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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 integrated 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; Call$im® for call-center analysis; and HiSpeed$im™ 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.

This paper introduces the Arena suite of products for modeling and simulation, 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 (Figure 1) 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.

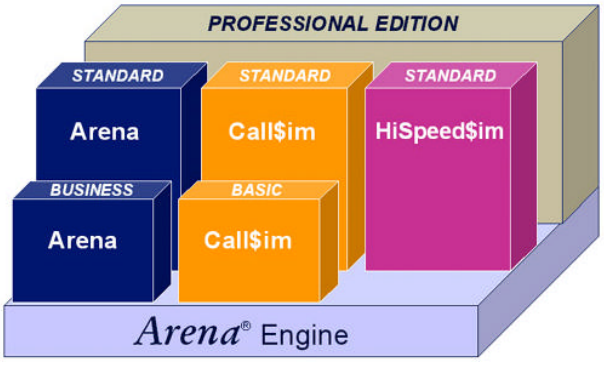


Figure 1: Arena Product Family

The Arena product offerings begin with the Business Edition (Arena BE), 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: Call$im and HiSpeed$im.

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. Each includes an "In Action" case study describing how an enterprise has successfully employed Arena to improve business planning and operations.

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, 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 2) 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

Figure 2: Arena Software Architecture

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.

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 tailorable to mirror the environment in which it will be used. Arena's AST technology creates the opportunity for organizations to craft their own simulation toolkits 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

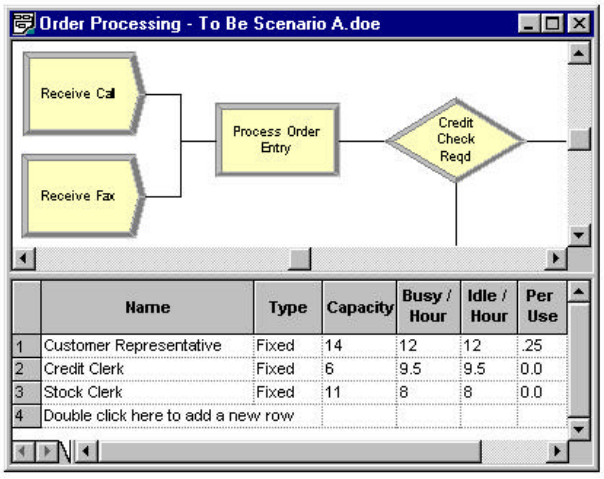
3.1 The Challenge: Improving Business Operations

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 BE represents process dynamics in a hierarchical flowchart and stores system information in data spreadsheets (Figure 3). With built-in activity-based costing and robust system performance data, Arena BE provides the measures needed to predict the impact of change and to choose the best process configuration.



	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use
1	Customer Representative	Fixed	14	12	12	.25
2	Credit Clerk	Fixed	6	9.5	9.5	0.0
3	Stock Clerk	Fixed	11	8	8	0.0
4	Double click here to add a new row					

Figure 3: Arena BE Process and Data Representation

Through its methodology independence, Arena BE 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.

Arena BE 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.

3.3 Arena BE in Action: Boeing Corporation

Boeing Corporation's Commercial Aircraft Group (BCAG) is a leader in commercial air transportation. Employing a strategy of working closely around the globe with airlines, manufacturers, and the aviation community, BCAG endeavors continuously to improve the transport system for air travelers and cargo.

A leading-edge organization in process improvement, BCAG utilizes process mapping and simulation to document, communicate, and improve its operations, from business ("white collar") processes through manufacturing. To help foster a process-oriented culture, Boeing Applied Research & Technology has led in the internal development of a methodology and toolset for process analysis (Bahrami and Sadowski, 1998). Static modeling is performed in Visio, a widely deployed desktop drawing tool, and the models are stored in a database, which provides security and multi-user features. The Visio models are simulated and animated in the Arena Business Edition for visualization and analysis. By employing the right combination of tools for different needs, Boeing is enabling its process owners and analysts to exploit simulation for better business operations.

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.

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.

4.3 Arena SE In Action

With its rich heritage of application for solving business problems, Arena SE is a proven decision-support tool. Universities throughout the world also use Arena as a teaching and research tool (Kelton, Sadowski, and Sadowski, 1998).

Manufacturers have analyzed a variety of production systems using Arena, including material handling systems (Bakst, Hoffner, and Jacoby, 1996), flexible manufacturing systems (Takakuwa, 1997), facility layout and design (Shadky, Spake, and Armstrong, 1997), and supply chain improvement (Clay and Grange, 1997). Arena is employed in transportation and logistics organizations for many uses, from facility and system design to operations analysis (Gatland, Yang, and Buxton, 1997; Pater and Teunisse, 1997).

Recently, planners in the health care industry have embraced simulation and Arena as well (Manansang and Heim, 1996), as have other service-oriented industries, such as restaurants (Whyte and Starks, 1996) and equipment service organizations (Watson et al., 1998).

With these and many other areas of use, Arena continues to be of significant business value as a general-purpose simulation tool.

5 IMPROVING CALL CENTER PERFORMANCE WITH CALL$IM

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 Call$im

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 Call$im 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.

Call$im is an Application Solution Template (AST) built on top of Arena and inherits and leverages its key functionality, including VBA and Microsoft Office compatibility. Call$im relates to the call-center domain of problems through specific constructs, such as Calls, Agents, Scripts, and Schedules, designed for quick model representation. Call$im 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.

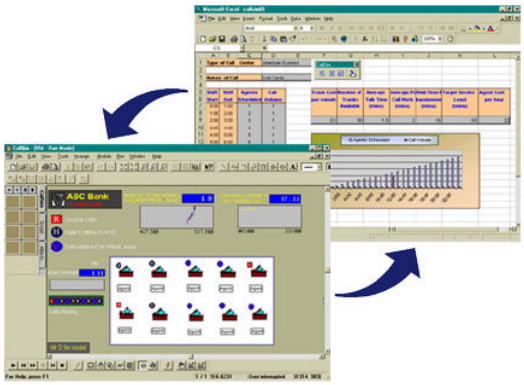


Figure 4: Leverage Enterprise Data with Call$im

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

5.3 Call$im in Action: Oracle Corporation

Oracle Corporation is the world's leading supplier of software for information management and the world's second largest software company. Oracle offers its database, application server, tools, and application products, along with related consulting, education and support services, in more than 140 countries around the world. In order to ensure customer success, Oracle provides round-the-clock technical support to its customer base across the globe.

Sam Kraut, Business Planning Specialist–Worldwide Customer Support at Oracle Corporation, is responsible for strategic planning and operational tuning of Oracle's worldwide call center operations. At Oracle, Sam used Call$im not just for back-office analysis, but also as a useful training tool to show managers of several call centers the dynamics of how their call centers actually work. For example, Call$im models were used to demonstrate how minor changes in call-routing structure can have a dramatic impact on customer response times—and on bottom lines. Call$im is enabling Oracle to optimize call center processes, procedures, and customized service offerings. Significantly, it also helps managers to understand their importance.

According to Sam, "Call$im's greatest attribute is its remarkable predictive capability combined with incredible ease of use. Call$im has helped us diagnose and improve some key areas in our call handling processes and its animation capabilities have literally made our call center come alive on the computer screen!"

6 ANALYZING HIGH-SPEED PROCESSES WITH HISPEED$IM

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 HiSpeed$im

HiSpeed$im is an Application Solution Template (AST) built on top of Arena. Designed in conjunction with leading consultants and practitioners in the packaging industry, it offers three powerful benefits to users analyzing high-speed processes.

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

HiSpeed$im'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.

HiSpeed$im 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 system.

6.3 HiSpeed$im in Action: Brach & Brock Confections

Brach & Brock Confections is a leading candy manufacturer headquartered in Chattanooga, TN. Within their manufacturing plants, automated, high-speed processing lines are key to producing large volumes of quality candy.

Brach & Brock employs simulation technology when designing new lines or making significant changes to existing ones. System characteristics that are modeled include equipment speeds and reliability, product changeovers, accumulator capacities, and dynamic control systems. Previously, engineers at Brach found general-purpose simulation packages difficult to use when modeling high-volume conveyor systems. Because HiSpeed$im was specifically developed for their applications, they find the product very flexible, accurate, and easy-to-use. Less time is spent building simulation models, and more time testing various scenarios and using the results to solve problems.

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 BE, Arena SE, Call$im, and HiSpeed$im) 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.

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 (Pater and Teunisse, 1997). 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).

7.3 Arena PE In Action: General Motors

Within General Motors, simulation is a proven tool for manufacturing system analysis. The Truck Group (GMTG) uses Arena PE for designing and improving material handling systems.

GMTG has created a set of templates to represent commonly used equipment, such as AMS, AGV, and CarTrak systems. Using these templates, GM has significantly reduced the time required to construct models and analyze systems. Engineers who are familiar with the production system can quickly understand the model and can use simulation to enhance their own knowledge and expertise. Arena PE provides the tool that enables GMTG to apply a standard modeling approach and to leverage knowledge gained through simulation use.

7.4 Arena PE In Action: IBM Travel and Transportation Consulting Services

Journey management—a concept IBM began developing in 1996—is concerned with delivering a positive experience to travelers as they proceed on their journeys. Using simulation techniques, IBM's consulting group is helping travel-related service providers such as Air Canada investigate new ways to eliminate bottlenecks, improve service, handle more customers, reduce costs, and enhance revenues using advanced technologies.

IBM's journey management models employ the IBM® Journey Management Library™ (JML™), an Arena PE solution containing reusable modules (as illustrated in Figure 5) to describe airline passenger processes and related new technologies, such as self-service kiosks and electronic ticketing. These reusable modules, together with the Visual Basic for Applications interface to Microsoft Excel, make it easy to change a baseline model and its parameters quickly to analyze alternative scenarios before investing in new technology.

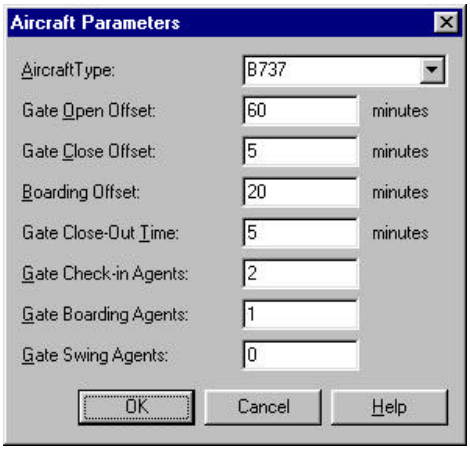


Figure 5: Custom JML Module Dialog

8 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 scaleable suite of tools for many business needs in modeling and simulation.

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.

ACKNOWLEDGMENTS

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IBM Corporation provided and granted permission to use information about the Journey Management Library.

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