THE ARENA PRODUCT FAMILY: ENTERPRISE MODELING SOLUTIONS

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ABSTRACT

Organizations throughout the world are quickly moving to adopt process modeling and simulation as an integral part of their business decision-making and continuous improvement initiatives. With wider acceptance of simulation, these consumers are demanding tools that support a breadth of applications, scale to fit different needs through a project life cycle, and integrate with corporate modeling and database systems.

Systems Modeling fulfills these needs in the Arena product family, encompassing Arena Business, Standard, and Professional Editions for mapping processes and simulating discrete and continuous systems; Arena Call Center for call-center analysis; and Arena Packaging for high-speed production-line modeling. These products complement each other in meeting the various needs for simulation in an enterprise via a common software interface and compatible features, providing a natural growth path as simulation needs expand.

One of the latest additions to the Arena family of products is OptQuest for Arena, an optimization software package. OptQuest helps users optimize performance parameters that are of critical importance in the design of the systems under study.

This paper introduces the Arena suite of products for modeling, simulation, and optimization highlighting product architecture and technology features that are targeted toward successful deployment of simulation and Arena throughout an enterprise.

1   INTRODUCTION

Today's business managers are rapidly embracing modeling and simulation as required competencies. Continuous process improvement, business process reengineering, and ISO 9000 compliance initiatives have motivated organizations to look for ways to capture, document, and communicate enterprise operations. Leading organizations employ these models further by simulating them to explore alternative changes to the business before implementation.

Simulation also has maintained significant growth in traditional decision-support activities. Many organizations have instituted policies requiring simulation analysis prior to capital expenditures over a prescribed threshold. Others have formed centers of expertise in modeling and simulation where professional analysts provide internal training, coaching, and consulting to institute a common methodology for using simulation successfully. In service, manufacturing, communications, government, and other segments of worldwide economies, simulation is employed widely for enabling better decisions, improving processes, and avoiding costly mistakes.

The Arena product suite is designed for use throughout an enterprise, from strategic business decisions, such as locating capacity in a supply chain planning initiative, down to operational planning improvements, such as establishing production line operating rates. All Arena products share a common software foundation so that integrated organizations can establish a common methodology using a scaleable tool, leveraging product knowledge throughout diverse business entities.

The Arena product offerings begin with the Business Edition (Arena Business Edition), which is targeted both at modeling business processes and at simulating other systems (e.g., manufacturing, service) in support of high-level analysis needs. For more detailed models of discrete and continuous systems, the Arena Standard Edition (Arena SE) provides complete modeling flexibility, enabling analysts to capture the dynamics of a system at any required level of precision. The Arena Professional Edition (Arena PE) enhances Arena SE with the capability to craft custom simulation objects that mirror components of the real system, including terminology, process logic, data, performance metrics, and animation.

The Arena family also includes products designed specifically to model call centers and high-speed production lines—two application areas of significant business value: Arena Call Center and Arena Packaging.

The design of the core product engine makes Arena easy to learn and use and provides robust modeling and integration capabilities. New users find an inviting, familiar interface through Arena's compatibility with Microsoft® Windows 95/NT® and Microsoft® Office 97. As simulation is employed more widely and for detailed system modeling, analysts can be confident of capturing the needed detail in Arena's robust modeling constructs.

The power afforded by Arena extends to its ability to integrate with other technologies, such as databases, drawing/modeling products, or spreadsheets. ActiveX™ and Visual Basic® for Applications (VBA), Microsoft's key technology backbone for desktop application integration, are fully implemented in all Arena products, enabling Arena to utilize existing enterprise models and data hosted in applications such as Microsoft Office, Visio®, Oracle®, etc.

After an overview of the Arena software engine, the following sections describe the role and value of each of the Arena product offerings. Finally, we will discuss and outline the tremendous value that using OptQuest for Arena brings to the decision making process.

2 ARENA: AN ENTERPRISE SOLUTION

2.1 Enterprise Needs for Adopting Simulation

Two overriding themes dominate the issues that organizations face as they craft strategies for deploying simulation widely. The first challenge is how to broaden effectively the use of simulation throughout the organization. Often, pockets of success exist in various parts of the company. Bringing these business entities together to implement a consistent, compatible approach can benefit the organization tremendously and can heighten the visibility of simulation in other parts of the company.

The second theme is a drive to enhance the value of simulation initiatives to the enterprise by leveraging investments in tools and methodologies. Here, there are elements of direct investment related to simulation use (e.g., software, and training) and of utilizing corporate assets that already are in place (e.g., databases, CAD, and other drawings).

2.2 Arena's Product Architecture

Arena products utilize a core software engine (Figure 1) that is designed with the following objectives to address these enterprise needs:

- Ease-of-use and rapid mastery
- Power for complex system modeling
- Modeling objects that closely fit the target systems
- Built-in integration with leading applications

- Open architecture to leverage corporate information and support custom applications

Certified as Office 97 compatible, Arena provides a clean, crisp appearance. Its user interface features include customizable toolbars; natural interface control such as drag-and-drop and context-sensitive right-click menus; and a unique Project Bar for accessing modeling constructs and navigating model hierarchy.

Figure 1: Arena Software Architecture

Investing in a simulation product for use throughout an enterprise requires the assurance that projects of any complexity or scale can be completed at the desired level of precision. With SIMAN inside, Arena exploits a heritage of power simulation software in a natural, graphical interface. More than 5,000 users have stretched model size and complexity to great extremes, finding Arena to be a capable and powerful tool.

For analyzing processes and systems that occur in many sites or segments of the organization, the simulation tool must be tailored to mirror the environment in which it will be used. Arena's AST technology creates the opportunity for organizations to craft their own simulation tool kits for these applications. As an enterprise matures in its use of simulation, suites of custom tools can be made available to new users, lowering the barriers to successful simulation use and encouraging standard practices and methodologies.

To enhance the value of simulation and its use of existing corporate information assets, Arena products deliver built-in, flexible interfaces with leading desktop applications. Data can be incorporated directly from Microsoft® Excel into models. Model logic and data can be transferred from Visio drawings, providing an inexpensive, widely adopted front-end for creating models that are to be simulated in an Arena product. And for animation, graphics in Visio or AutoCAD® can be

imported directly for Arena's static background or for dynamic pictures of entities, resources, etc.

Finally, Arena's robust ActiveX Automation support and Visual Basic for Applications gives forward-thinking organizations confidence in making the right choice in simulation software. ActiveX and VBA are Microsoft's strategic technologies for desktop application integration. This standard, open architecture provides insurance against future change in corporate information resources. VBA further enables the creation of custom interfaces and applications using a widely adopted programming engine.

3 MAPPING PROCESSES WITH ARENA BUSINESS EDITION

3.1 The Challenge: Improving Business Operations

One of the most significant outcomes of the recent attention to process improvement has been a rediscovery of the value of modeling. Until recently, any understanding of the sequence of activities required to complete a process—whether fulfilling an order, producing a part, or servicing a customer—typically was stored in written documents. These operation manuals often failed to reflect the actual rules and metrics used in the organization, quickly became outdated, and were strictly intended to document the "as-is" operations.

With the growth business process reengineering (BPR) initiatives, spurred by the challenge to change in *Reengineering the Corporation* (Hammer and Champy 1993), organizations have begun to view their business operations in a new light. Understanding the "as-is" environment and looking at revolutionary possibilities for the future "to-be" organization require methodologies and tools to enable process documentation and analysis (Taylor 1995). And, many of the reengineered process implementations depend on broad, timely access to information, driving the creation of robust, continuously maintained corporate databases

3.2 The Solution: Dynamic Process Modeling and Animation with Arena Business Edition

Arena Business Edition represents process dynamics in a hierarchical flowchart and stores system information in data spreadsheets (Figure 2). With built-in activity-based costing and robust system performance data, Arena Business Edition provides the measures needed to predict the impact of change and to choose the best process configuration.

Through its methodology independence, Arena Business Edition is effective for analyzing business, manufacturing, service, and other systems. Common drivers for simulation—visualizing the dynamics of a process, measuring costs, identifying bottlenecks, and

establishing staffing and equipment capacities—are easily accomplished in the Arena environment.
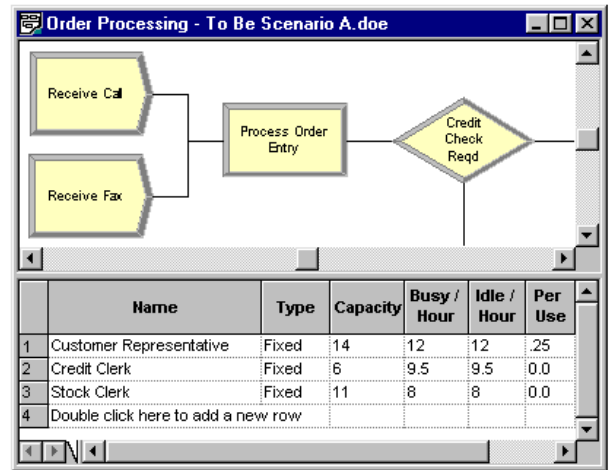

Figure 2: Arena Business Edition Flowchart and Data

Arena Business Edition readily exploits existing information systems. Its close integration with Visio allows wide access to models and modeling tools in the enterprise. And through Arena's standard ActiveX and DAO interfaces and VBA, corporate data can be incorporated directly into the simulation models.

4 ANALYZING SYSTEMS WITH ARENA STANDARD EDITION

4.1 The Challenge: Enhancing Critical Business Decisions

Though the use of modeling and simulation in business process improvement is a recent trend, its benefits for analyzing manufacturing, service, transportation, and other complex systems are well-established. In these environments, simulation is most often used on a "project" basis. A model is created, validated, and analyzed to serve a particular purpose, typically in support of a decision involving significant process change or capital acquisition.

The nature of the systems that have been successfully analyzed with simulation varies significantly. The items moving through the system might be customers, engine parts, candy, chemicals, or electronic data packets. Even within a single enterprise, simulation might be employed in service of widely disparate needs.

4.2 The Solution: Flexible Modeling and Animation with Arena Standard Edition

To exploit simulation effectively, organizations are selecting software tools that provide the assurance of capturing all of the essential aspects of critical business operations. Investing in the use of simulation as an ongoing

part of decision-making also requires a tool that can incorporate data, models, and graphics from many different sources, ranging from corporate databases to desktop drawing programs.

The Arena Standard Edition delivers to the enterprise the capabilities needed for analyzing all types of systems. First released in 1993, Arena employs an object-oriented design for entirely graphical model development. Simulation models are built using graphical objects—called modules—to define system logic and physical components such as machines, operators, clerks, etc.

The Arena template is the core collection of modules providing general-purpose features for modeling all types of applications. In addition to standard features, such as resources, queueing, process logic, and system data, the Arena template includes modules focused on specific aspects of manufacturing and material-handling systems. Arena SE also effectively models combined discrete/continuous systems, such as pharmaceutical and chemical production, through its built-in continuous modeling capabilities.

Arena SE's broad acceptance is greatly attributable to its flexibility for accurately capturing the essence of a wide variety of systems. At the heart of Arena is the SIMAN simulation language, which provides a powerful foundation for modeling complex systems and a fast simulation engine for efficient analysis of design alternatives.

For animating simulation models, Arena's core modeling constructs are accompanied by standard graphics for showing queues, resource status, entity flow, etc. Compelling animations are easily created using Arena's built-in drawing tools and by incorporating clip art, AutoCAD, Visio, and other graphics (Figure 3).
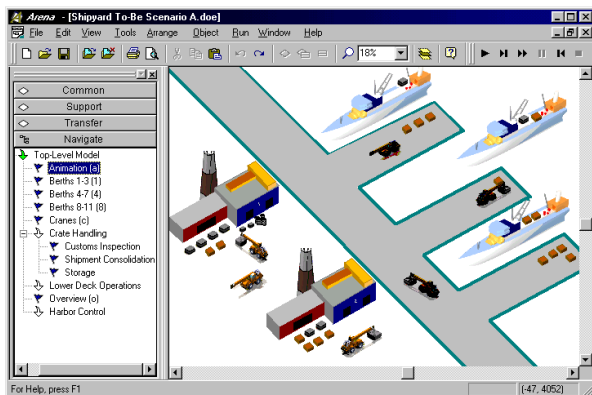

Figure 3: Arena Animation

Arena mirrors the natural organization of system models via its robust hierarchy. Models can be created "top-down," adding detail at lower levels of hierarchy as a project progresses. Or, a model can be composed from the bottom up by combining individual submodels into a complete system model. Arena's novel submodel aggregation enables quick change of model hierarchies by automatically moving a set of objects to a lower-level submodel and adjusting all affected model connections.

All of the supporting services needed for successful simulation accompany Arena SE. The Input Analyzer automates the process of selecting the right distribution and its parameters for representing existing data, such as process and interarrival times. Built-in confidence intervals measure the reliability of simulation results to aid in establishing proper run parameters. And the Output Analyzer and Scenario Manager automate comparison of different design alternatives.

5 IMPROVING CALL CENTER PERFORMANCE WITH ARENA CALL CENTER

5.1 The Challenge: Managing Change in Call Centers

A company's call center is its most visible strategic weapon. It is a business battlefront where millions of dollars of products and services are purchased, sold, and traded. It is also a place where thousands of customers are won and lost every second of every minute. As leading companies become more creative in disseminating information and providing value to their customers over telephone lines, it is only natural that they are looking at their call center as their beachhead into the market or industry that they serve.

The trend within the call-center industry itself is that of increasing complexity. The management and design of the modern call center is becoming extremely complicated due to rapid enhancements in technology, reengineering initiatives, and call-routing strategies. Added to this are constant pressures of reducing costs while still maintaining service-level objectives.

5.2 The Solution: Improving Call Centers with Arena Call Center

Traditionally, call-center management has employed analytical techniques ranging from paper and pencil approaches to spreadsheets and mathematical tables. Although good enough in the past, these techniques simply cannot take into account the total dynamics and variability inherent in the modern call-center business. The power of simulation addresses these shortcomings and delivers the information required to plan for tomorrow.

With simulation, companies can design new call centers and accurately predict their performance prior to implementation, or can design competitive strategies to manage future growth and organizational change. Applying complementary simulation technology leverages the investment in current workforce management systems by

fine-tuning their output to incorporate the complexity of the modern call center.

Arena Call Center is an Application Solution Template (AST) built on top of Arena and inherits and leverages its key functionality, including VBA and MS Office compatibility. Arena Call Center relates to the call-center domain of problems through specific constructs, such as Calls, Agents, Scripts, and Schedules, designed for quick model representation. Arena Call Center provides seamless data transfer from workforce management tools through commonly used interfaces such as Excel and Access (Figure 4). In addition, it also features a call flow or script generator, a schedule editor, and a call pattern editor to describe graphically call-arrival patterns across the planning horizon.
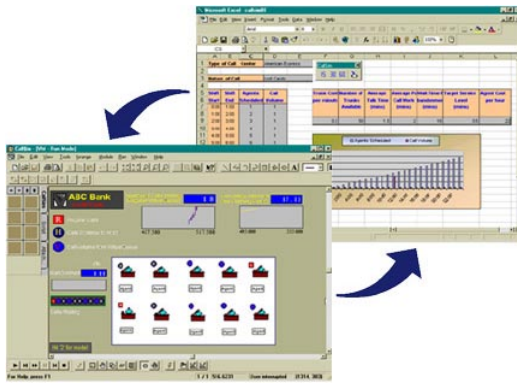

Figure 4: Utilize Enterprise Data with Arena Call Center

The compelling visual representation and detailed reporting capabilities of Arena Call Center deliver the insight and information necessary for resolution of complex business issues. And, organizations can begin leveraging the power of simulation immediately with Arena Call Center Basic Edition, which models individual agent groups or teams of up to 50 agents and provides all of the features and benefits of the Arena Call Center Standard Edition.

6 ANALYZING HIGH-SPEED PROCESSES WITH ARENA PACKAGING

6.1 The Challenge: Optimizing Line Efficiency with Simulation

High-speed processing lines are highly automated and may process entities at rates of hundreds, even thousands of units per minute. They are a fundamental part of packaging and filling operations found in consumer goods industries such as food and beverage, tobacco, and pharmaceuticals.

Designing and operating a high-speed line is difficult. Problems include equipment reliability and speeds, accumulator capacities, flow and speed controls, product changeovers, and labor. Equipment is expensive to purchase and maintain, and even small inefficiencies can inflict huge opportunity costs over time due to the high volumes of production. For example, if a system produces a $2 product at 200 units per minute over two shifts per day, the opportunity cost of a 1% downtime is $3,840 a day and nearly $1 million per year.

Optimal line efficiency is critical to meeting production targets with the minimum capacity required. Therefore, companies have increasingly turned to simulation to analyze and validate overall line performance accurately. Historically, these efforts have been impeded by the discrete-entity orientations and engines of general-purpose simulation packages. Aggregations and simplifying assumptions have been required to address the large volumes encountered in high-speed processes. Unfortunately, these approximations have often caused the models to be poor predictors of real-world systems.

6.2 The Solution: Leveraging Simulation with Arena Packaging

Arena Packaging combines the intuitive modeling framework of Arena with specially designed constructs and algorithms for capturing the complexities of high-speed, high-volume production lines. Designed in conjunction with leading consultants and practitioners in the packaging industry, it offers three powerful benefits to users analyzing high-speed processes.

Arena Packaging's constructs and dialogs are specifically designed for modeling the complex control logic and specialized equipment of automated lines. With built-in palletizers, machines, fillers, conveyors, controls, sensors, reliability, loss, merges, and splits, Arena Packaging models are incredibly easy to build and understand (Figure 5).
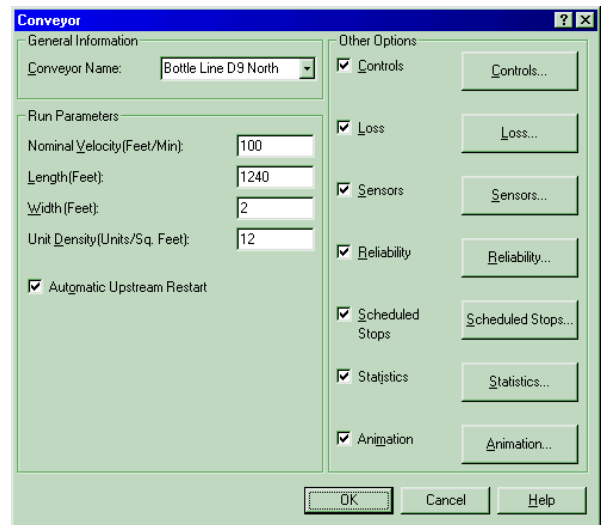

Figure 5: Conveyor Dialog from Arena Packaging

Arena Packaging's core simulation engine combines the powerful discrete simulation language of SIMAN with an algorithmic engine specifically designed for accurately tracking high-volume flow. No aggregation is required, and model execution times are independent of the volume of units in the system. Therefore, simulation projects are completed on-time and with accurate results.

Arena Packaging integrates with the general-purpose Arena template in such a way that "slow-speed" logic such as warehousing or bulk deliveries can be included easily within models. This flexibility allows users to model all aspects of their systems.

7 CRAFTING CUSTOM ENVIRONMENTS WITH ARENA PROFESSIONAL EDITION

7.1 The Challenge: Exploiting Simulation Throughout the Enterprise

Organizations that have proven simulation to be a valuable decision-support tool face new challenges for utilizing the technology consistently and efficiently. A particular type of system might be modeled in dozens of instances throughout the enterprise. As each model is created, new approaches are explored and insights are gained. In many companies, simulation is targeted for use by those who are most familiar with the process. To utilize their time effectively and to minimize the disruption of their normal responsibilities, model creation and data analysis need to be straightforward, requiring minimal training or skill in the software tool.

To promote reuse of knowledge and techniques obtained and validated in successful simulation studies, organizations look to create templates for modeling various types of systems. Model logic, data, performance metrics, and animation all are customized to match the system, with the necessary options to support composing accurate models.

With these templates, studies can be completed more quickly by leveraging earlier modeling efforts. Simulation also can be placed more safely in the hands of process experts, who need only an understanding of the nature of simulation analysis and rules for composing models rather than training in general-purpose simulation software. For highly integrated enterprises, a standard methodology can be strongly reinforced by the tool, enhancing the appropriate use of the technology and improving the likelihood of accurate, timely results.

7.2 The Solution: Customized Modeling Tools with Arena Professional Edition

The Arena product family is built on a fundamental architecture of customizable modeling components—called modules—rather than a fixed set of simulation objects.

Each commercial tool offered by Systems Modeling (Arena Business Edition, Arena SE, Arena Call Center, and Arena Packaging) incorporates a library of these modules, called an Application Solution Template (AST). The template dictates the product's target applications: types of systems it can effectively model, process representation, data requirements, etc.

These templates are created in the Arena Professional Edition (PE), a version of Arena that adds to the Arena Standard Edition module design features for building and maintaining Arena templates. Systems Modeling employs Arena PE to build its own commercial AST's and in its consulting practice. SM customers use it to exploit simulation more effectively.

A module created in Arena PE encapsulates logic and data for reuse in Arena models. For example, in simulating a rail line, Holland Railconsult and Incontrol Business Engineers designed modules to represent nodes and pipes in the rail system, to create "the embodiment of a specific modeling approach, rather than only a smart way of re-using program code" (Pater and Teunisse 1997).

Customers who want to deliver simulation tools to others in the enterprise can build complete, self-contained templates. Model construction in these tools involves placing modules that closely match elements of the real system, not only in terminology, but also in the important aspects of model logic, collection of performance measures, and animation. These tools also can incorporate other technologies, such as optimization, as in the use of a knapsack solution for truck loading at Fluor Daniel (Baker 1997).

8 OPTIMIZING SIMULATED PROCESSES WITH OPTQUEST FOR ARENA

Simulation by itself is an extremely powerful technology that enables you to describe, model, and analyze several competing scenarios so as to select one that best meets your objectives. In a practical setting, it is extremely difficult to determine the numerous alternatives that ought to be considered in order to uncover the best course of action. Further more evaluating every alternative can be extremely time consuming and difficult to manage.

OptQuest for Arena employs state-of-the-art optimization techniques to create an efficient way to identify scenarios and alternatives that merit investigation. Fine-tuned to work with the suite of Arena products, OptQuest also lets you define various system inputs (controls and constraints) and desired system outputs (objective functions). It guides the process of selection of system inputs, and then executes the model by running several scenarios for each set of inputs in order to achieve the desired system outputs. OptQuest combines the metaheuristics of Tabu search, neural networks, and scatter

search into a single, composite search algorithm to provide maximum efficiency in identifying new scenarios.

OptQuest uses search outputs as self-learning aids to intelligently seek the next set of alternatives. If an alternative in its search space does not fit the constraints you defined, it is automatically eliminated, and better alternatives that are more likely to match your needs are explored.

OptQuest allows you to explicitly define integer and linear constraints (such as budget limits, space restrictions, and workforce allocations), as well as boundaries on your objective functions. You can even include logical conditions to better refine your search. OptQuest rounds off the Arena family of products to arm users with an end-to-end decision support tool.

9   CONCLUSIONS

As simulation use and market needs have changed, Systems Modeling has continuously been a leader in providing cutting-edge tools to address the changing environment. The visibility of modeling and simulation in senior business management and as part of strategic operations planning has driven SM to create new products and adopt new technology to drive success at new levels. The Arena family is a scalable suite of tools for many business needs in modeling, simulation, and optimization.

This strategy enhances Arena for all constituents— from experienced analysts to simulation newcomers. At the same time, it positions the Arena software line to become the *de facto* standard for simulation throughout an enterprise, leveraging corporate investments in software, training, and relations with Systems Modeling as the premier simulation solutions provider.

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