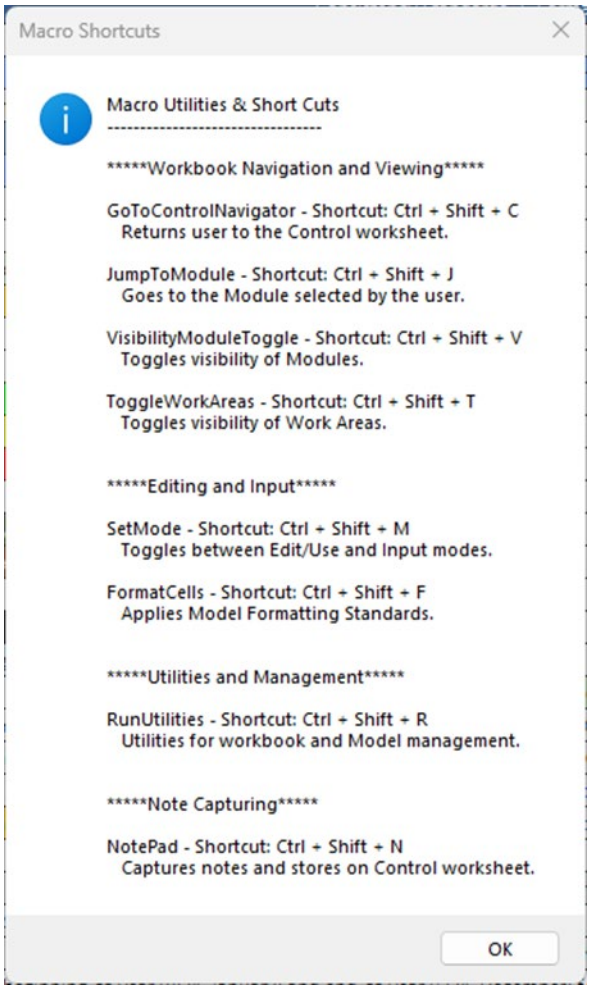
All Macro utilities and their corresponding keyboard shortcuts are detailed in the Control worksheet, as seen below.

Life Product Model Control Worksheet | Macro Utilities & VBA Environment			
General			
Macro Name	CTRL + SHIFT +	VBA Module	Description
ShowAvailableMacros()	A	SHORTCUT_A_ShowAvailableMacros	Displays all Macros and their respective keyboard shortcuts
Workbook Navigation and Viewing			
Macro Name	CTRL + SHIFT +	VBA Module	Description
GoToControlNavigator()	C	SHORTCUT_C_GoToControlNavigator	Returns user to the Control worksheet
JumpToModule()	J	SHORTCUT_J_JumpToModule	Goes to the Module selected by the user
VisibilityModuleToggle()	V	SHORTCUT_V_ModuleVisibility	Toggles visibility of Modules
ToggleWorkAreas()	T	SHORTCUT_T_ToggleWorkAreas	Toggles visibility of Work Areas
Editing and Input			
Macro Name	CTRL + SHIFT +	VBA Module	Description
SetMode()	M	SHORTCUT_M_SetMode	Toggles between Edit/Use and Input modes
FormatCells()	F	SHORTCUT_F_FormatCells	Applies Formatting Standards
Utilities and Management			
Macro Name	CTRL + SHIFT +	VBA Module	Description
RunUtilities()	R	SHORTCUT_R_RunUtilities	Utilities for workbook and Projection Model efficiency
CopyProfitOutputRow()	P	SHORTCUT_R_RunUtilities	Copies Profit Output Row for paste
Personal Productivity			
Macro Name	CTRL + SHIFT +	VBA Module	Description
NotePad()	N	SHORTCUT_N_NotePad	Captures notes and stores on Control worksheet

MACRO INTERFACE

All Macros are designed to be accessible via keyboard shortcuts through a series of user menu interfaces and directly executable Macros.

The Show Available Macros interface, CTRL + SHIFT + A, displays all user menu interfaces, directly executable macros, and their corresponding keyboard shortcuts. It is illustrated below, followed by a discussion of the utilities available on each interface or where they are discussed in the Manual.



GOTOCONTROLNAVIGATOR(): CTRL + SHIFT + C

Returns the user to the Control worksheet.

It is discussed in the Projection Model Functionality Modules & Worksheet Structure section.

JUMPTOMODULE(): CTRL + SHIFT + J

Goes to the Module selected by the user.

It is discussed in the Model Area section.

VISIBILITYMODULETOGGLE(): CTRL + SHIFT + T

Toggles visibility of Modules

It is discussed in the Work Areas section.

SETMODE(): CTRL + SHIFT + M

Toggles between Edit/Use and Input modes

It is discussed in the 'Edit/Use' or 'Input' Mode section.

FORMATCELLS(): CTRL + SHIFT + F

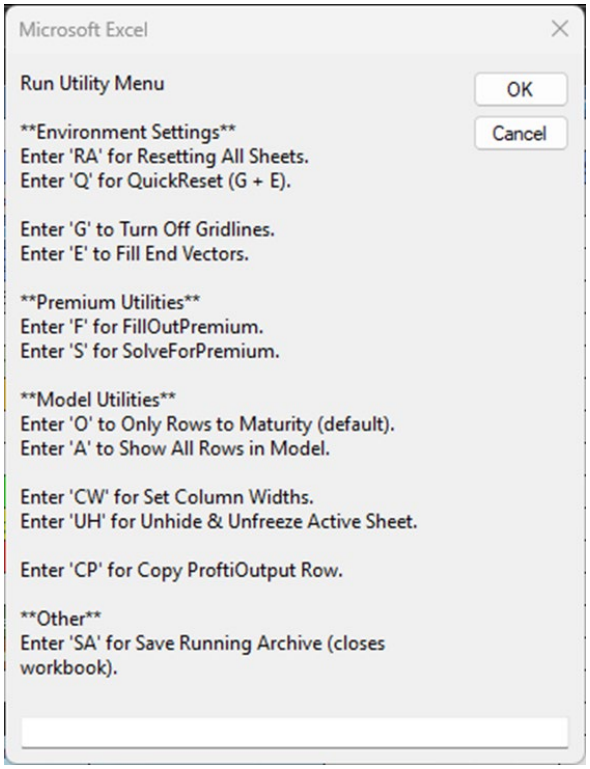
Applies Formatting Standards

It is discussed in the Formatting Standards section.

RUNUTILITIES(): CTRL + SHIFT + R

Utilities for workbook and Projection Model efficiency

The Run Utilities menu is discussed throughout the manual and is presented below, followed by an outline of the available utilities.



ResetAllSheets | RA

Resets All *worksheets to their original settings for a standardized workbook.*

This Macro:

- Sets a uniform zoom level across all worksheets
- Unhides all rows and columns in each worksheet
- Standardizes column widths and row heights to default settings
- Applies uniform font style and size across all cells in each worksheet
- Centers cell content vertically for all cells
- Applies Frozen Pane views
- Turns off gridlines in all worksheets
- Fills End Vectors
- Sets Column Widths to default
- Navigates to the Control navigator

QuickReset | Q

Quickly *resets specific settings to maintain the workbook's structure.*

This runs the Turn Off Gridlines and Fill End Vectors Macros:

Turn Off Gridlines | G

Disables gridlines*, allowing for easy identification of worksheet components.*

FillEndVectors | E

Fills and highlights the End *Vectors.*

It is discussed in the End Vector Framing section.

FillOutPremium | F AND SolveForPremium | S

Fills *premium values across different periods according to the payment schedule.*

Solves *for the premium based on the specified criteria.*

It is discussed in the Current Illustration section.

OnlyRowsToMaturity | O AND Show All Rows in Model | A

On the Run *Utility Menu,* CTRL + SHIFT + R*, the* O *option displays* only *the rows to maturity, allowing you to quickly navigate to the end of the policy.*

The A *option displays* all *rows in the Calculations Area.*

SetColumnWidths | CW

Adjusts column widths *to default sizes, ensuring consistent formatting.*

It resets the columns to the width as defined in the Column Width Vectors section.

UnhideAndUnfreezeSheet | UH

Unhides *all hidden rows/columns and* Unfreezes *all panes*

CopyProfitOutputRow | CP

Copies *the Profit Output Row for pasting into the archive on the "*Profit *Summary" worksheet.*

It is discussed in the Profit Summary Worksheet section.

SaveVersionAndLogDetails | SA

Saves a backup version with timestamped comments for version control.

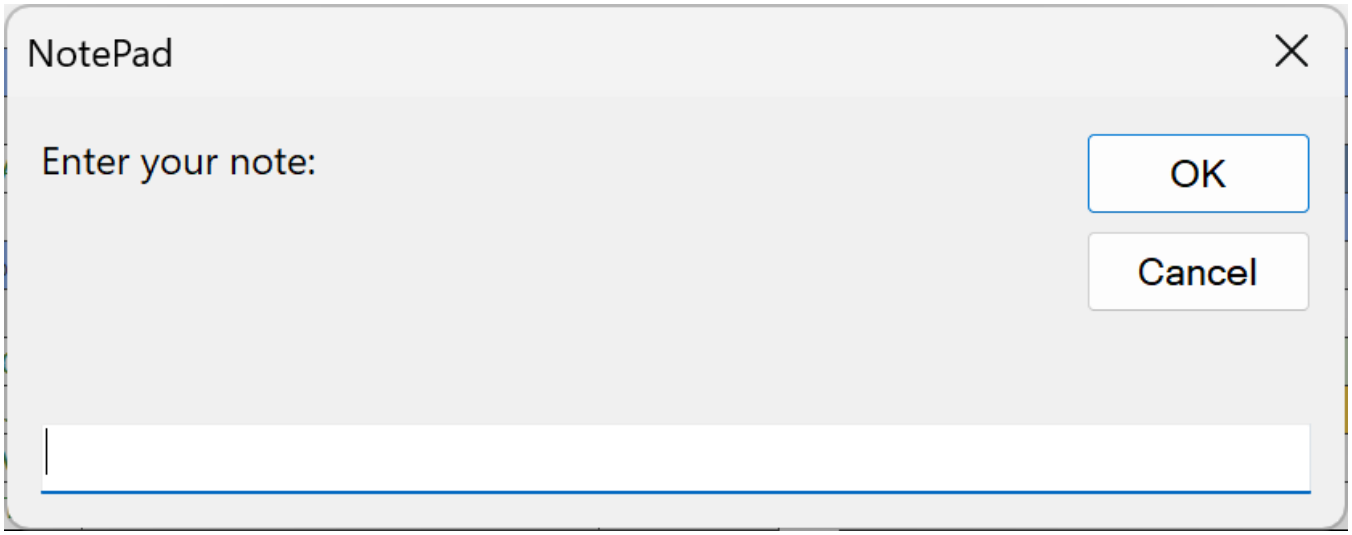
It is discussed in the Save Running Archive section.

NOTEPAD: CTRL + SHIFT + N

Allows you to write and store notes directly in the workbook.

The Note Pad Macro emerged as a pleasant outcome during the development of the Life Product Model. It was created to quickly capture notes without leaving the keyboard and has proven to be a wonderful addition, enhancing both the environment and overall personal productivity.

CTRL + SHIFT + N opens the following dialogue box:



The notes are stored in the Note Pad / Note Repository section of the Control worksheet, as seen below:

Life Product Model Control Worksheet | Note Pad / Note Repository

Note Pad		
ID	Description	Date
1	test	3/21/2024
2	test2	3/21/2024
3	Double check calculation XYZ	3/21/2024
4	Follow up with John regarding roofing estimate	3/21/2024
5	Adjust worksheet structure pending decision on approach.	3/30/2024
6	call about dinner reservations	4/2/2024

Currently, the cleanup of the Note Pad on the Control worksheet is manual.

PROJECTION MODEL

This section discusses the Projection Model of the Life Product Model.

It first discusses the product being modeled and establishes the lexicon used throughout this manual and the tool. It then details the Projection Model, organized into Inputs, Calculations, and Outputs.

The Current Assumption Universal Life sub-section discusses the modeled product and establishes the lexicon used throughout this manual and the tool.

The subsequent sub-sections are Input, Calculations, and Output:

Inputs: Discusses the input assumptions for the Projection Model and is organized by the general types of inputs and their locations:

- Projection Model Inputs: Located in the Input Area
- Projection Model Inputs: Arrays Selected In Input Area
- Infrastructure Inputs: Located in the Model Work Areas
- Workbook-Level Inputs: Included in the Control worksheet

Calculations: Discusses the 12 Functionality Modules that comprise the calculation engine for the Projection Model.

Outputs: Discusses the types of outputs for the Projection Model and their locations:

- Calculations Area: Located in the Model Area
- Model Work Areas
- Projection Model Output In The Model Worksheet
- Worksheets in the Output==> Section

CURRENT ASSUMPTION UNIVERSAL LIFE

The product modeled is a Current Assumption Universal Life (CAUL) policy. CAUL is a type of permanent life insurance that typically provides coverage for the insured's lifetime, although it can be designed for shorter durations. The policy includes a specified maturity age or date upon which the policy terminates. Coverage is generally designed to last for the insured's life, often up to a maturity age of 121, at which point the death benefit is likely paid.

The minimum amount of insurance provided must always qualify as life insurance under one of two tests prescribed in IRS Section 7702: the Guideline Premium and Corridor Test or the Cash Value Accumulation Test (CVAT). Additionally, policies are subject to testing under the Modified Endowment Contract (MEC) rules, which determine the taxation of disbursements for personal income tax purposes.

Premiums are flexible, with modeled or illustrated patterns specifying the duration they are to be paid. Examples include 20-pay, pay to 65, pay to 105, or lifetime pay. The choice of premium payment pattern depends on the insurance objectives and case design. For instance, the policy may be structured to pay premiums to age 105, targeting a Cash Surrender Value of $10,000 at that age.

Insurance coverage, or the Death Benefit, is adjustable and available in several options, such as level (Option 1), increasing (Option 2), or Return of Premium (ROP, Option 3). The Death Benefit can also be increased or decreased, subject to various constraints and conditions, such as requiring new underwriting.

In addition to paying the Death Benefit, the policy offers a non-forfeiture value as a Cash Surrender Value (CSV). The CSV is calculated by subtracting the Surrender Charge from the Account Value (AV). Ignoring benefits paid, the AV is determined through a monthly roll-forward calculation that accounts for:

- Premiums paid, minus
- Loads (expense charges) and Cost of Insurance (COI) charges collected, plus any
- Credited interest.

Loads, COIs, and Crediting Rates may be current (not guaranteed) or guaranteed, collectively called the current or guaranteed scales. Although the guaranteed scale provides certain guaranteed values, such as guaranteed premiums, the product's performance is often evaluated based on its current values.

The policy lapses if the Cash Surrender Value becomes negative unless another policy guarantee is provided, such as a minimum premium guarantee provision. This provision ensures that the policy remains active while acquisition costs are being recovered, typically during the first 10 to 20 years.

Other secondary premium guarantees may also be offered. A specified premium guarantee prevents the policy from lapsing if the premiums paid exceed the specified premiums, typically reflecting interest. Additionally, a shadow account guarantee ensures that the policy remains in force as long as the value of this shadow account is maintained. Both guarantees can provide coverage for life or a shorter period.

The policy may provide other benefits such as liquidity options (loans, withdrawals, etc.) or riders (such as pay-for-chronic illness benefits).

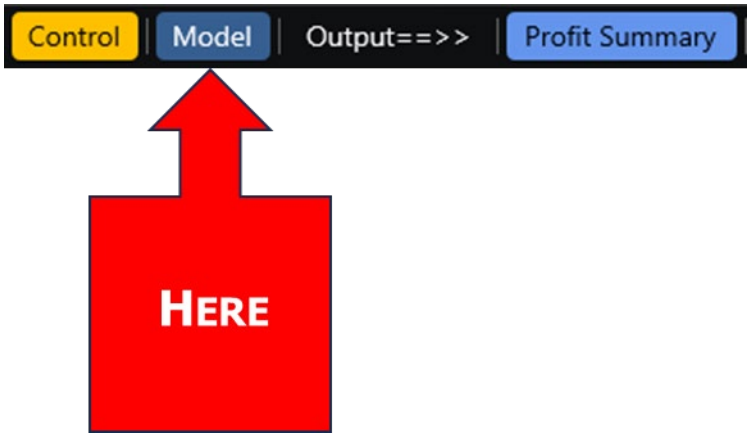
The cost to acquire the policy is usually reflected as either distributor compensation or a lead cost. This compensation varies each year and is calculated as a percentage of the Target Premium plus an additional excess percentage on any deposits that exceed the Target Premium.

INPUTS

The Projection Model inputs are organized as follows.

PROJECTION MODEL INPUTS: INPUT AREA

The Input Area is on the Model worksheet.



The Input Area contains all the inputs that determine the Projection Model results.

The Projection Model inputs are specified in the sections displayed on the Input Dashboard below.

Life Product Model | Input Area | The Life Product Model v0.0.0.xlsm | April 13, 2024	
Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,510.82
NIER	5.25%
Spread (in *bps)*	50
Target Capital	425%
Key Results	
IRR	8.2%
ProfitMargin	10.9%
VONB	1.2%

Input Sections	Dashboard
Input Dashboard	
General	
Premium and Death Benefit	
Loads	
Crediting Rates	
Commissions	
Expense Assumptions	
Lapse Rates	
Multipliers	
Reference Values	

The inputs can appear in various forms with the most common discussed below:

As demonstrated in the dashboard above, the values can be single-point values, such as **5.25%** as observed in the NIER input, or they can reference a vector, such as **RR70 MNS ANB 40**, used for pricing mortality.

This pricing table is loaded into the Vector Data worksheet as seen below.

Life Product Model | Vector Data | The Life Product Model v0.0.0.xlsm | April 1, 2024						
	Table Category	experience tables				
	VectorIdentifier	RR70 MNS ANB 35	RR60 MNS ANB 40	RR70 MNS ANB 40	RR60 MNS ANB 45	RR70 MNS ANB 45
	descriptor	2015 Relative Risk Table	2015 Relative Risk Table	2015 Relative Risk Table	2015 Relative Risk Table	2015 Relative Risk Table
	TableType	select	select	select	select	select
	Issue Age for Vector	35	40	40	45	45

ultimate	select & ultimate					
ages	years					
0	1	0.00010000	0.00009000	0.00011000	0.00018000	0.00022000
1	2	0.00012000	0.00015000	0.00019000	0.00024000	0.00030000
2	3	0.00019000	0.00022000	0.00027000	0.00032000	0.00039000
3	4	0.00022000	0.00026000	0.00032000	0.00039000	0.00048000
4	5	0.00026000	0.00030000	0.00037000	0.00043000	0.00053000

They can be a choice such as the choice between "**full**" or "**accelerated**" underwriting expenses or in the form of a **horizontal table** referenced by the Calculations Area, as demonstrated in the example below:

Expense Assumptions							
U/W expenses	full						
		per Issue			% of premium	per year	
		Acquisition Per Unit	Acquisition	Order Requirements	Marketing	Maintenance	Overhead (yr 1)
Expense		0.38	175	105	2.0%	50	50
Fixed Expense %		5%	10%	0%	3%	5%	95%

The Lapse Rates input section combines a **choice** with a **vertical table** referenced by the Calculations Area.

Lapse Rates

lapse scale	protection

		lapse scales	
lapse rates	years = y	protection	accumulation
4.0%	1	4.0%	6.5%
6.0%	2	6.0%	7.5%
5.5%	3	5.5%	6.8%
5.0%	4	5.0%	6.2%
4.0%	5	4.0%	5.5%
3.5%	6	3.5%	5.3%
3.5%	7	3.5%	4.7%
3.5%	8	3.5%	4.5%
3.0%	11	3.0%	4.2%
2.0%	16	2.0%	4.5%
1.5%	26	1.5%	4.0%

Three methods exist to populate the premium used for the Current or Guaranteed Illustration.

- The first is to enter the premiums directly into the Premium column in the Calculations Area.
- The second method involves populating the Premium column using the Fill Out Premium Macro (option F) within the Run Utility interface (CTRL + SHIFT + R).
- The third method populates the Premium column using the Solve For Premium Macro (option S), also on the Run Utility interface (CTRL + SHIFT + R).

These methods are further discussed in the Projected Premiums section within the Current Illustration functionality Module discussion.

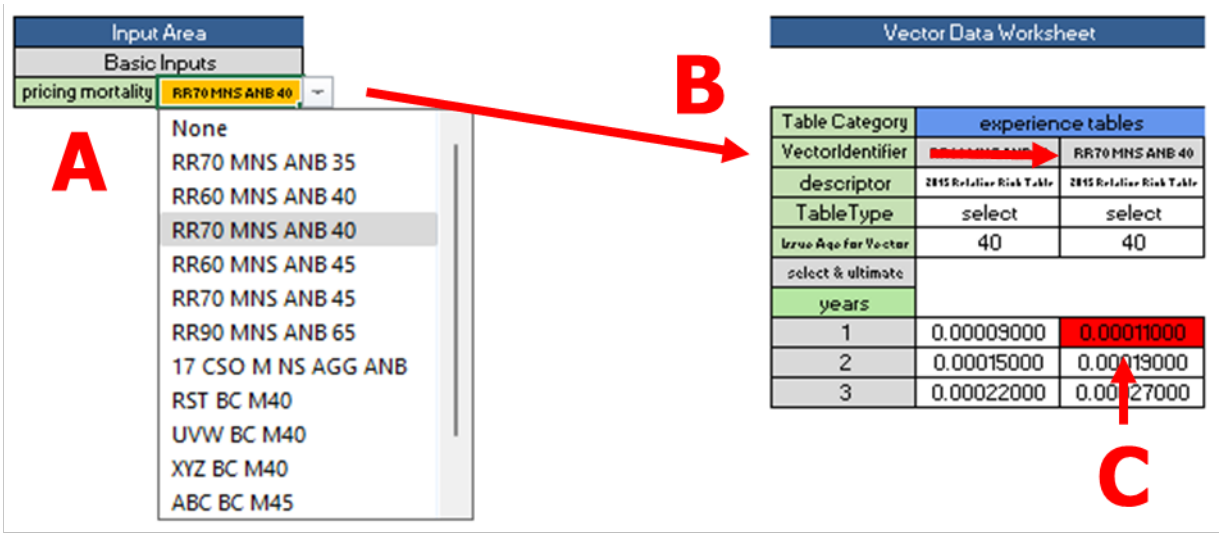
PROJECTION MODEL INPUTS: ARRAYS SELECTED IN INPUT AREA

Projection Model assumptions can also be *selected in the Input Area* by identifying arrays that are then retrieved into the Calculations Area. These inputs are discussed below.

VECTOR DATA

The Vector Data worksheet is designed to maintain vectors of COI and mortality assumptions, which are identified in the Input Area and then retrieved into the Calculations Area.

The Vector Data is retrieved into the Calculations Area using the Vector Data Retrieval Structural Element, which is discussed in its dedicated section.



REFERENCE A

The pricing mortality input is chosen from the validation list, determined by the Vector Identifier array on the Vector Data worksheet, shown in Reference B.

REFERENCE B

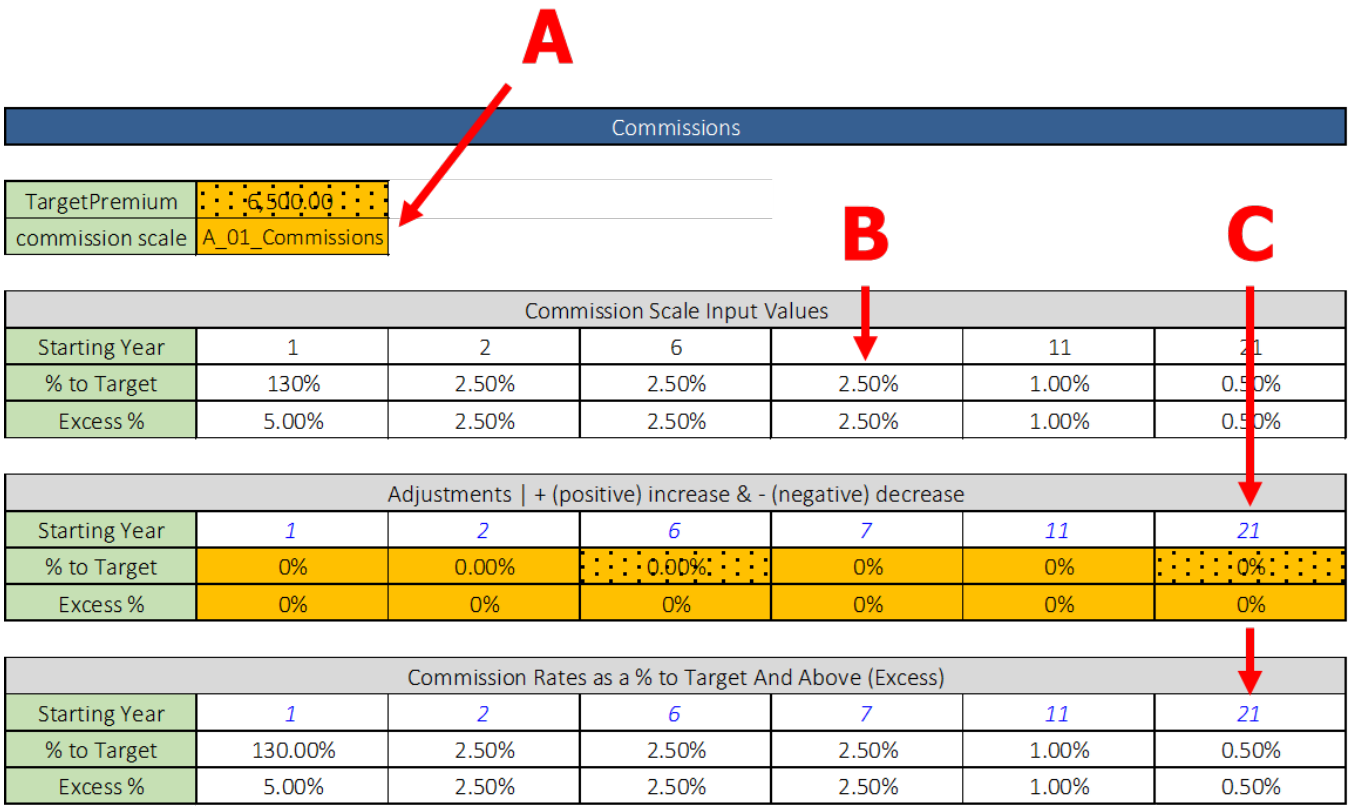
Reference B tracks the Vector Identifier horizontally to the selected vector.

REFERENCE C

Reference C indicates the column of the array loaded into the Calculations Area. The highlighted cell represents the formula's return value, which is the intersection of the two dimensions in the Vector Table's two-dimensional array, as discussed in the Vector Data Retrieval section.

Load Designs and Commission Scales

The Load Design and Commission Scale arrays are retrieved from their respective worksheets into the Calculations Area via selections made in the Input Area. Since both processes are similar, only the input method for Commission Scales is demonstrated below.



Commissions	
TargetPremium	6,500.00
commission scale	A_01_Commissions

Commission Scale Input Values						
Starting Year	1	2	6		11	21
% to Target	130%	2.50%	2.50%	2.50%	1.00%	0.50%
Excess %	5.00%	2.50%	2.50%	2.50%	1.00%	0.50%

Adjustments | + (positive) increase & - (negative) decrease						
Starting Year	*1*	*2*	*6*	*7*	*11*	*21*
% to Target	0%	0.00%	0.00%	0%	0%	0%
Excess %	0%	0%	0%	0%	0%	0%

Commission Rates as a % to Target And Above (Excess)						
Starting Year	*1*	*2*	*6*	*7*	*11*	*21*
% to Target	130.00%	2.50%	2.50%	2.50%	1.00%	0.50%
Excess %	5.00%	2.50%	2.50%	2.50%	1.00%	0.50%

Reference A

The commission scale input identifies the Commission Scale to return from the Commission Scales worksheet.

Reference B

The commission scale is loaded into the Input Area as an array.

Reference C

The loaded commission scale is adjusted before being retrieved into the Calculations Area.

INFRASTRUCTURE INPUTS: LOCATED IN THE WORK AREAS

The Work Areas were developed to perform interim calculations and facilitate infrastructure management.

The Model Work for the Section 7702 calculations shows an example of both interim calculations and infrastructure management items.

ModelWorkArea	3. Section 7702				3. Section 7702		3. Section 7702	
	7702 Offset Formula							
	range specified	Reference	array		Vector Data Retrieval Reference Values			
	specified 0 in formula	Rows	start at t = 0		=Data_Vector_Type			
	specified 0 in formula	Cols	no column offset		S7702COIVector			
	972	Height	time to maturity		17 CSO M NS AGG ANB			äx:7
	specified 1 in formula	Width	set to 1 in formula		ultimate			78.0837120081
					ages			äx:n
					12			342.9296915059
Toggle	reference values | loads				reference values | mortality			
time	loads				lookup	2.00%	live t, discount to t=0	
t	% of Premium	Per Unit Load	Policy Fee	Facet	12qxS7702	vt S7702	(tpxtS7702) * (vt S7702)	
0	*9.00%*	*0.06*	*6.00*	*1,000,000*	0.00143000	1.0000000000	1.0000000000	
1	*9.00%*	*0.06*	*6.00*	*1,000,000*	0.00143000	0.9983511419	0.9982322496	

WORKBOOK-LEVEL INPUTS: LOCATED ON THE CONTROL WORKSHEET

The Control worksheet contains various workbook-level inputs, such as those for Macro functionality, validation lists, and Section 7702 Corridor facts. For instance, the Life Product Model typically opens with the User Agreement, but this can be disabled in the Life Product Model Workbook Information section, as seen below

Life Product Model | Control | The Life Product Model v0.0.0.xlsm | May 7, 2024

Life Product Model Workbook Information

Developer & Contact Information	
name	Rod Rishel
phone or text	615.806.9631
email	rod@rodrishel.com
phone or text	615.806.9631
website	www.rodrishel.com

Life Product Model File Name and Version	
FileName / Version	The Life Product Model v0.0.0.xlsm

Life Product Model Enviroment Information
AutoSave is turned OFF
Calculation Method is set to Manual (F9)

Workbook Settings	
Workbook Zoom Default	75
User Agreement on OR off at open	off
directory to store running archive	C:\Life Product Model and Tools\RunningArchive

CALCULATIONS

The **Life Product Model** Projection Model results and output are derived from a series of functionality Modules, which are sequentially built upon each other. These Modules are arranged from left to right in the Model Area, generally reflecting the order in which the results are developed. The Modules are listed below, followed by a discussion of any developmental or cautionary notes regarding the functionality.

LPM MODULE	FUNCTIONALITY
Survival Model	Develops the model cohort, applying decrement attrition through mortality and persistency
Current Illustration	The projection of current policy values
Section 7702	Guideline Level Premium (GLP), Guideline Single Premium (GSP), & Modified Endowment Contract Premium (MEC) calculations
Guaranteed Illustration	The projection of guaranteed policy values
Statutory Reserves	Calculates Statutory Reserves and applies cash value floor
Commission Calculations	Computes commissions up to target and excess
Expenses	Calculates variable & fixed expenses and applies inflation
Capital Development	Develops Target Capital as a multiple of 100% NAIC RBC, including covariance adjustment
Cash Flow	Develops and organizes the beginning and end-of-month cash flows
Assets & Investment Income	Asset development, including investment income calculations
Statutory Income Statement	Develops a Statutory Income Statement detailing the allocation of premiums across various income items
Surplus Account & Balance Sheet	Includes Surplus Account transfers and Balance Sheet Items

1. Survival Model

The values are derived using the pricing or expected mortality and lapse assumptions.

The remaining life expectancy (e_x) and the cohort half-life are calculated, representing the number of years until **50%** of the cohort has terminated.

It provides for the ability to apply a mortality or lapse multiplier and a mortality improvement factor.

The cohort size default is **100** lives.

Mortality and COI Retrieval for all Modules

The process for retrieving a mortality or COI table from the Vector Data worksheet has been standardized and discussed in the Vector Data Retrieval section within the Structural Elements discussion. The reference values needed to facilitate this retrieval are included in the Model Work Area, as seen below:

ModelWorkArea	1. Survival Model
	Vector Data Retrieval Reference Values
	=Data_Vector_Type
	MortalityVector
	RR70 MNS ANB 40
	select
	years
	13
Toggle	
time	lookup
t	12qx
0	0.00011000
1	0.00011000
2	0.00011000

The tool has several Work Areas whose visibility can be toggled using the Toggle Work Areas Macro (CTRL + SHIFT + T).

Work areas are designated for performing interim calculations and managing infrastructure.

No Decrement Applied in Modules 2 -7

2. Current Illustration

Values are projected using the modeled assumptions under the current Loads, COIs, and Crediting Rates.

This Module's output is commonly referred to as a non-guaranteed illustration.

The Module has been *tested against various insurer illustrations* and has been found to closely replicate the underlying values, matching insurer values down to the penny ($0.01) in certain instances. Any discrepancies observed were analyzed, and given their pattern and other characteristics, it is reasonable to assume they are attributable to known differences in calculation methodologies, such as the approach to converting annual rates to monthly.

COI Development

Two methods exist to develop the COI rates.

The first method involves incorporating the COI scale into the Vector Data worksheet and specifying the corresponding vector in the Input Area.

Cost of Insurance Charges	
COIUses	Vector
COIVector	RST BC M40

The second method calculates the COI rate as a multiple of the current pricing or experience assumption.

This method is selected and configured within the Input Area.

Cost of Insurance Charges	
COIUses	Calculated
COIVector	None

Multipliers			
starting COI load	multiplier	COI to q_x multiplier	y
1.01	1.000	1.010	1
1.01	1.000	1.010	2
1.01	1.000	1.010	11
1.01	1.000	1.010	26

PROJECTED PREMIUMS

Three methods exist to populate the premium used for the Current or Guaranteed Illustration.

The first is to enter the premiums directly into the Premium column in the Model Area.

	2. Current Illustration				
		starting			
age	COI in **t**	Account Value	deposit		
x	COI_t	AV_t	$Premium_t$	$Premium\ Expense\ Charge_t$	$Net\ Premium_t$
40	0.00000963	0	7,651	918	6,733
40	0.00000963	6,676	0	0	0

The second method involves populating the Premium column using the Fill Out Premium Macro (option F) within the Run Utility interface (CTRL + SHIFT + R). This method utilizes the configuration settings specified in the Premium and Death Benefit section of the Input Area, as seen below.

Inputs | FillOutPremium() run from RunUtilities() Menu		description or notes
PremiumToProcess	current	current or guaranteed Illustration to populate
Premium	7,650.8800	input premium, used as part of macro process
PaymentPeriod	81	input payment period, default = ProjectionYears
PaymentMode	annual	annual, semi-annual, quarterly, monthly

The third method populates the Premium column using the Solve For Premium Macro (option S), also on the Run Utility interface (CTRL + SHIFT + R). This macro utilizes the Fill Out Premium macro and incorporates its settings from the Premium and Death Benefit section of the Input Area to perform the solve:

FillOutPremium() | CTRL + SHFT + R		description or notes
PremiumToProcess	current	current or guaranteed Illustration to populate
Premium	7,650.8800	input premium, used as part of macro process
PaymentPeriod	81	input payment period, default = ProjectionYears
PaymentMode	annual	annual, semi-annual, quarterly, monthly

SolveForPremium() | CTRL + SHFT + R		description or notes
TargetValueForSolve	1,000,000	default is set to the CSV at maturity
t time for solve	972	default is set to maturity
GuessValue	6,500	initial guess for solve, default set to TargetPremium

Since there's no limit on the number of decimal place accuracy to which the premium will be solved, it continues iterating until convergence. It is helpful to observe the results update; you may notice convergence and intervene accordingly, breaking the loop if necessary (ESC) or determining if the values are converging at an unacceptable level for the objective at hand. Monitoring the process allows for intervention, *although the routine generally converges quickly*.

LAPSE CONSIDERATIONS

The policy will lapse if the Cash Surrender Value is less than zero and the minimum premium guarantee period has expired. The default minimum premium guarantee period is **10 years**. If a lapse occurs, the key profit metrics will error (#VALUE!), and a lapse status will be indicated in the CSV column, as seen in the example below:

Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,000.00
NIER	5.25%
Spread (in bps)	50
Target Capital	425%
Key Results	
IRR	#VALUE!
ProfitMargin	#VALUE!
VONB	#VALUE!

t at target	972
CurrentTargetValue	191,980,018,779.91

			2. Current Illustration			
			ending	policyholder values		
age	year	time	Account Value	Cash Value		
x	y	t	AVt+1	SCt+1	CalculatedCSVt+1	CSVt+1
94	55	652	27,287.79	0	27,288	27,288
94	55	653	10,600.59	0	10,601	10,601
94	55	654	-6,439.26	0	-6,439	lapse
94	55	655	-23,839.20	0	-23,839	lapse
94	55	656	-41,606.84	0	-41,607	lapse

If a policy lapse occurs, the Projection Months must be set to the last month during which the policy remains active. As indicated below, the duration is 653 months in this specific case.

Life Product Model | Input | The Life Product Model v0.0.0.xlsm | March 27, 2024	
Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,000.00
NIER	5.25%
Spread (in bps)	50
Target Capital	425%
Key Results	
IRR	10.7%
ProfitMargin	11.9%
VONB	2.5%

ModelInputFreezeCell

General		
variable	value	description or notes
MaturityAge	121	age at policy maturity (BOM)
MaturityYears	81	number of years, from time 0, to policy maturity.
tAtMaturity	972	time (t) at the point of policy maturity.
ProjectionYears	81	total number of years in projection
ProjectionMonths	653	total number of months in projection
tAtLapse	654	month policy lapses

3. SECTION 7702

This Module has undergone testing with various **insurer illustrations** and largely **replicates the values**. It produces values consistently and *immaterially* below the insurer's values. This is attributable to the lack of calculation optimization to maximize the 7702 premiums, such as selecting the specific mortality table to use.

There is no 7702 limit testing logic; only the premiums are calculated.

The GLP, GSP, and MEC values are calculated following the Section 7702 Calculation Methodology included as Methodology Note A.

The GLP & GSP calculations use current Loads and a guaranteed or loaded mortality rate, which is currently discounted at **2%** and **4%**, respectively.

The MEC calculation uses a guaranteed or loaded mortality rate, currently discounted at **2%**.

Interim actuarial calculations are integrated into the Model Work Area, with output values displayed above the Calculations Header as depicted below:

					Annual7-Pay	
					66,783.31	
ModelWorkArea	3. Section 7702					
					Monthly 7-Pay	
					5,565.28	
		äx:7				
		78.0837120081				
		äx:n		AX:n	DBNSPX:n	DBNSPX:ngrossed up
		342.9296915059		0.43455740362	434,557.40	452,797.76
Toggle	Guideline Level Premium and 7-Pay calculations					
time	2.00%	live t, discount to t=0	2.00%	live to t, die in t, disc. to t=0	* Face	grossed up
t	vt S7702	(tpxtS7702) * (vt S7702)	vt+1 S7702	(vt+1 S7702) * (t|qxS7702)	(vt+1 S7702) * (t|qxS7702) * Facet	[(vt+1S7702)*(t|qxS7702)*Facet]/(1-Premium load)
0	1.0000000000	1.0000000000	0.9983511419	0.0001188923	118.89	135.10
1	0.9983511419	0.9982322496	0.9967050026	0.0001186821	118.68	134.87

The Module does not reflect Death Benefit Option 2 (level NAaR).

4. Guaranteed Illustration

Values are projected using the modeled assumptions under the guaranteed scale, including Loads, COIs, and Crediting Rates.

It is structurally the same as the Current Illustration Module.

This Module's output is commonly referred to as a guaranteed illustration

This Module calculates the Guaranteed Maturity Values (GMVs) for the Statutory Reserves Module.

5. Statutory Reserves

This Module generates either a calculated Statutory Reserve computed in accordance with Methodology Note B or the CSV, as selected in the Input Area.

While this Module reproduces various examples from "Statutory Valuation of Individual Life and Annuity Contracts, Fifth Edition," authored by D. Clarie, L. Lombardi, and S. Summers and copyrighted in 2023 by ACTEX Learning, *it is an area in which I am seeking assistance, or more specifically calculation review.*

Interim actuarial calculations are integrated into the Model Work Area. Alongside the referenced calculations, the example below highlights the Unique formatting standard (ID #12). During the initial 12 months, the Statutory Net Premium is established to be equivalent to the cost of insurance during the first year, a distinction from the calculations starting in month 13 and onward.

ModelWorkArea	5. Statutory Reserves	
	premium	monthly
	NLPx:n	1,267.19
	NLPx+12:n-12	1,308.41
	ExpensePremium	41.22
	AX+12:n-12	äx-12:n-12
	0.44243944	338.15
	AX:n	äx:n
	0.43455761	342.93

Toggle	survival calculations		FPT Reserve at time t				Statutory Net Premium Reserve at time t		
time	NSP at t	Annuity Due at t	Reserve	EA	Unamortized	Reserve	PV of Benefits	PV of Premiums	Reserve
t	Ax+t:n-t / [(tpx|Stat) * (vt Stat)]	äx+t:n-t / [(tpx|Stat) * (vt Stat)]	NLPVt	Expense Premiumt	NPV of Expense Premiumt	FPTVt	NPV Benefitst	NPV of Statutory Net Premium	Statutory Net Premium Vt
0	0.4345576074	342.9296917100	*0.00*	41.22	14,136.29	0.00	118.89	118.89	0.00
1	0.4352080543	342.5352084455	*1,150.33*	41.22	14,120.03	0.00	118.68	118.68	0.00
2	0.4358596531	342.1400265982	*2,302.70*	41.22	14,103.74	0.00	118.47	118.47	0.00
3	0.4365124058	341.7441449309	*3,457.11*	41.22	14,087.42	0.00	118.26	118.26	0.00
4	0.4371663144	341.3475622043	*4,613.57*	41.22	14,071.07	0.00	118.05	118.05	0.00
5	0.4378213810	340.9502771770	*5,772.07*	41.22	14,054.69	0.00	117.85	117.85	0.00
6	0.4384776077	340.5522886053	*6,932.63*	41.22	14,038.29	0.00	117.64	117.64	0.00
7	0.4391349965	340.1535952432	*8,095.24*	41.22	14,021.85	0.00	117.43	117.43	0.00
8	0.4397935494	339.7541958427	*9,259.90*	41.22	14,005.39	0.00	117.22	117.22	0.00
9	0.4404532685	339.3540891535	*10,426.63*	41.22	13,988.89	0.00	117.01	117.01	0.00
10	0.4411141560	338.9532739230	*11,595.43*	41.22	13,972.37	0.00	116.81	116.81	0.00
11	0.4417762138	338.5517488965	*12,766.30*	41.22	13,955.82	0.00	116.60	116.60	0.00
12	0.4424394440	338.1495128170	*13,939.24*	41.22	13,939.24	0.00	442,439.44	442,439.44	0.00
13	0.4431001406	337.7488133221	*15,107.70*	41.22	13,922.72	1,184.98	443,100.14	441,915.16	1,184.98

6. Commission Calculation

The Commission Calculation Module computes both the commissions and any charged-back commissions.

		GDC NPVNIER		
		10,425		
		6. Commission Calculations		
		commissions & chargebacks calculated		
year	month	commissions	chargebacks	
y	m	GDCt	*Cumulative Commissions*	Chargebackt
1	1	8,501	8,501	28
1	2	0	8,501	28
1	3	0	8,501	28
1	4	0	8,501	28
1	5	0	8,501	28
1	6	0	8,501	28
1	7	0	8,501	14
1	8	0	8,501	14
1	9	0	8,501	14
1	10	0	8,501	14
1	11	0	8,501	14
1	12	0	8,501	14
2	1	188	8,688	0
2	2	0	8,688	0

7. EXPENSES

The expense assumptions are entered on a per-unit basis in the Input Area.

Expense Assumptions							
U/W expenses	full						
	per Issue			% of premium	per year		
	Acquisition Per Unit	Acquisition	Order Requirements	Marketing	Maintenance	Overhead (yr 1)	Overhead (all years)
Expense	0.38	175	105	2.0%	50	50	10
Fixed Expense %	5%	10%	0%	3%	5%	95%	95%

U/W expense type	Acquisition Per Unit	Acquisition	Order Requirements
accelerated	0.00	175	50
full	0.38	175	105

The development of the per unit expenses for use in the Module occurs in the Model Work Area, where the expenses are categorized into Variable and Fixed expenses. Additionally, a check is implemented to ensure that the derived expenses match the modeled expenses, indicating either a "good" or "error" status, as seen below:

7. Expenses	7. Expenses	7. Expenses	7. Expenses	7. Expenses	7. Expenses	7. Expenses	7. Expenses	7. Expenses
	CellCalculations calculated expenses by category for month 1						directly calculated expenses by category for month 1						check_A
expenses month 1	380.00	175.00	105.00	153.02	4.17	4.17	0.83	380.00	175.00	105.00	153.02	4.17	4.17	0.83	good
expense categories	Variable Expenses							Fixed Expenses							
	Acquisition Per Unit	Acquisition	Order Requirements	Marketing	Maintenance	Overhead (yr 1)	Overhead (yrs 2+)	Acquisition Per Unit	Acquisition	Order Requirements	Marketing	Maintenance	Overhead (yr 1)	Overhead (yrs 2+)	
expense %	95%	90%	100%	97%	95%	5%	5%	5%	10%	0%	3%	5%	95%	95%	
expense	0.36	157.50	105.00	1.94%	47.50	2.50	0.50	0.02	17.50	0.00	0.06%	2.50	47.50	9.50	
mode	1	1	1	1	12	12	12	1	1	1	1	12	12	12	
Expense for Projection	0.36	157.50	105.00	1.94%	3.96	0.21	0.04	0.02	17.50	0.00	0.06%	0.21	3.96	0.79	
reference values	expenses by type | **NO** inflation applied														total expenses | inflation factor applied
Inflation	Variable Expenses							Fixed Expenses							Acquisition vs. Maintenance
inflationfactor$_t$	Acquisition Per Unit	Acquisition	Order Requirements	Marketing	Maintenance	Overhead (yr 1)	Overhead (yrs 2+)	Acquisition Per Unit	Acquisition	Order Requirements	Marketing	Maintenance	Overhead (yr 1)	Overhead (yrs 2+)	$BOM_{Acquisition_t}$	$BOM_{Maintenance_t}$
1.00000000	361.00	157.50	105.00	148.43	3.96	0.21	0.04	19.00	17.50	0.00	4.59	0.21	3.96	0.79	813	9
1.00165158	0.00	0.00	0.00	0.00	3.96	0.21	0.04	0.00	0.00	0.00	0.00	0.21	3.96	0.79	0	9

The splits between Variable and Fixed expenses are used to calculate the impact of changes in the placement rate.

Assumed Placement Rate	55.0%
Revised Placement Rate	65.0%
PlacementRatioFactor	100%

The Module applies inflation and further divides the expenses into acquisition expenses (assumed to occur at the beginning of the month) and maintenance expenses (assumed to occur at the end of the month).

Decrement Applied in Modules 8-11

8. Capital Development

The calculations in this Module reproduce those detailed in the study "Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions," which was published in July 2023 by the SOA Research Institute and authored by Ben Leiser and colleagues.

The Target Capital is calculated by applying a specific multiple, adjusted for covariance, to the 100% NAIC Risk-Based Capital (RBC). For example, **425%** of 100% RBC.

The RBC component factors (C1, C2, C3, and C4) are formulated on the Target Capital worksheet.

9. Cash Flow

The beginning and end-of-month cash flows are summed by "sign," where "+" indicates positive cash flows and "-" indicates negative ones.

See the beginning-of-month example:

9. Cash Flow		9. Cash Flow		9. Cash Flow	
beginning-of-month cash flows					
+	-	-	+	-	total
Premiumst	Commissionst	Acquisition Expenset	*positive*	*negative*	BOM Cash Flows
765,088	*850,754*	*81,302*	*765,088*	*932,056*	-166,968
0	*0*	*0*	*0*	*0*	0
0	*0*	*0*	*0*	*0*	0
0	*0*	*0*	*0*	*0*	0
0	*0*	*0*	*0*	*0*	0

Additional columns, marked with their respective "sign," can be added to either the beginning or end-of-month cash flows.

10. Asset & Investment Income

Assets and investment income are developed based on the maintenance of the following relationship at the end-of-month:

Assets = Reserves + Target Capital,

To maintain this relationship, any required assets are transferred from the surplus account at the end of the month.

Any shortfalls at the beginning of the month are assessed a charge at the Inter Month rate; the default rate is **1%**, as seen below:

Investment Earnings & Discount Rates		description or notes
$^{Annual}AssetLoadingFactor_{(in\ bps)}$	25	misc. non-modeled profit, applied against reserves
$^{Annual}NIER_{capital}$	2.50%	
$^{Annual}InterMonth_{rate}$	1.00%	rate assessed on beginning-of-month asset shortfalls
$^{Annual}Hurdle_{rate}$	8%	

11. Statutory Income Statement

The NPV of the income statement items is calculated above the Column Headers as seen below for the Total Revenue and Total Benefit items.

FY Premium							
765,088							
Premiums	Investment Income	Asset Load	Total Revenue	Death Benefits	Net Surrender Benefits	Increase in Reserve	Total Benefits
8,982,577	6,996,911	325,750	16,305,238	3,979,269	2,459,673	6,632,517	13,071,459
100.0%	77.9%	3.6%	181.5%	44.3%	27.4%	73.8%	145.5%
11. Statutory Income Statement				11. Statutory Income Statement			
Total Revenue				Total Benefits			
BOM	EOM	EOM	**SUM**	EOM	EOM / NET	EOM	**SUM**
Premiums	Investment Income	Asset Load	**Total Revenue**	Death Benefits	Net Surrender Benefits	Increase in Reserve	**Total Benefits**
765,088	*0*	*0*	765,088	*917*	*0*	0	917
0	*730*	*0*	730	*914*	*0*	0	914
0	*728*	*0*	728	*911*	*0*	0	911

12. Surplus Account & Balance Sheet

Key profit metric calculations are developed above the column headers, as seen below:

VONB
1.2%
NPVHurdleRate
8,857
NPVNIER
261,349
NPVIRR
0.00

IRR	MIRR
8.2%	5.8%

12. Surplus Account & Balance Sheet			
Surplus Account	Balance Sheet		
EOM	Assets = Reserves + Capital		
Distributable Surplus	Assets	Reserve	Capital
-515,273	*352,951*	*0*	*352,951*
2,312	*351,999*	*0*	*351,999*

OUTPUTS

This section discusses the various types of outputs from the Life Product Model:

CALCULATIONS AREA: LOCATED IN THE MODEL AREA

The Calculations Area on the Model worksheet maintains the Projection Model's first-order Output. These results are used to derive all other Output values.

MODEL WORK AREAS

Work areas are designated for performing interim calculations and managing infrastructure, with these interim calculations representing Output.

PROJECTION MODEL OUTPUT IN THE MODEL WORKSHEET

Above the Calculations Header in the Model Area of the Model worksheet, various Output is created as seen below:

		FY Premium						
		751,082						
		Premiums	Investment Income	Asset Load	Total Revenue	Total Benefits	Pre-Tax Income	After-Tax Income
		8,818,011	6,989,535	325,417	16,132,963	13,061,282	1,211,661	957,212
		100.0%	79.3%	3.7%	183.0%	148.1%	13.7%	10.9%
	ModelWorkArea	11. Statutory Income Statement				11. Statutory Income Statement		
	Toggle	Total Revenue					Income	
month	time	BOM	EOM	EOM	**SUM**	**SUM**	EOM	EOM / NET
m	t	Premiums	Investment Income	Asset Load	**Total Revenue**	**Total Benefits**	Pre-Tax Income	After-Tax Income
1	0	*751,082*	*0*	*0*	751,082	917	-205,282	-162,173
2	1	*0*	*727*	*0*	727	914	1,721	1,359

WORKSHEETS IN THE OUTPUT==> SECTION

Each worksheet in the Output==> section represents the output of the Life Product Model and is discussed in the Output==> Section within the workbook Design Techniques discussion.

ANALYSES

This section demonstrates the Life Product Model's functionality through several analyses.

The modeled product is a single-life, fully underwritten Current Assumption Universal Life policy within the highly competitive independent distribution market.

The first analysis, Analysis 01, defines the baseline results loaded upon opening the workbook. It also explores using the tool to determine the necessary premium change to maintain profitability due to increased mortality. Further, it begins to explore a framework for evaluating various headwinds I see to the continued maturation of accelerated underwriting programs.

For Analysis 01, the Loads, COIs, and Crediting Rate spreads are *set to cover expenses and ensure profitability annually*. It does not directly employ product leverage mechanisms such as lapse support dynamics. *As an aside*, while this analysis does not utilize lapse support dynamics, these mechanisms are not inherently problematic and are common in most individual life insurance policies.

The crediting strategy for Analysis 01 uses a declared fixed account rate of **4.75%**, which aligns with currently available rates. To establish the Net Investment Earnings Rate (NIER) for both analyses, a fixed interest spread of **50 bps** is assumed, resulting in an NIER of **5.25%.**

The second analysis, Analysis 02, explores the tool's application in comparing products within a unified framework of assumptions. It focuses on three high-performing, protection-oriented index universal life (UL) products modeled under the framework developed in the first analysis. Some results are discussed, but the focus is primarily on investigating the Life Product Model's functionality.

> *As an aside*, this analysis indirectly touches on the heavily debated topics in AG49-A, B, C, D, etc., by illustrating that competitively benchmarked premiums would be priced to lapse before the targeted duration of the scenario benchmarked. I do not intend to wade into those debates but simply illustrate the usage of the Life Product Model and the pricing as I see it.

Further details include:

- The insured is a 40-year-old male who qualifies for the best fully underwritten class available (Preferred Plus, Super Preferred, etc.).
- The policy provides a $1 million death benefit with level premiums paid until age 105, which provides for a target cash surrender value of $10,000.
- Product Specifications and Model Assumptions are detailed in their respective sections.

Analysis 01 | Baseline Results

The Loads and COIs, combined with a **4.75%** account crediting rate, result in an annual premium of **$7,511**. This premium ensures a minimum surrender value of **$10,000** at age **105** and offers a reasonable profit profile. The baseline results are shown below:

Life Product Model | Illustrations | The Life Product Model v0.0.0.xlsm | April 9, 2024

Illustration Summary	
Basic Inputs	
IssueAge	40
pricing mortality	RR70 MNS ANB 40
expected age at death	87.02
cohort half-life in yrs	20.25
Face	1,000,000
solved for premium	7,510.82
NIER	5.25%
Spread (in bps)	50
Target Capital	425%
Key Results	
IRR	8.2%
ProfitMargin	10.9%
VONB	1.2%

year	Cash Surrender Value	Death Benefit
1	0	1,000,000
10	57,233	1,000,000
20	204,156	1,000,000
40	581,744	1,000,000
65	21,451	1,000,000

Section 7702 Premiums	
7-Pay	66,783.31
Guideline Level	15,989.30
Guideline Single	219,030.49

Some common sensitivities include:

Life Product Model | Profit Summary | The Life Product Model v0.0.0.xlsm | April 9, 2024

		Analysis 01 | Baseline Model | Results & Sensitivities								
		Profit Measures			Key Metrics		Multipliers			
ID	Description	IRR	Profit Margin	VONB	Premium	Age at Proj. End	Mortality	Lapse	COI	COI to qx
A	**Analysis 01 Baseline Result**	8.2%	10.9%	1.2%	7,510.82	105.00	1.00	1.00	1.0000	1.0500
A1	A: ↑ mortality x 1.25	#DIV/0!	6.5%	-22.6%	7,510.82	105.00	1.25	1.00	1.0000	1.0500
A2	A: ↓ mortality x 0.75	12.4%	15.8%	27.1%	7,510.82	105.00	0.75	1.00	1.0000	1.0500
A3	A: ↑ lapse rates x 1.5	16.5%	11.3%	17.6%	7,510.82	105.00	1.00	1.50	1.0000	1.0500
A4	A: ↓ lapse rates x 0.5	6.3%	11.0%	-20.2%	7,510.82	105.00	1.00	0.50	1.0000	1.0500
A5	A: ↑ FYC + 10% up to Target	7.3%	10.3%	-5.5%	7,510.82	105.00	1.00	1.00	1.0000	1.0500
A6	A: ↓ FYC - 10% up to Target	9.9%	11.4%	7.8%	7,510.82	105.00	1.00	1.00	1.0000	1.0500

DISCUSSION

As an initial exploration into using the tool to determine the necessary premium change to maintain profitability as a result of increased mortality, the following analysis was performed:

Life Product Model | Profit Summary | The Life Product Model v0.0.0.xlsm | April 9, 2024										
		Analysis 01 | Baseline Model | Results & Sensitivities								
		Profit Measures			Key Metrics		Expenses	Multipliers		
ID	Description	IRR	Profit Margin	VONB	Premium	Age at Proj. End	U/W Method	Mortality	COI	COI to qx
A	**Analysis 01 Baseline Result**	8.2%	10.9%	1.2%	7,510.82	105.00	full	1.00	1.0000	1.0500
A7	A1: ↑ COIs & Prem. | full U/W	9.4%	10.9%	6.3%	8,274.40	105.00	full	1.25	1.2750	1.0500
A8	A7: ↓ COIs & Prem. | accelerated U/W	10.4%	10.9%	8.2%	8,209.69	105.00	accelerated	1.25	1.2500	1.0500

ID A7 demonstrates the COI increase required to align the profit margin with ID A (the original baseline result) and the corresponding premium to ensure a **$10,000** surrender value following a **25%** increase in mortality.

ID A8 assumes **accelerated underwriting** expenses, where the underwriting is largely automated and does not include any invasive requirements such as labs (blood, urine, etc.).

The results below indicate that the **8.5%** figure in the Expense Offset column denotes the percentage reduction in premium increase attributable to lower accelerated underwriting expenses.

ID	Description	Premium	Increase	% Increase	Expense Offset
A	**Analysis 01 Baseline Result**	7,510.82	na	na	na
A7	A1: ↑ COIs & Prem. | full U/W	8,274.40	763.58	10.2%	na
A8	A7: ↓ COIs & Prem. | accelerated U/W	8,209.69	698.87	9.3%	8.5%

The Expense Offset would peak at the lowest death benefit available and grade towards zero as that size increases and the mortality cost overwhelms any fixed expense savings. Time permitting, I want to again (it seems like this is a good exercise every few years) graph the relationship of the Expense Offset to the death benefit across at least several age and risk class combinations.

This initial work focuses on aligning Profit Margins, not IRRs. Presently, the IRR is derived directly from the monthly distributable earnings using Excel's IRR function. However, this calculation exhibits considerable volatility, attributed to fluctuations in cash flow directions and the configuration of Loads and COIs. *Time permitting*, I intend to incorporate some form of IRR smoothing technique, such as cash flow aggregation or introducing artificial cashflows akin to calculating a Becker IRR.

All results from this analysis are included in the archive area of the Profit Summary worksheet.

Initial Thoughts on Accelerated Underwriting Programs

The following outlines some initial thoughts on potential anti-selection constraints that might hinder the maturation of accelerated underwriting programs. I have been considering these programs due to the mortality headwinds they appear to be facing, to be discussed elsewhere.

Specifically, the absolute change in premium illustrated in *ID A8* is important. I hypothesize and strongly believe the following:

- The healthier insured knows their health (possesses asymmetric information) and acts upon it.
- In exchange for a certain level of premium savings, a healthy insured, or any insured, for that matter, would be willing to undergo a more intrusive underwriting process, such as providing a blood specimen.
- The consideration of these premium savings is based on an absolute amount, not a percentage saved.

It is these factors that may impose the anti-selective constraint mentioned above.

They don't come into play today because accelerated and fully underwritten programs are largely available at the same $7,511 premium. Consequently, *the insured has no incentive to undergo full underwriting*. However, the impact of this constraint is illustrated in the following example:

> An accelerated underwriting program is experiencing a 25% increase in mortality within its best class. Although modest expense savings offset this mortality increase, the reduction in profits must ultimately be addressed. As a result, premiums are increased as necessary to maintain profitability.
>
> The premium for this insured has been increased by $764 to $8,210 a year to restore the original profitability.
>
> However, this increase assumes that the same number of healthy individuals will opt for the $8,210 premium as they did for the $7,511 premium.
>
> However, the healthy insured now faces a decision: Should they save $764 annually by submitting to the more invasive full underwriting or pay extra for the convenience of accelerated underwriting?
>
> It is reasonable to expect some healthy insureds to opt for full underwriting to save money. Consequently, the remaining pool of insureds in the accelerated underwriting program will be less healthy than anticipated, leading to further excess mortality.
>
> This situation could necessitate further price increases, thereby setting the dynamics of a "mortality spiral" well into motion.

As a disclaimer, I acknowledge that the premium increase above is higher than what would typically be priced in the market, influenced by some of the same design considerations discussed in Analysis 02. Nonetheless, it highlights the underlying point: There is a level of savings significant enough to persuade a healthy insured to opt out of the convenience of accelerated underwriting. Whatever this level of savings may be:

- $1 a month / $12 annually, or
- $12 a month / $144 annually, or
- $24 a month / $288 annually, or
- etc.

Analysis 02 | Competitive Protection Oriented IUL

The second analysis aims to explore the application of the Life Product Model in comparing products within a unified framework of assumptions. It focuses on three high-performing, protection-oriented index universal life (UL) products modeled under the methodology previously discussed in Analysis 01.

The three products are identified as follows:

- Design RST
- Design UVW
- Design XYZ

Specific steps were taken for each design to develop key metrics for the analysis, with the RST design steps detailed below. The results for all three designs, RST, UVW, and XYZ, have been compiled and are included in the archive area of the Profit Summary worksheet.

DESIGN RST

The first (1) step is to incorporate the Loads and COIs from Design RST into the Baseline from Analysis 01, which produces the following results, including the same sensitivities previously performed.

		Analysis 02 | RST Loads & COIs | Results & Sensitivities										
		Profit Measures			Key Metrics		Product Design				Multipliers	
ID	Description	IRR	Profit Margin	VONB	Premium	Age at Proj. End	Crediting Rate	COI Uses	COI Vector	Load Scale	Mortality	Lapse
A	**Analysis 01 Baseline Result**	8.2%	10.9%	1.2%	7,510.82	105.00	4.75%	calculated	None	A_01_Current_Loads	1.00	1.00
B	**A: RST Loads & COIs**	39.9%	13.1%	65.6%	7,510.82	105.00	4.75%	vector	RST BC M40	RST_Loads	1.00	1.00
B1	B: ↑ mortality x 1.25	3.3%	9.3%	42.9%	7,510.82	105.00	4.75%	vector	RST BC M40	RST_Loads	1.25	1.00
B2	B: ↓ mortality x 0.75	41.6%	17.3%	89.2%	7,510.82	105.00	4.75%	vector	RST BC M40	RST_Loads	0.75	1.00
B3	B: ↑ lapse rates x 1.5	43.6%	15.5%	79.6%	7,510.82	105.00	4.75%	vector	RST BC M40	RST_Loads	1.00	1.50
B4	B: ↓ lapse rates x 0.5	#DIV/0!	10.7%	43.0%	7,510.82	105.00	4.75%	vector	RST BC M40	RST_Loads	1.00	0.50
B5	B: ↑ FYC + 10% up to Target	34.3%	12.6%	58.9%	7,510.82	105.00	4.75%	vector	RST BC M40	RST_Loads	1.00	1.00
B6	B: ↓ FYC - 10% up to Target	47.0%	13.7%	72.2%	7,510.82	105.00	4.75%	vector	RST BC M40	RST_Loads	1.00	1.00

The second (2) step involves updating the premium of **$7,511** to Design RST's competitively benchmarked index-illustrated premium. This is for the same policy design objective of premiums until age **105**, targeting a **$10,000** surrender value but with an index illustration crediting rate of **5.8%.**

This results in an illustrated premium of **$4,528** (from their illustration software and reproduced in the tool as discussed in the Current Illustration functionality module) for this insured.

The index-illustrated premium for Design RST causes the policy to lapse shortly before the insured reaches age **94.** It's important to note that the tool will produce '#VALUE!' errors for key metrics if the policy lapses before the conclusion of the projection period. To address this, the projection period must be set to match the last month the policy is active.

The outcomes of implementing this step and the same sensitivities discussed so far are included below:

		Analysis 02 | RST Loads & COIs | Results & Sensitivities							
		Profit Measures			Key Metrics		Product Design	Multipliers	
ID	Description	IRR	Profit Margin	VONB	Premium	Age at Proj. End	Crediting Rate	Mortality	Lapse
B	**A: RST Loads & COIs**	39.9%	13.1%	65.6%	7,510.82	105.00	4.75%	1.00	1.00
BB	**B: RST Premium & Lapse**	6.4%	0.2%	47.8%	4,528.14	93.75	4.75%	1.00	1.00
BB1	BB: ↑ mortality x 1.25	8.1%	-8.7%	-1.5%	4,528.14	93.75	4.75%	1.25	1.00
BB2	BB: ↓ mortality x 0.75	4.3%	10.4%	102.3%	4,528.14	93.75	4.75%	0.75	1.00
BB3	BB: ↑ lapse rates x 1.5	4.6%	8.6%	83.5%	4,528.14	93.75	4.75%	1.00	1.50
BB4	BB: ↓ lapse rates x 0.5	8.4%	-10.1%	-15.2%	4,528.14	93.75	4.75%	1.00	0.50
BB5	BB: ↑ FYC + 10% up to Target	6.6%	-0.4%	40.2%	4,528.14	93.75	4.75%	1.00	1.00
BB6	BB: ↓ FYC - 10% up to Target	6.2%	0.9%	55.5%	4,528.14	93.75	4.75%	1.00	1.00

The third (3) step solves for the crediting rate that would be necessary to achieve the original policy design objective of obtaining age **105** with a target surrender value of **$10,000.** See below:

		Key Metrics		Product Design
ID	Description	Premium	Age at Proj. End	Crediting Rate
B	A: RST Loads & COIs	7,510.82	105.00	4.75%
BB	B: RST Premium & Lapse	4,528.14	93.75	5.80%

The fourth (4) and final step replaces the RST Premium with the **average premium** for the RST, UVW, and XYZ Designs. This was done to compare each Design under a constant premium assumption of **$4,416**, as seen below.

	Analysis 02 | RST Loads & COIs | Results & Sensitivities				
	Profit Measures			Key Metrics	
Description	IRR	Profit Margin	VONB	Premium	Age at Proj. End
B: RST Premium & Lapse	6.4%	0.2%	47.8%	4,528.14	93.75
BB: Avg RST, UVW, & XYZ Premium	6.3%	0.4%	49.7%	4,416.07	92.83

Summary Results by Step

Step 1: All Load Designs Evaluated with Analysis 01 Baseline Premium

	Step 1: Premium $7,511 with $10k at Age 105			
	Key Metrics	Lapse Rates		
Load Design	Profit Margin	↑ x 1.5	↓ x 0.5	range
RST	13.1%	15.5%	10.7%	4.8%
UVW	13.1%	15.5%	10.7%	4.9%
XYZ	10.8%	13.0%	8.8%	4.2%

STEP 2: Each Load Design is Evaluated with its Illustrated Premium for the Scenario

	Step 2: Load Design Premium and Lapse					
	Key Metrics			Impact of Lapse Rate Change on Profit Margin		
Load Design	Profit Margin	Premium	Lapse Age	↑ x 1.5	↓ x 0.5	range
RST	0.2%	4,528.14	93.75	8.6%	-10.1%	18.7%
UVW	4.1%	4,626.08	91.25	11.4%	-4.6%	15.9%
XYZ	0.9%	4,094.00	89.83	8.4%	-7.9%	16.3%

STEP 3: SOLVE FOR NECESSARY CREDITING RATE TO CARRY TO AGE 105

	Key Metrics		
Load Design	Premium	Lapse Age	Necessary Rate
RST	4,528.14	93.75	5.8%
UVW	4,626.08	91.25	6.5%
XYZ	4,094.00	89.83	7.1%

STEP 4: ALL THREE LOAD DESIGNS AT THE SAME PREMIUM

	Constant Premium		
	Key Metrics		
Load Design	Profit Margin	Premium	Lapse Age
RST	0.4%	4,416.07	92.83
UVW	4.4%		90.50
XYZ	1.0%		91.50

Some of these results are intriguing, even if somewhat predictable. Load Design RST seems less dependent on index interest outperformance, as observed in Step 3, possibly due to a lower margin, as seen in Step 4. However, a few apples and oranges must be investigated before drawing any conclusions.

That said, some avenues one could explore include: Which load designs optimize specific types of performance? The ongoing expansion of the unified framework, developed to compare these products, could be extended to include factors such as commissions, ratings, expense models, etc. That could be an interesting assessment of various products' relative risk and return. However, it is recognized that this may only be an interesting intellectual exercise.

PRODUCT SPECIFICATIONS

ANALYSIS 01: CURRENT LOADS, COIS, AND CREDITING RATES

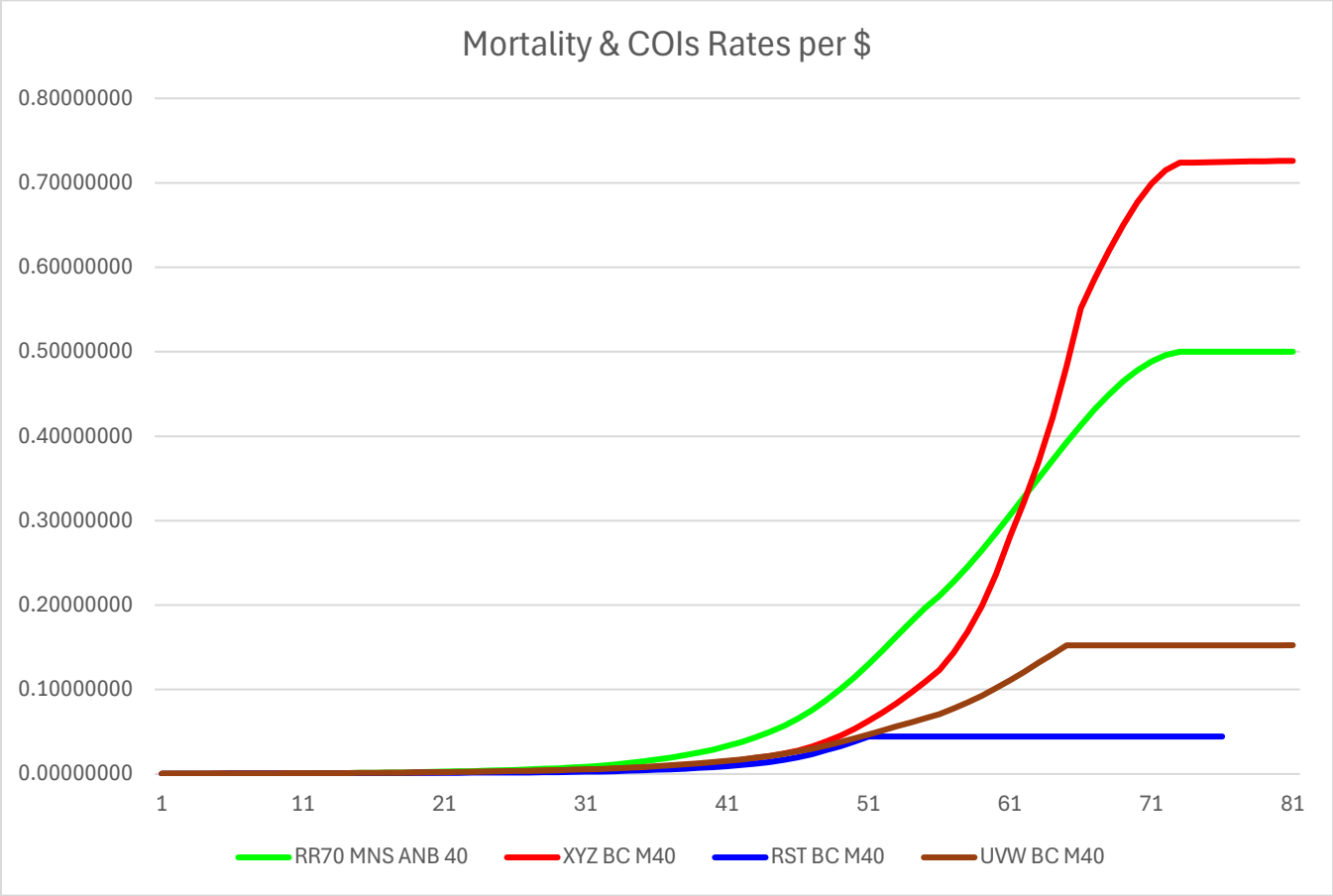
SPECIFICATION	VALUE
% OF PREMIUM LOAD	9% in the First Year, 3% Years 2+
PER UNIT LOAD	$0.72 per $1,000 of Death Benefit in Each of the First 10 Years
MONTHLY FEE LOAD	$6 per Month in All Years
COI	105% of Expected Mortality, excluding Mortality Improvement
CREDITING RATE	4.75%
INTEREST RATE SPREAD	50 bps

Current and Guaranteed Surrender Charges start at **$26** per unit of Death Benefit and **grade off** over **19** years.

LOAD DESIGNS RST, UVW, AND XYZ: CURRENT LOADS AND COIS

Life Product Model | Load Designs | The Life Product Model v0.0.0.xlsm | April 13, 2024									
Load Design Input Area									
Load Design Identifier	RST_Loads			UVW_Loads			XYZ_Loads		
y	% of Premium	Annual Per Unit Load	Monthly Fee	% of Premium	Annual Per Unit Load	Monthly Fee	% of Premium	Annual Per Unit Load	Monthly Fee
1	12.00%	1.44	9.00	7.00%	1.81	10.00	9.90%	1.51	19.00
2	12.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
3	12.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
4	11.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
5	10.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
6	9.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
7	8.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
8	7.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
9	6.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
10	5.00%	1.44	9.00	7.00%	1.81	10.00	5.40%	1.51	19.00
11	5.00%	1.44	9.00	7.00%	0.00	10.00	3.40%	0.00	19.00
16	5.00%	1.44	9.00	7.00%	0.00	10.00	3.40%	0.00	19.00
21	5.00%	1.44	9.00	7.00%	0.00	10.00	3.40%	0.00	19.00

The COI scales for each Design can be found on the Vector Data worksheet but are highlighted in the following exhibit:



Analyses 01 and Analysis 02: Guaranteed Loads, COIs, and Crediting Rates

Specification	Value
% of Premium Load	12.50% in All Years
Per Unit Load	$3.5 per $1,000 of Death Benefit in Each of the First 10 Years
Monthly Fee Load	$10 a Month in All Years
COI	2017 CSO Male Non-Smoker Aggregate ANB Table, this is also used for Statutory Reserves & Section 7702
Crediting Rate	2%

Analyses 01 and Analysis 02: Commission Rates as a % up to Target and Above (Excess)

Distributor compensation, which can also be considered the cost to acquire the policy or lead cost, is outlined below. It would be considered low overall and moderate in the highly competitive premium segment.

Starting Year	1	2	7	11	21
% to Target	130%	2.50%	2.50%	1.00%	0.50%
Excess %	5.00%	2.50%	2.50%	1.00%	0.50%

The Target Premium for the product is **$6,500.**

The compensation is charged back on lapse at **100%** in the first **6 months** and **50%** in **months 7-12**.

Both Case Designs: Insured

Parameter	Value
Gender	Male
Issue Age	40
Underwriting Class	Best Class Available (i.e. Preferred Plus, Super Preferred, etc.)
Face	$1M and Level for Life (Death Benefit Option 1)
Premiums & Target Values	Pay to Age 105 with Target CSV = $10,000

Modeled Assumptions

Set based on professional judgment unless otherwise noted.

Pricing

Assumption	Value
Expected Mortality	RR70 2015 VBT ANB, sex and tobacco distinct, Relative Risk table with no additional loading
Mortality Improvement	0.5% for 20 Years
NIER	5.25%
Target Capital	425%, with specific RBC Factors, developed on the Target Capital worksheet
Reinsurance	Not Modeled

Pricing: Lapse Rates

Year	1	2	3	4	5	6-10	11-15	16-25	26+
Lapse Rate	4.0%	6.0%	5.5%	5.0%	4.0%	3.5%	3.0%	2.0%	1.5%

Pricing: Expenses

Assumption	Value
Per Issue Acquisition	$175
Per Issue Requirements	Full Underwriting: $105 Accelerated Underwriting: $50
Per Unit Acquisition	Full Underwriting: $0.38 per $1,000 of Death Benefit Accelerated Underwriting: Zero
% of Premium Marketing	2.00%
Per Year Maintenace	$50
Per Year Overhead	$50 in Year 1, $10 a Year thereafter
Inflation Rate	2%
Premium / DAC Tax	3.5% of all premiums

Financial

Assumption	Value
Statutory Reserves	Net Premium Reserve using VM-A and VM-C (or existing UL CRVM reserves) with No Stochastic or Deterministic Testing
NIER Backing Capital	2.50%
Misc Profit Loading	25 bps load applied against reserves (discussed further below)
Hurdle Rate	8% Cost of Capital
Inter-Month Lending Cost	1.00% annual effective rate, assessed on all negative cash flows carried between monthly Surplus Account transfers
Projection Period	Equals the premium paying period

The Misc Profit Loading represents sources of profit not included in the product loads. Examples include option cost efficiencies and other non-product leverage not captured by the model. The 25 bps Misc Profit Loading for these analyses was set to produce an IRR of over 8%.

METHODOLOGY NOTES

The "Methodology Notes" section is work I intend to build on independently of the Life Product Model. These notes represent my understanding of the topics discussed based on the necessary investigations to build the Projection Model. For example, it includes the notes I began taking as I investigated the necessary UL CRVM calculations. I see enormous personal benefits in this work; if they develop into something in their own right, all the better.

METHODOLOGY NOTE A | SECTION 7702

Draft Developed by Rod Rishel in January of 2024

Cash Value Accumulation Test (CVAT) factors are calculated at the applicable Accumulation Test Minimum Rate (or contract guaranteed rate if greater) and reasonable mortality (or qualified additional benefit) charges.

The Accumulation Test Minimum Rate is the lesser of 4% or the Insurance Interest Rate.

Guideline Single Premium (GSP) & Guideline Level Premium (GLP) are calculated using reasonable mortality & expense charges and interest at the applicable Guideline Premium Minimum Rate.

The applicable Guideline Premium Minimum Rate is:

> For GSP, it is the applicable Accumulation Test Minimum Rate plus 2 percentage points.
>
> For GLP, it is the applicable Accumulation Test Minimum Rate.

The Insurance Interest Rate is only updated in an Adjustment Year, the calendar year following a change in the Valuation Interest Rate, and is the lesser of :

> Valuation Interest Rate for life insurance with longer durations (guaranteed durations greater than 20 years). This rate is 35% of the lesser of the 12-month & 36-month rolling average of Moody's Seasoned Corporate Bond rates and 3%.
>
> The average (rounded to the nearest whole percentage point) of the applicable Federal mid-term rates, a five-year average of treasury rates between 3 and 9 years duration.

METHODOLOGY NOTE B | STATUTORY RESERVES

The reserves in the Model are calculated pursuant to the PBR Calculation Schematic on page 4 of the Public Policy Practice Note, titled Life Principle-Based Reserves (PB) Under VM-20, published in April 2020 by the American Academy of Actuaries. Specifically, for policies other than Term or ULSG, calculate the Net Premium Reserve using VM-A and VM-C (or existing UL CRVM reserves).

No Stochastic or Deterministic reserves are modeled and are not considered material for the current objectives of the Model.

The UL CRVM reserves in the Model are calculated consistent with the general approach outlined in Chapter 14 of Statutory Valuation of Individual Life and Annuity Contracts, Fifth Edition, written by D. Clarie, L. Lombardi, and S. Summers, copyright 2023 ACTEX learning. This includes:

The Guaranteed Maturity Premium (GMP) is calculated as the gross level premium that endows the policy for the face amount at the maturity date using guaranteed loads, mortality, and expense charges.

The Guaranteed Maturity Values (GMVs) represent the amounts that will endow the policy when combined with future GMPs.

The Current Values are projected forward under the applicable policy design, current COIs, loads, and expense charges under a reasonable interest rate assumption.

The r-ratio is calculated as the Current Values divided by the Guaranteed Maturity Values.

The UL CRVM Model Regulation reserve is equal to:

(r-ratio * NLP Reserve) – (r-ratio * Unamortized CRVM Expense Allowance)

The Model uses this approach with the UL CRVM Mode Regulation reserve written from a first principles perspective as:

r-ratio * Statutory Net Premium Reserve, or

r-ratio * (Present Value of Statutory Benefits – Present Value of Statutory Net Premiums),

where:

The Present Value of Statutory Benefits and Present Value of Statutory Net premiums are set to the cost of insurance in year one and is a net level premium reserve thereafter.