Proceedings of the 1996 Winter Simulation Conference
ed. J. M. Charnes, D. J. Morrice, D. T. Brunner, and J. J. Swain

ARENA® SOFTWARE TUTORIAL

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ABSTRACT

The Arena modeling system from Systems Modeling Corporation is a flexible and powerful tool that allows analysts to creates animated simulation models that accurately represent virtually any system. First released in 1993, Arena employs an object-oriented design for entirely graphical model development. Simulation analysts place graphical objects—called modules—on a layout in order to define system components such as machines, operators, and material handling devices. Arena is built on the SIMAN simulation language. After creating a simulation model graphically, Arena automatically generates the underlying SIMAN model used to perform simulation runs.

The graphical modules used by simulation analysts to create models are provided "off-the-shelf" with Arena. These modules can also be custom designed by the end user to produce a modeling environment that is tailored to a specific application area (e.g., welding, cross-dock, etc.) or a specific vertical market (e.g., semiconductor, textiles, etc.). The resulting collection of user-created modules is contained inside an Application Solution Template (AST) that can be shared by any licensed Arena user.

1 THE PRIMARY TEMPLATE — ARENA

The Arena template is the core collection of more than modules provided as part of the general Arena system. It was designed to provide a general-purpose collection of modeling features for all types of applications. In addition to providing core features for resources, queueing, inspection, system logic, and external file interface, the Arena template provides modules specifically focused on specific aspects of manufacturing and material handling. For manufacturing, it contains modules that incorporate such features as machine downtime and maintenance schedules. For material handling applications, modules exist for representing conveyors (synchronous and asynchronous) and various types of transportation devices.

Three panels compose the Arena template: the Common panel, containing modules representing fundamental simulation processes such as arrivals, service, and departures; the Support panel, containing supplemental modules for specific actions and decision logic; and the Transfer panel, whose modules are used to model the transfer (or flow) of entities through the system. Modules from these panels may be combined in the same model or may be used with other ASTs.

In order to develop a simulation model using the Arena template, the user simply picks a module, places it in the model, and then is prompted for the necessary information. For example, when placing the Server module from the Arena template, the user is asked for such information as how long entities spend at the server, the server's operating schedule, and where entities should go. After responding with the appropriate information, the user closes the dialog to accept the completed module.

Animation is automatically included with many of the modules in the Arena template to allow for rapid development of both a simulation model and accompanying animation. Graphics symbols that are automatically provided when placing a module from the Arena template can be changed with Arena's built-in graphics tools (similar to CAD systems) or can be replaced with icons from Arena's symbol library or from external applications (e.g., clip art).

2 ANIMATION

Arena animations can be run either concurrent with the executing simulation model or in post-process mode. Animations can be created in several ways: they can be created entirely using Arena's graphics drawing tools,

they can be created from AutoCAD or other .DXF file formats, they can be created by using other Windows®-compliant drawing systems that can be pasted into Arena layouts, or any combination of the above.

Arena's drawing tools include all standard CAD objects (e.g., rectangle, ellipse, arc, text, etc.) and provides virtually unlimited color selection. Arena's interface with .DXF file formats was developed to allow for a direct import of CAD drawings to provide the animation background and dynamic icons. Once the drawings have been imported to Arena, the user can take advantage of Arena's drawing tool to embellish the layout. Dynamic paths contained in the CAD drawing can be used directly in Arena by "promoting" the paths. .DXF files containing dynamic icons can also be used in Arena.

Arena includes various animation options for real-time display of model statistics. For example, the user can place dynamic plots, histograms, levels, and time clocks directly within a simulation in order to illustrate system status as the model performs. This information is displayed on a real-time basis as well as on a post-process basis in the Arena statistical summary report.

3 FLOWCHART MODEL DEVELOPMENT

Arena was designed to make creating simulation models an entirely graphical process. All system behaviors are represented by using the graphical modules described above. For system logic such as IF/THEN/ELSE-type branching and queue selection rules, the user creates a flowchart of his system by placing the appropriate graphical modules on the Arena layout and directly connecting these modules. Non-animated modules from the Arena template that make up the majority of this flowchart can be freely interspersed with modules that contain animation.

4 MODEL JUMP-START WIZARD

When first starting a simulation model in Arena, the user may opt to utilize the Model Jump-Start Wizard. This technology allows for the rapid description of key system parameters such as the number of stations, entity or product information, and other data relevant to a model. After answering a series of questions regarding the new model, the Model Jump-Start Wizard rapidly creates a base-level simulation model using this information.

The Model Jump-Start Wizard was designed for users who are new to simulation and Arena, as well as for those who are more experienced. More experienced users typically use the Wizard to build a base level application quickly that they will substantially embellish using modules from the Arena template or other AST's outside of the Wizard itself.

5 CUSTOM DEVELOPMENT OF AST'S WITH ARENA PROFESSIONAL EDITION

A user can create a customized collection of graphical modules by using the features contained in the Professional Edition version of Arena. For example, a user working in the automotive industry may wish to develop a custom AST that contains modules for simulating welding lines quickly. User-created modules have focused dialogs, animation, and modeling functionality. Arena's hierarchy allows for the creation of higher-level modules from those contained in the Arena template, the SIMAN template, and/or other AST's.

Various AST's exist on the market today—some of which have been created and commercialized by Systems Modeling Corporation, others that were developed by other organizations who are licensed users for Arena Professional Edition. Currently available AST's include the BPSimulator, Call$im, and MP$im from Systems Modeling. Other organizations have developed AST's for such applications as automotive, production, process/chemical systems, forest resource management, and railroad operations.

6 SIMAN

The core technology of Arena is the SIMAN simulation language. The modules contained in the Arena template were created using SIMAN's modeling blocks as their components. This hierarchical concept prevails throughout the Arena template and other AST's that can be used within Arena. SIMAN blocks are made available to all Arena users in the SIMAN template.

SIMAN modules provide the user with increased flexibility and increased control of detailed system logic. Those users who have become accustomed to writing SIMAN code directly in a text editor are able to do so within Arena. In this case, Arena provides an option for directly recognizing this code, which is contained in a file external to the Arena graphical modeling environment.

7 INTEGRATION VIA ODBC, OLE

Arena is a Microsoft® Windows® 95 and Windows® NT compliant product. The entire product was developed using Microsoft's Foundation Classes (MFC) and is written in object-oriented Visual C++™. This allows users to leverage Microsoft's open architecture to integrate external data and applications with Arena models. Arena is also Microsoft® Office compliant that means that it utilizes all of the standard user interface options (e.g., toolbar buttons, function keys, etc.) that are in use in all Microsoft® Office products.

Arena's support of OLE (Object Linking and Embedding) allows the user to embed other technologies such as Excel® spreadsheets, Microsoft® Word files, clipart, and Microsoft® PowerPoint® presentations within simulation models.

Arena's support of ODBC (Open Database Connectivity) allows the user to integrate all database systems that are compliant with Microsoft's ODBC standard. Model data contained in products like FoxPro® database, Excel®, Oracle®, Informix®, and many others can easily be read into an Arena model without taking the time to enter it manually. For example, if a user has an Excel® file containing information on a manufacturing process plan, it can be directly imported to an Arena model via an ODBC wizard.

8 INPUT/OUTPUT ANALYZERS

Arena contains additional tools that are valuable for successfully conducting entire simulation projects. The Input Analyzer is useful for determining an appropriate distribution for input to an Arena model. The Input Analyzer allows the user to take raw data (e.g., time studies on process breakdowns or historically based order level information) and fit it to a statistical distribution. This distribution then can be incorporated directly into your model.

The Output Analyzer is used to display and analyze model data after the simulation run (or runs) has been performed. Graphical display options include plots, correlograms, histograms, and more. Multiple replications can be displayed on a single chart or can be lumped together for display of the aggregate performance over multiple runs. The Output Analyzer also provides analysis features such as confidence intervals, one-way analysis of variance, and comparisons (of multiple systems). Both the Input and Output Analyzers are directly available on the Arena Tools menu.

9 SCENARIO MANAGER

In order to manage the execution of multiple simulation runs, Arena's Scenario Manager provides an integrated environment for easy setup. The Scenario Manager allows the user to specify multiple executions (scenarios) of a model to be run on a batch basis. For example, once a valid model has been developed accurately representing the user's system, it is often useful to find out what the effects are on that system based on whether input1, input2, or input3 is used. The output from these runs can then be analyzed via output reports or within the Output Analyzer.

10 REAL-TIME CONTROL/MONITORING

An extension to Arena (called Arena RT) is available for the purpose of using a simulation model to interact with external client applications. This interaction is performed via an online messaging system. For example, the simulation model might contain aggregate-level system logic that sends tasks in real-time to a facility's shop floor control system. In this case, Arena's client might be a messaging queue that interfaces directly with PLCs. After completion of this operation (automated or manual), a message is sent back to the model so that the simulation can be updated and further instructions can be issued. During the execution of the model, the simulation and actual shop floor could operate concurrently. The animation could serve as a real-time monitoring device.

In addition to providing real-time control and monitoring of the shop floor, Arena RT provides the ability to spawn a concurrent model session so that the shop floor manager can look ahead at system performance while the factory is operating. This allows for the change of system configuration parameters in order to improve performance.

11 CONCLUSION

This paper has provided a basic overview of the Arena simulation system. A more complete review of the product can be arranged by contacting Systems Modeling Corporation. Also, additional information can be obtained on vertical market AST's offered for use in conjunction with Arena.

Arena is currently installed in more than 1,000 sites worldwide. It has been successfully used to simulate many types of manufacturing systems (e.g., automotive, aerospace, electronics, consumer goods, etc.) as well as applications in BPR, health care, call centers, warehousing, distribution, and more.

Arena has been certified by Microsoft® as a fully compliant Windows® 95 and Windows® NT application.

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