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Actuarial Modeling Systems: How Open We WANT Them to be vs. How Closed We NEED Them to be

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The debate over whether closed or open code systems are better positioned to meet actuarial modeling needs has been going on in the insurance industry for decades. Discussions on this topic can become very passionate and involve insurers, consulting companies and vendors. Moreover, the debate can rage within organizations, often dividing functional teams and departments based on their strong opinions. Functional teams tend to focus on their unique business requirements and ultimately choose the type of system that best meets their specific needs. In a real-world setting, typical divisions exist between pricing groups, which desire the ability to customize on the fly, and valuation and projection groups that need to maintain locked-down, controlled environments for financial reporting. Both sides have valid arguments expressed through lively and often contentious debates.

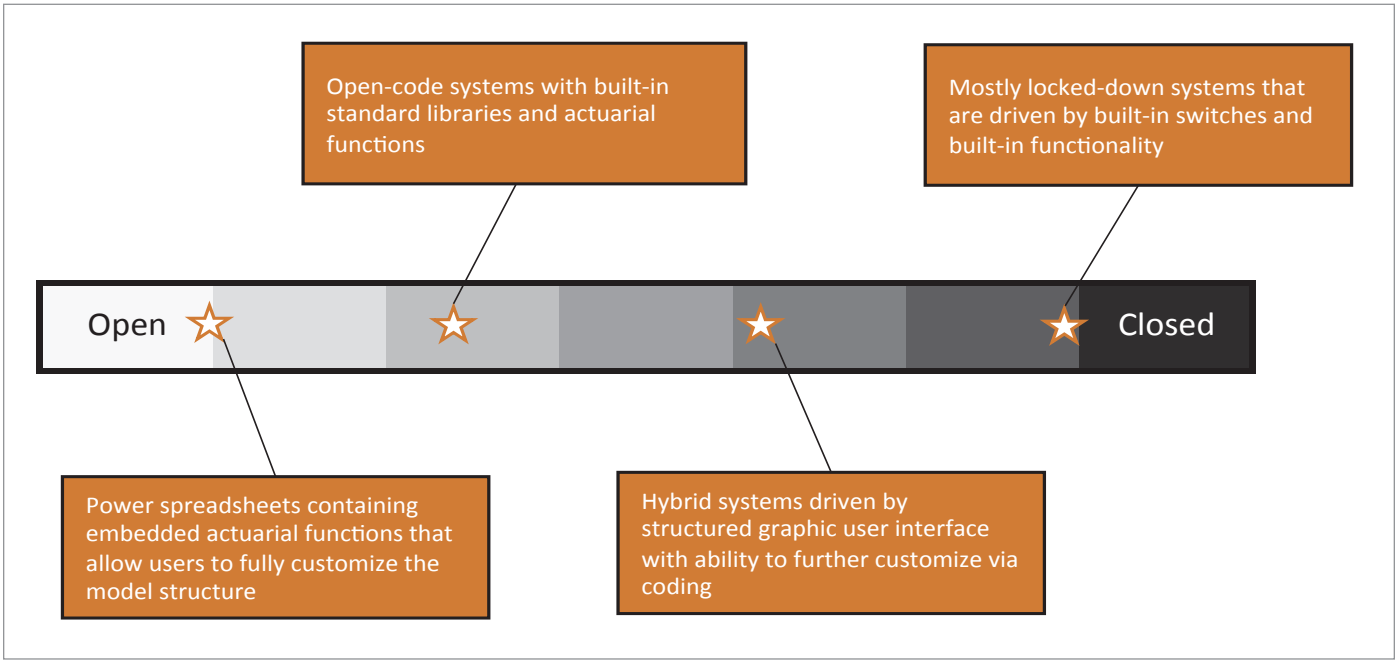
As a result of key stakeholders' competing priorities and varying business requirements, there is no clear front-runner in the systems race. In certain instances, some insurers have drastically changed their operating models in order to force a single-system solution, as they satisfied the priorities of the more vocal group's priorities. However, this is not a common practice in the insurance market and often results in discontent, frustration and lost productivity within the losing group. With unique strengths and weaknesses to each type of system, companies often end up using a combination of systems to satisfy the need of various groups. The way companies use the systems is dictated by the business requirements of each group and can vary drastically. Some companies see actuarial systems as simply an actuarial liability calculator, where data are prepared and transformed externally and the exported cash flows are aggregated and summarized in a database platform. Others prefer an all-in-one solution, utilizing the system functionality to its greatest potential, carrying out data transformation and reporting analytics within the system environment. Additional differences in system use typically include level of automation, model governance practices, modeling environment setup and supporting tools used in conjunction with actuarial systems.

Actuarial system vendors have taken a distinct approach to address competing priorities (and variation in use); some systems are built to satisfy a specific need and/or function, such as valuation, while others are designed to be multipurpose with the ability to support pricing, valuation and projection in a consistent manner. In both approaches, as vendors cater to their clients, differences between open and closed systems are becoming less and less clear.

As the differences between open and closed systems continue to blur, it is helpful to take a minute and understand the evolving universe of systems. Closed systems have become more open to allow the users to customize their models via coding and advanced logic, while open-system vendors have built additional out-of-the-box functionality into the systems' standard libraries. As a result of these actions, the evolution in actuarial systems has created a system openness spectrum rather than two mutually exclusive system types.

On the open end of the spectrum, there are the power spreadsheet systems that provide an Excel-like environment for the user to embed actuarial formulas relevant to their calculations. These systems are fully user-driven and offer maximum flexibility in the way companies choose to build their models. Closer to the middle are the open code systems that allow actuaries significant flexibility in customizing their models and calculations to their needs. These systems typically use coding languages similar to VBA or C++ and rely on the user to code in the logic referencing standard libraries and other out-of-the-box functions. Closer toward the closed end of the spectrum one finds the hybrid systems that provide a structured graphic user interface with some built-in model configuration switches and options, yet allow the user to do a fair bit of coding to map

Figure 1
Actuarial Systems—Openness Spectrum



model components and create complex calculation logic. Finally, on the closed end of the spectrum are the mostly locked-down systems that rely on the built-in functionality and flexibility to meet all the model customization needs of the users. Figure 1 graphically depicts the actuarial system openness spectrum.

As one can expect from a market perspective, there is no widely accepted solution to help traverse issues surrounding competing priorities. Obvious as it may sound, insurance companies are looking for modeling systems that are open where the modelers want them to be open and closed where they need them to be closed. This perpetuates the conflicting priorities that are being faced by companies. Moreover, these needs will vary from company to company, and, therefore, no one-size-fits-all system can exist. When the conflicts occur within a company, this often results in a company operating with two or more systems, each fit for different modeling needs. This satisfies the priorities of each group but may not be economically or practically viable.

With no "silver bullet" solution offered by vendors or demanded from the industry at large in sight, this article discusses various factors that should be considered when evaluating the business requirements and subsequent modeling priorities within your organization. We compare and contrast mostly open and mostly closed systems across multiple business dimensions, highlighting the key advantages and disadvantages of each type of system. We focus on the common areas where conflicting priorities arise within functional groups, including model governance, efficiency and functionality, auditability and transparency, and cost and risk of system maintenance.

GOVERNANCE AND CONTROL ENVIRONMENT

Governance and model controls have become a concern in recent years. Stakeholders, including vendors, insurance companies, regulators and rating agencies, all have strong opinions on this topic. As actuarial models become more complex and highly integrated into production processes, controls over model access, revision and execution have become critical. Both open- and closed-system vendors have taken steps to improve their systems' ability to build in model controls and implement governance policies. Table 1 highlights several items to consider as part of the healthy discussion on choosing a closed or open system.

Table 1
Governance and Control Environment: Open/Closed Systems Comparison by Category

Category	Closed Systems	Open Systems	System Selection Considerations
Model governance	Model governance frameworks are provided by the vendor and are customized by the customer. Advantage: The provided governance frameworks are industry tested and improved over time through customer feedback. Disadvantage: Users are only allowed to customize their model governance framework within the limits offered by the vendor.	Each customer is responsible for setting up their own model governance framework. Advantage: Users can customize the governance framework as needed to reflect their company's specific needs. Disadvantage: Governance framework for the same system can differ significantly across users, making it hard to derive industry-leading practices and potentially requiring multiple refinements over time.	Company risk appetite Existing governance programs in place Resource availability Company-level vs. function-level requirements Ability to create, monitor and enforce governance policies within organization Audit requirements
Control environment	Models would generally allow users to customize calculations, but warn them when illogical operations are performed. Prescribed calculations are controlled and locked in (these include items like prescribed statutory reserves calculations). Advantage: Risk of illogical or not actuarially sound calculations is minimized. Disadvantage: Less transparency into calculations behind locked-in components, and potential over-reliance on the system may increase human-error risk.	Users are able to customize controls over calculations for each model component. Systems often include role-based controls customized for each user. Advantage: Customized controls work well for unique calculations and the customer achieves full transparency into all model calculations. Disadvantage: Customized controls may not be adequate or correctly set up.	Actuarial and IT operating model Company risk appetite Uniqueness of product design and level of customization Existing controls around actuarial processes Audit requirements
System documentation	Robust vendor-provided documentation accompanies the system and gives insight into calculations of actuarial components as well as technical documentation for the system to the extent the customer needs to be aware of its functionality. Advantage: Detailed explanations of system calculations increase customer's ability to understand complex model calculations. Disadvantage: Not all calculations and variable interactions are defined within the system documentation. Items that are extremely obscure or rare may require direct communication with the vendor for supporting documentation.	Robust documentation that details standard libraries, out-of-the-box functionality and methods to customize are typically provided. Advantage: Customer has the ability to gain a complete understanding of standard libraries and out-of-the-box functionality. Disadvantage: Documentation does not provide comprehensive detail on how to perform customization for company's unique needs.	Resource skill and understanding level Actuarial support model (reliance on third parties) Model and product complexity Level of customization required Audit requirements

Clearly both open and closed systems are moving toward allowing the users to implement governance policies and model controls. However, closed systems have taken a more restrictive position over governance processes, while open systems leave much of the setup and implementation work of these processes to the user. In this category, it is key to match system capabilities with the distinct operating model of the company, since it would help resolve the open versus closed system debate.

EFFICIENCY AND FUNCTIONALITY

Actuarial models are challenged to carry out increasingly complex calculations, driven by product features, risk mitigation strategies such as sophisticated hedging techniques and evolving regulation. Despite exponential increases in processing speed, and the scalability of grid and cloud approaches, model run time and expense remain a concern. In a practical sense, virtually infinite computing power is available through a variety of technology solutions, but in reality, multiple concurrent and tiered processes extend production timelines beyond typical management comfort zones. Outside of production and financial reporting function groups, other groups within the organization have calculation requirements that vary dramatically. Table 2 highlights several efficiency and functionality considerations that should be openly discussed in the debate regarding closed and open systems.

Table 2
Efficiency and Functionality: Open/Closed Systems Comparison by Category

Category	Closed Systems	Open Systems	System Selection Considerations
Automation	Closed systems can be seamlessly automated as part of the larger end-to-end production process. The system environments tend to include pre- and post-model elements such as data transformation and structured reporting layers. Advantage: Automation allows for accelerated production timeline, efficient end-to-end process execution and minimization of the risk of human error all the way through the process, from data transformation to structured reporting. Disadvantage: Interaction protocols with outside systems are limited to vendor-provided functionality.	Business process management tools are built in and enable interaction with outside systems and databases. Advantage: Automation allows for accelerated production timeline; interaction protocols are flexible to customers' unique needs. Disadvantage: Interaction protocols with outside systems are limited to vendor-provided functionality.	Existing automated processes in production cycle Pre- and post-model processes The need for manual adjustments pre/post model run Model and process run time Model complexity IT support available
Speed	The vendor has the ability to optimize calculations to increase speed through ongoing testing and customer feedback. Advantage: Since vendor coders are professional programmers, they have deep expertise in code optimization that results in faster model runs. Disadvantage: The customer does not have control over model efficiency outside of what is available through user interface.	Open systems leave it up to the customer to optimize model run time through efficient model processes. Advantage: The customer has control over model efficiency and run time and can gain understanding of efficient modeling techniques through testing. Disadvantage: Actuaries typically do not have sufficient understanding of the technical side of model optimization and are likely not to best optimize model run time.	Model and process run time Computing power available (number of CPU cores and servers) Model and product complexity Speed of model-adjacent processes IT support available

CONTINUED ON PAGE 20

Table 2
Efficiency and Functionality: Open/Closed Systems Comparison by Category, *continued*

Category	Closed Systems	Open Systems	System Selection Considerations
Flexibility and out-of-the-box functionality	Out-of-the-box functionality is available, industry tested and improved over time through customer feedback. Vendors are open to implementing system modifications for missing features. Advantage: Industry-tested out-of-the-box functionality minimizes the risk of errors in calculations and reduces implementation time. Disadvantage: System flexibility is limited within the vendor setup, it is impossible to implement additional functionality without help from the vendor and it may be difficult to leverage built-in functionality for unique product features.	Standard libraries and out-of-the-box functionality are available but need to be customized by the customer. Advantage: Ability to customize calculations increases flexibility and allows for coding of unique model components and product features, while the incremental changes needed for customization and implementation time might be reduced. Disadvantage: System openness increases the risk of calculation error and makes it more difficult to remain consistent across models.	Model complexity Uniqueness of product design and level of customization Resource skill and understanding level Appetite for manual adjustments pre/post model run Vendor flexibility and ability to modify the system
Regulatory readiness	Vendors keep on top of regulatory developments as dedicated resources maintain an ongoing dialogue with the users, implementing new regulatory requirements in a timely manner. Advantage: Users receive new functionality through routine system version upgrades. Logic is industry tested and refined by the vendor, as the vendors have dedicated resources to build new regulations into the systems. Disadvantage: Unique, customer-specific interpretation of regulations would need to be requested as a customized modification that may take some time to implement.	The customer has the flexibility to code new regulatory modules on their own without vendor help. For the more complex regulatory needs, the vendor would update the standard libraries and out-of-the-box functionality. Updates can vary in their timeliness. Advantage: Open system provides additional flexibility in implementing new regulatory requirements into the models, and unique interpretations of regulatory rules can be easily coded by the modeler. Disadvantage: Customized coding of new regulatory requirements may lead to misinterpretation of the regulation or incorrect implementation. The effort needed to incorporate changes can vary significantly based on the update.	Uniqueness of product design and level of customization Resource skill and understanding level Vendor flexibility and ability to modify the system Company interpretation of specific regulatory requirements
Reporting of results	Closed systems have multiple flexible built-in, customizable reports in lieu of the customer having to access calculations to produce output. Some systems include user formula report options, allowing the user to build in custom report variables. Advantage: Minimal customization is required and many template reports are available, industry tested and enhanced over time. Disadvantage: It is difficult to get additional details outside of what the template reports offer.	Standard reports with a high degree of customization are typically available within open systems. Advantage: Open systems allow for flexibility in report building and full transparency into the calculation formulas used. Disadvantage: Coding may be required to extract desired interim and final values.	Existing reporting processes and potential future enhancements Silo or aggregated result reporting The need for manual adjustments pre/post model run Regulatory requirements affecting the company Model and product complexity IT support availability

While open systems allow more flexibility to users to model their product features more accurately, the concept of "industry tested" functionality gives some actuaries peace of mind. With open code systems the user has full control over model efficiency; however, it takes a strong programmer to truly optimize model structure and code execution behind the scenes. Clearly, the trade-offs between the two types of systems are significant and the breakdown of efficiency and functionality provides additional fuel to the fire in the debate.

AUDITABILITY AND TRANSPARENCY

The argument surrounding actuarial systems typically involves a discussion on their ability to justify and reconcile results. Whether it is a leadership or auditor request, model reconciliation and policy-level calculation replication using standard tools like MS Excel are common practice in our field. While some products can be easily reconciled by reviewing the mortality and lapse decrements, others are much more complex and involve advanced calculations. Therefore, model auditability and transparency remain important considerations for actuarial modelers and could potentially become a deciding factor for competing priorities. Table 3 provides a comparative view of audit and transparency advantages and disadvantages for open and closed systems that are often part of an actuarial system discussion.

Table 3
Auditability and Transparency: Open/Closed Systems Comparison by Category

Category	Closed Systems	Open Systems	System Selection Considerations
Auditability and transparency of assumptions and calculations	Closed systems allow the customer to extract high-level summaries of assumptions used and some calculated values used in interim calculations. Advantage: Vendors have proactively increased the transparency of the system by creating extracts of assumptions and interim values. Disadvantage: In some closed systems, these summary-level reports would not be sufficient for detail policy reconciliation exercises if they do not show intermediate calculated values.	Open systems offer full control over calculations and the ability to output interim calculated values. Advantage: By allowing full control of calculations, open systems make it easier to reconcile policy-level results and gain full transparency into step-by-step model calculations. Disadvantage: Coding may be required to extract desired values from the calculation sequence.	Model and product complexity Complexity of calculations Uniqueness of product design and level of customization Resource skill and understanding level Actuarial support model (reliance on third parties) Existing documentation of legacy models and products Model testing protocols and reconciliation thresholds

Although it may seem obvious, companies should consider the underlying need for auditability and the level of transparency offered by the actuarial system. The level of comfort around internal methodologies/calculations and corresponding transparency will vary by company and functional area. While closed-system vendors continue to improve model auditability by building in additional reporting tools that report intermediate policy-level calculations in a detailed manner, open systems remain mostly transparent and are often easier to reconcile.

SYSTEM MAINTENANCE

An often overlooked consideration that is extremely critical to the operating model success of an organization and model sustainability is system maintenance. While building a functional and efficient model is an important and complex process, appropriately maintaining the model and the system it resides in is key for model longevity and risk management. Vendors play a big role in system maintenance—they are the ones who continue to improve their respective systems and add functionality to them. They are often the ones who can train modelers or offer consulting services if a certain skill is missing within an organization. Table 4 provides a few aspects of actuarial system maintenance that should be considered when weighing pros and cons of closed and open systems.

Table 4
System Maintenance: Open/Closed Systems Comparison by Category

Category	Closed Systems	Open Systems	System Selection Considerations
User interface	Closed systems have a logical graphic user interface (GUI) built in. Advantage: The GUI makes it easy to navigate through the model, requiring minimal coding. Disadvantage: The GUI presents a risk of inadvertently changing a switch or value in the model.	Varying level of GUI is available in open systems. Advantage: It is more difficult to inadvertently change code since it has predefined syntax. Disadvantage: Less logical code or formula-based environment can be difficult to get accustomed to and in-house expertise will need to be developed and maintained to successfully manage models.	Resource skill and understanding level Model and product complexity Uniqueness of product design and level of customization Available system documentation
Cost and required skills for model maintenance	Since closed systems are more user-friendly, they are easier and less costly to maintain. Maintenance processes can be automated and performed by actuaries and IT teams without requiring system-specific code knowledge. Advantage: Streamlined model maintenance processes can reduce costs and do not require specialized skills. Disadvantage: It is possible to make accidental changes to existing models; for instance, inadvertently changing a drop-down option choice.	Model maintenance processes would require additional coding but can be partially automated. Advantage: Model updates would be thought through in detail as they would need to be specifically coded into the system. Disadvantage: This mostly manual approach can be time-consuming with potential room for human error.	Model and product complexity Resource skill and understanding level Actuarial support model (reliance on third parties) Vendor support model
Key-person risk	Closed models are more standardized across the industry. Advantage: Closed models are easier to understand due to their being generally standardized across the industry, which makes them easier to maintain and modify. Disadvantage: Although easier to understand, closed models present their own unique set of institutional knowledge risk. Parameters can sometimes be cryptic and workarounds incorporated to accommodate rigid aspects of the system.	Intimate understanding of open-system company models remains in-house, not with a vendor or third party. Advantage: Open code is more widely known and does not require system-specific expertise. Disadvantage: Key-person risk potential is increased with open models since only a small group of modelers intimately understand the model and the history of code development.	Model and product complexity Resource skill and understanding level Actuarial support model (reliance on third parties) Vendor support model Knowledge transfer and training protocols Model and product documentation Department size Employee retention

Table 4
System Maintenance: Open/Closed Systems Comparison by Category, *continued*

Category	Closed Systems	Open Systems	System Selection Considerations
Version upgrades	Closed systems allow for vendor-pushed version upgrade. Advantage: For closed systems, version upgrades are automated processes that easily up-convert the model and all its components to the next version. Disadvantage: Thorough model testing would be required to confirm that no unintended impacts affected the model from version conversion.	Open systems allow for vendor-pushed version upgrades. Advantage: For open systems, version upgrades are streamlined processes that compare vendor and company modifications. Disadvantage: Manual comparison of models and merging of vendor and company modifications are required. Often undertaking a version upgrade could pose an insurmountable task.	IT support available Vendor support model Model and product complexity
Vendor role and dependency	Closed-system vendors are highly market focused, implementing new functionality into their systems as regulations evolve and providing customer support for their platforms. Advantage: Vendor support allows closed-system models to be consistent across the industry since vendors typically focus on leading practices while assisting users. Disadvantage: closed-system users are highly dependent on the vendors for available system flexibility and functionality.	Open-system vendors provide various levels of support with the software agreement that include development, upgrade and maintenance support. Advantage: Vendors maintain their standard libraries and out-of-the-box functionality and are available to answer questions on these. Disadvantages: Users are responsible for model build and customization, which can be costly to support as there is no standardized model build. Vendors need to understand customization before they can provide support.	Vendor support model Model and product complexity Resource skill and understanding level Actuarial support model (reliance on third parties) Knowledge transfer and training protocols

Closed systems make it easier for the modelers to maintain models residing in these systems, as part of the responsibility for system maintenance lies with the vendor. Open systems are often more difficult and costly to maintain and update, due to the varying levels of model customization. Additionally, closed systems make it easier for new modelers to become proficient as a result of structure consistency across models, thereby reducing key-person risk. When trying to select between the two systems, understanding the near-term and long-term maintenance implications is critical.

In the previous comparisons, we outlined explicit advantages and disadvantages to both open and closed systems as well as items to consider when going through system selection. With these in mind, the question that will drive the system selection is, at what cost and at what risk to the organization would the company decide on implementation of a particular system, be it open or closed? Both short-term and long-term costs and risks need to be defined and considered at company and functional group level, as these will vary significantly at both levels. In

Several questions need to be considered when navigating competing priorities in open and closed systems:

1. Which functional group or key constituencies need a seat at the table to determine the considerations that need to be addressed (or their priority)?
2. How do you develop an appropriate business case that communicates the priorities that are most relevant to the organization, the complexity of the problem, practical considerations and the ultimate solution to senior leadership and constituents?
3. Which priorities (or issues) are being defined in hopes of developing point solutions versus defining capabilities that need to be addressed for future considerations and requirements?
4. What costs and potential risks could originate from a particular system implementation, both short and long term?

general, short-term costs would be incurred as a result of system implementation and model environment setup, while long-term costs would originate from ongoing model use and maintenance, ad hoc model updates and model validation exercises. These costs would include time and resources resulting from hiring and training talent with specialized system expertise, hiring external consultants to support system implementation, system licensing and potential vendor support costs. Similarly, short-term risks would result from delays and scope creep in system implementation, while long-term risks would include key-person risk, human-error risks, model-complexity risks, risks related to misinterpretation of results and other similar risks resulting from an inadequately governed and maintained model or modeling system that does not satisfy users' business requirements. These business requirements can generally be grouped into four categories, consistent with our comparison earlier in the article, and would require the system of choice to support the following tasks:

1. **Supporting governance.** Creating a controlled modeling environment and enforcing model governance policies
2. **Maximizing efficiency.** Automating processes to reduce model run time and enabling a company to model all of its products and product features
3. **Enhancing transparency.** Providing the ability to clearly identify and review all model components and calculations through auditability functionality of the system
4. **Minimizing costs.** Allowing for implementation of system and model maintenance routines while avoiding additional costs and risks over the model life cycle

Navigating the competing and occasionally conflicting priorities in the system selection journey will remain a challenging exercise for insurance companies. The evolution of systems is somewhat uncertain, but as the trend would indicate, as closed systems become more open and allow for more flexibility, open systems provide more out-of-the-box, locked-in functionality. Undoubtedly, each company will need to decide on the system that best aligns to its needs. Although alignment may vary between groups, we recommend the selection process be rooted in categories that are ultimately relevant to the actuarial organization. These items are increasingly becoming topics that redefine the actuarial operating model to be less involved with routine technical tasks and more focused on result analysis and problem solving. ■

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