Proceedings of the 2002 Winter Simulation Conference
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THE CURRENT AND FUTURE STATUS OF SIMULATION SOFTWARE (PANEL)

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ABSTRACT

In this panel, principal members of seven leading simulation-software companies discuss two important questions concerning the current and future status of simulation software.

1 QUESTION NUMBER 1

Suppose that a potential client asked you why they should buy your simulation software instead of another product. What are the specific features and capabilities of your software that distinguish it from other products in the simulation marketplace?

1.1 Robert Diamond

Simulation applications were developed to defeat the common flaw of inductive (intuitive) reasoning by, as philosopher Sir Karl Popper has said, "…Theorizing, questioning, and testing a design." Experiments, not conjecture, are certainly the best basis to determine the performance of a system and simulation is a preferred method of experimentation. But simulation tools will not be used if they are too difficult and time-consuming.

From the beginning, Extend was scientifically designed to maximize modeler productivity. This was accomplished by creating Extend as an interactive, reusable, and visually communicative tool that provides a quick turnaround in model building, data production, and analysis. Often model builders familiar with other simulation

products are surprised at how efficiently Extend models can be built. The existence of the following productivity features, and how they are implemented, distinguishes Extend from other products:

- **Interactivity**: Even during a model run, Extend parameters and model logic can be changed "on the fly." If it were to take too long to make a change and see results, or if you found limits to interactivity, you might learn to reduce the number of questions asked, filtering your questions and potentially eliminating a winning solution. Extend's point-and-click interactivity translates into faster answers and also quicker and easier restating of problems.
- **Reusability:** Extend blocks (modeling components and hierarchical sub-models) can be saved in libraries, reused in other simulations, and even distributed to other modelers. This feature increases productivity and consistency of design.
- **Scalability:** Because of Extend's unlimited hierarchical structure, it is used to produce enterprise-wide models with hundreds of thousands of blocks. While you can add more capability to Extend, in the form of third-party modules and companion products, you always have full capability to model even the largest projects.
- **Visual transparency:** Extend's block icons are designed specifically to convey the structure and behavior of the model at a glance. For example, a FIFO queue has a different appearance than a LIFO queue. In Extend, both the flow of items (entities) and the flow of values are graphically represented. This unique mapping of visual meanings into their equivalent ideograms promotes quick understanding of a model to anyone viewing it, without having to navigate model internals.
- **Connectivity:** Extend supports the COM model (ActiveX/OLE) and ODBC. It can contain and be controlled by external applications such as Microsoft Excel. Unlike other simulation tools, these technologies have been implemented in Extend as modeling components so that inter-application communication is a drag-and-drop operation, with no programming necessary.
- **Extendibility (open source):** The blocks that come with Extend are developed using Extend's compiled language and integrated development environment. They are open source to allow modification and enhancement. This speeds the evolution of better modeling techniques, as the user can improve components and develop new proprietary components. Because Extend is also scriptable, you can create wizards that build models interactively. These features give you the freedom to model anything.
- **Third-party support:** Because of its integrated development environment, Extend has proven to be the simulation engine of choice for more third-party applications than any other simulation tool. Vertical disciplines powered by Extend include semiconductor production, supply-chain management, pulp and papermaking, rock-aggregate production, analytical chemistry, chemical-process control, and pharmaceutical processes. Any Extend user can create a library of custom components for internal or external customers.

These features have been carefully integrated into an application that provides accurate and precise modeling of any system. By facilitating the development of theory, argument, and test, Extend maximizes the modeler's productivity.

1.2 Charles R. Harrell

PROMODEL products have always been known for effectively combining powerful simulation capability with ease-of-use. Other unique features and capabilities that contribute to PROMODEL's success in the marketplace include the following:

- **Targets specific customer needs:** Rather than provide just another generic modeling tool, PROMODEL provides tools that are industry and problem specific. For example, PROMODEL has the largest healthcare following of any vendor because of our unique capability to understand and address healthcare needs. We have strong expertise in all of the areas in which our products are being applied.
- **Maximizes user productivity:** We get users up and running very quickly and make difficult problems easy to model. Our software works the way a person naturally thinks and requires little, if any, "coding" for most modeling. The maturity and robustness of our software helps ensure error-free models. Ultimately, getting an answer in a timely manner makes the difference between success and failure in most simulation projects.
- **Component oriented for embedded applications:** Because PROMODEL products are completely ActiveX enabled, users can create any desired interface for either model building or output analysis. Data can be imported from external databases and models can be built and run as a completely embedded component of another application. For example, models have been created and run within Excel, MS Project, Visio, and supply-chain and ERP applications.

- **Includes a plug-in to Visio:** The PROMODEL plug-in to Visio provides a flowcharting and simulation tool that is unrivaled in appearance and capability. Whether part of a Six-Sigma effort or simply a process-improvement initiative, you can quickly flowchart and simulate processes completely within Visio. Models created in Visio port easily to traditional PROMODEL products for more complex modeling.
- **Provides browser-based simulation:** Our *free* PROMODEL Player provides a familiar Internet Explorer interface for conveniently viewing and sharing simulation models. Models can easily be shared over networks or the Web. This greatly facilitates the communication of simulation models regardless of distance.
- **Comes with superb customer support:** Not only do we provide a toll-free hotline with 24-hour support, but also our outstanding support team is committed to quick customer response. This helps ensure that users will be successful in meeting project deadlines and expectations.

1.3 James O. Henriksen

Wolverine Software's SLX modeling platform offers three advantages over other simulation products: performance, computation/data management, and a well-conceived layered architecture.

Performance is an issue whose importance to simulationists has blown hot and cold over the years. It has taken on greater importance recently for two reasons. First, simulationists are tackling larger and larger projects. Applications such as detailed network-protocol simulation or air-traffic control can take many hours to run. Second, current interest in optimization has created a new demand for efficient simulation "engines" to run the many replications that optimization typically requires. SLX simulation models compile directly into a PC's Intel machine instructions. A lot of simulation software is either interpretive or translated into a high-level language such as C/C++. The disadvantages of interpretive execution have been well known for decades. For tools that translate into intermediate languages, generic translation of the intermediate representation compares unfavorably to that generated by a compiler intimately coupled to a run-time environment specifically designed for simulation.

SLX is modeled on the syntax of C. It is therefore capable of describing very complex data structures. In addition to C's data-structuring capabilities, SLX includes such features as sets and ranked sets, which serve as repositories of objects in a model. In contrast, many simulation tools are still heavily influenced by FORTRAN. The principal data-structuring tool in such tools is often the indexed array. Consider, for example, what it takes to model life-cycle spare-parts requirements for jet engines on military aircraft. Such models manipulate vast amounts of data. Data-management issues are often more difficult than simulation issues; just keeping track of "where everything is" is a major problem. Representing such data using arrays of indices into arrays of indices … into arrays is a nightmare.

Layered software has been around for a long time. As early as the mid-60s, we saw simulation software with two layers: the product itself and subroutines written in another language. The distance between these layers was vast. In contrast, SLX is implemented as a larger number of layers that are much closer together. When a needed feature does not exist in one layer, one can "drill down" to the next layer relatively painlessly. SLX provides access to its inner workings by using layers that are significantly lower than those typically found in simulation software, and SLX's extensibility mechanisms facilitate end-user construction of layers that are well above that of typical simulation software. Thus, one can develop customized, application-dependent toolkits that exploit efficiently implemented kernel features.

1.4 William B. Nordren

Flexsim is currently one of only two true object-oriented simulation-software packages on the market. It is the only one that allows for the complete customization of industry-specific applications (user interface, menus, objects, graphics, and object libraries). Flexsim is different from most simulation software on the market, because it is a completely new approach to simulation modeling and it provides a new simulation engine that has been redesigned and programmed over the last two years. At the heart of Flexsim is a powerful simulation-application compiler that allows users to develop new simulation applications that include unique graphical user interfaces, object libraries, and menu structures for any niche market. Simulation-development projects are then compiled into simulation applications that are sold and distributed by the developer as a new and unique application, much like current simulation software is sold in today's marketplace. Thus, Flexsim is not a simulation-software package in the traditional sense; it is a comprehensive development environment, complete with powerful development tools to create simulation-software applications that are truly object oriented (with inheritance for classes and class instances).

Every application has fully integrated 2-D and 3-D virtual-reality animation. All 3-D animation graphics are displayed in real-time using Flexsim's advanced virtual-reality graphics engine that is included in every simulation application that is compiled. (The Flexsim graphics engine has been developed to optimize simulation animation and has video-game realism and graphics quality.) All graph-

ics used in any Flexsim product are industry-standard objects such as 3D .DXF, .WRL, and .STL images.

Flexsim uses the C++ compiler and FlexScript (a C++ function library) for development. Therefore, all C++ libraries and functions can be utilized for application development. As a result of this unique approach, Flexsim simulation applications are extremely flexible and contain a user-friendly environment for model development. Third-party applications such as ExpertFit®, OptQuest®, and Visio® can be compiled into the application to add flexibility and ease-of-use for analysts building simulation models. Flexsim will link to any ODBC database (e.g., Oracle and Access), data structure (text, Excel, or word files), and virtually any hardware device that can be connected to a computer.

Current simulation applications that use the Flexsim application compiler are **Flexsim GP** for simulation of general-purpose manufacturing and material-handling systems, **Flexsim FabModeler** for simulation of semiconductor fabs and tools, **Flexsim Port** for simulation of marine-container terminals, and **Flexsim SANS** for simulation of shared-access, network-storage systems. Other simulation vendors are using the Flexsim application compiler to develop their own simulation products for resale.

1.5 C. Dennis Pegden

There was no response to this question.

1.6 Matthew W. Rohrer

Getting more out of your models using AutoMod: Simulation modeling is about return on investment. The return garnered from simulation studies comes from making better decisions. These better decisions help improve performance, help reduce costs, and help operate a system more efficiently. The investment in simulation is in the time to build the model, and in the cost for the hardware and software required for simulation. Time to build the model is a function of the modeler's skill and experience, the complexity of the system being modeled, and the software tool used. Thus, the simulation software can affect the return on investment in two ways:

- Increasing the return by extending the model's useful life and application.
- Decreasing the investment by being easy to apply to the problem at hand.

AutoMod can accomplish both of these tasks.

Increasing the return with AutoMod: Most real-world systems that require simulation are complex. If a system is simple, then in most cases decisions about the system can be made without using simulation. But, if the system is complex, then simulation is more than likely required. AutoMod's ability to capture detail is unparalleled. AutoMod provides a rich environment of material-handling objects that are accurate and can be customized to a specific application. And AutoMod's language allows complex decision logic to be created and validated with relative ease.

Many operations are controlled by software, such as the Warehouse Management System for deciding how to pick product, the Programmable Logic Controller for operating a conveyor merge, and the control systems that run much of the world we live in. But control systems need to be tested to make sure that they can handle the many different conditions under which they will operate. Simulation models can be used to test control systems, and AutoMod is unique in this regard because it allows for highly accurate models. AutoMod's ability to handle details and complexity help the modeler create models that can be used to "emulate" the real system. With AutoMod, the level of accuracy is only dictated by the availability of data and by the modeler's expertise, not the software tool.

Decreasing the investment with AutoMod: AutoMod is a modeling environment created for ease of application to large and complex systems. In software, ease of use is often used as a metric to compare different tools. But often a tool that seems "easy to use" for certain types of applications becomes much more difficult to use as the problems grow in size and complexity. AutoMod is well suited to handle problems of any size, and there are no software limitations that can hinder the accuracy of a model.

Version 11.0 of AutoMod also provides for reusability of modeling objects. This allows users to save parts of their models for re-use in other models, saving time in modeling. Additionally, models can be built by different modelers and then merged into one model for experimentation.

AutoMod includes pre-defined objects and logic for many common devices. Using these objects and customizing them to an application can reduce model-building time. For example, using AutoMod's conveyor system is as easy as drawing the conveyor sections and defining their operating parameters such as speed and product spacing. AutoMod takes care of much of the work, such as routing and queuing on the conveyor sections. Also, users can override the default behavior of AutoMod to represent their own application-specific operations.

1.7 Anthony P. Waller

Lanner develops and markets the WITNESS suite of products, which offers a wide range of options reflecting the diverse nature of our client base. The key strength of the core simulation functionality lies in the range and usefulness of the fundamental building blocks offered. They are powerful enough to offer quick, simple modeling, while at the same time flexible enough to be used for a wide variety of modeling tasks. I believe that WITNESS has the right balance. Some systems offer building blocks that are at too

low of a level, which results in a "build your own simulation system." On the other hand, the narrow focus of some products limits their ability to model systems outside of the intended application area.

The interface is vitally important and WITNESS has a great amount of detail on tabbed single-level dialogs, which reduces the number of mouse-clicks that are needed. Other options offered by WITNESS, such as the ability to specify rules and to interact with Excel by using the mouse, reduce the time and complexity of modeling. WITNESS is an extremely interactive modeling environment. Unlike other systems models can be run, changed and run again, without restarting the model. Models can be stepped forwards and backwards. Elements can be stopped and restarted during a run. This makes testing and interacting with the model during creation and experimentation much easier.

WITNESS has all of the right features. It includes hierarchy, designer-element libraries, great graphics and video support, customizable and unique reports such as meteor trails, easy integration with databases, CAD import, a wide choice of distributions including user-defined options, arrival profiles, part-schedule files, flexible labor rules and shifts, HTML and XML format models and reports, links to MINITAB, and more.

Added to the core WITNESS functionality is a range of optional modules. WITNESS VR offers sensational graphics, which can be generated directly from the 2-D schematic. Recent options include photo realistic fly-throughs. Few simulation packages come close to matching this range of 3-D visualization.

The WITNESS Optimizer has a very good interface, has easy set up of parameters and constraints, and has a wide range of algorithms and results displays, such as objective-function graphs and confidence intervals. Our tests indicate that the WITNESS Optimizer is well adapted to most types of simulation experiments and can outperform the competition. The latest Six-Sigma algorithm, which is included with the optimizer, increases the applicability further.

WITNESS Miner offers a data-mining capability, which is useful for analyzing both input and output data. We also offer the ExpertFit® distribution-fitting software through one of our many third-party company links.

SIMBA is Lanner's offering to companies wishing to embed simulation in other applications. It offers simulation object models and ActiveX functionality and special viewers. All combine to offer the simulation engine both power and, as needed, the interfaces necessary to present simulation in a customized way.

Why to buy from Lanner is also about Lanner itself. We are the largest independent simulation vendor and offer quality customer support and consulting throughout the world. The stability of the company and also the depth and breadth of the experience of its staff offer a true long-lasting partnership to clients.

2 QUESTION NUMBER 2

What features do simulation-software products need to have in the future in order to increase the number of organizations using simulation modeling? Please keep in mind that easier-to-use software is only part of the answer, since there are many other substantive issues that a simulation analyst must address such as problem formulation, level of model detail, validation, selecting input probability distributions, design and analysis of simulation experiments, and project management.

2.1 Robert Diamond

The question assumes that the problem is in the products, but I think it is more global than that. Simulation is difficult. The very act of creating a logical abstraction of a real-world phenomenon is inherently a difficult undertaking.

Informing and educating the public is another major issue. Universities are just now adding simulation to their curriculum. And there are many organizations which could benefit from using simulation, but don't because they are never exposed to it or don't understand it.

There is no silver bullet, but if you want to know in what directions we should be going, the simulation software of the future will assist the user with powerful nested wizards, conform to standards, and will contain templates that can be adapted to specific uses.

Has the promise of simulation been realized? Tools need to educate the users and must be engaging enough to keep the user involved. If we make educating the user a priority when designing simulation applications, then users will see more success and vendors will see more users.

2.2 Charles H. Harrell

Two factors that expand the use of any tool or technology are: (1) the value or benefit it provides, and (2) reducing the cost or effort required. So the key is to provide maximum gain with minimal pain. With simulation software this will likely continue to occur in the following ways:

- **Canned solutions:** Simulation tools will become better at addressing specific problems and providing custom solutions. Embedded applications where the user doesn't even know a simulation is being run will expand the use of simulation in applications where simulation makes a good solution tool. Parameterized models that provide for experimentation in a controlled environment is another area that will increase in popularity. This will reduce the intimidation factor and allow the decision-maker to focus on solving the problem instead of building the model. The offering of canned solutions is probably the single greatest

technology improvement that will get simulation in the hands of more people.

- **Enterprise solutions:** To be used more extensively and routinely in an enterprise environment, simulation must continue to integrate more seamlessly with enterprise databases and other enterprise applications such as ERP systems and supply-chain analysis tools. This also requires more complete Web enabling, so that data can be automatically shared over the Internet. Simulation must also continue to integrate more intuitively with standard enterprise practices and methodologies such as lean manufacturing and Six Sigma, so that it becomes a more natural activity in process-improvement initiatives.
- **General modeling solutions:** For general simulation modeling, more intelligent components or agents will be developed to make model building more of a model "assembly" activity. The statistical issues that novices stumble over will become more automated, such as determining the number of replications and the run length. Output analysis will be simplified and the software will be more helpful in making suggestions for improvement based on the objectives of the study.

2.3 James O. Henriksen

I believe that the largest growth area for simulation products is in mid-to-high-end modeling of complex, highly application-specific projects. Competition for the low end of the simulation marketplace is already extremely vigorous. While vendors who focus in this area will be able to attract new users, one wonders when this marketplace will become saturated. To succeed in the mid-to-high-end range, a vendor must provide a tool that can be easily customized by the end user. It is impossible to cope with demand by adding more and more built-in features. Ultimately, a vendor must provide a platform that provides kernel functionality, but supports and encourages end-user tailoring to specific applications. Companies that provide tools that interface easily with other tools, without forcing users into the tool-providers' paradigms will succeed. High-end users are frequently in the business of inventing new paradigms for solving problems. Inventing new paradigms is difficult when you're forced to use someone else's.

2.4 William B. Nordgren

Every simulation vendor agrees that the future of simulation will be in the introduction of powerful simulation tools that fulfill a specific niche application at an affordable cost. The day of the general-purpose simulation tool will end. Users will demand products that will fill a specific need and will do it extremely well. Industry knowledge, heuristics, and know-how will be compiled into the product to allow for fast, concise, and graphical solutions to stochastic-process problems. Information and data to run the simulation will be extracted from current database locations directly through automated data-mining techniques and real-time data links using SQL within the simulation software. Experimentation will be automated so less-skilled users can conduct statistically accurate studies, and users will spend much more time in using information learned from simulation modeling than in building models. Reports, charts, and graphs will be displayed automatically in the standard for each industry to promote quick understanding. Animation will be in virtual reality and models will be used at the highest level of corporate management. Flexsim Software Products, Inc. has developed the framework and development environment to allow this transformation to take place. Products developed with the Flexsim Application Compiler can be designed to fulfill the needs of any industry or niche. Powerful simulation applications can be competitively priced to make simulation affordable and usable, thus increasing the use of simulation throughout every industry. While others look to the future, Flexsim is already there.

2.5 C. Dennis Pegden

Simulation modeling is used by enterprises throughout the world to improve the design and operation of complex systems. The technology is becoming more powerful, easier to use, and useful for an expanding range of applications. The presentation will focus on the current and future status of simulation software.

Simulation software will become easier to use: In the past decades the focus within the simulation community has been on making it possible to model a wide range of systems. This has led to the development of very rich and powerful modeling tools. However rich and powerful tools are by their nature complex and difficult to learn. There are still many potential applications of simulation that are passed by because of the complexity of the tools and technology.

In the past simulation has been a tool used by a small group of trained experts to model complex and expensive systems. In the future, analysts throughout the enterprise will routinely use this technology. To support this new class of users, the tools will become significantly easier to learn and use.

Simulation software will support collaborative modeling: As the number and size of simulation models increase, there will be new demands placed on simulation tools to make it easier for people to share models across the enterprise, and also collaborate on the development and maintenance of models.

In the future, an enterprise will maintain a knowledge base of their systems, processes, and products that can be accessed across the Internet. The processes will be defined

in terms of animated simulation models that can be executed by any individual within the enterprise. Simulation will emerge as the preferred way of documenting and communicating processes within the enterprise.

Simulation software will support component-based modeling: As we look to the future of simulation, one of the promising ideas is the concept of having pre-built models or model components that can be plugged together to form a model of our system. The idea is that we simply select these components from a library and use them directly. For example, we might build a model of our entire supply chain by simply connecting together pre-built, generic models of our plants, distribution centers, and transportation centers. The goal is to build each model component once, verify its operation, and then make it available in a library to be used in many different applications.

Simulation software will support both design and operation: The mainstream application for simulation software has been the design and analysis of complex systems. Models have been used to select between competing systems and to optimize a specific design. However models have the potential to be used in many different ways – including operational scheduling and real-time system control. In the future our models will be used to help improve performance throughout the life cycle of the system – including both design and operation. For example a single model will serve multiple purposes in the life cycle of a factory, including visualization, simulation/animation, hardware emulation/testing, factory scheduling, and real-time factory control.

2.6 Matthew W. Rohrer

In order to grow the number of organizations that use simulation, the simulation community, as well as the software vendors, need to simultaneously consider the return as well as the investment of doing a simulation study. Too much emphasis has been put on incremental improvements to the simulation software that only affect a small part of the equation.

Model re-use, object orientation, and application-specific templates are just some of the ways that the simulation software can decrease the investment required to build a model. But we must keep the whole equation in perspective.

Using models for controls testing and for operational-decision support are just two of the areas where the model life cycle and, consequently, the return from the simulation can be increased.

In order for managers to consider simulation as a viable alternative, they need to see increased value from the simulation effort while the level of effort itself decreases. Only by looking at both sides of the equation can simulation grow in popularity.

2.7 Anthony P. Waller

In the future the world of software will continue to develop apace. New interface options will become available and alignment with conventions will continue to be important. Software will become more distributed. Successful simulation vendors will need to offer a range of networked and Web functionality, and also services. This will include, and in some cases already includes, browser viewing, Web publishing of models and results, parallel distributed experimentation and optimization, full E-mail integration, and technologies such as WebEx and NetMeeting.

It is vital to integrate simulation within other technologies and applications. This is the key development that will widen the market for simulation. Through J2EE and .NET technologies, simulation will become embedded in many larger systems.

Lanner believes that a wider use of simulation stems from the correct presentation of a particular domain problem to a potential user. Lanner's large consulting team provides many such solutions for clients where the simulation component is wrapped in such a way to present easy options for the user – such as Excel or VB front ends. The development and offering of SIMBA technology from Lanner will continue to be a focus as this offers others the capability and tools to easily develop and run simulation-based applications. Developments of XML structures will also broaden the scope for applications that use two or more technology areas.

The conventional use of simulation will also continue to grow. Vendors can help promote simulation by making its use more explicit within programs such as Six Sigma and lean manufacturing. Terminology is important here to understanding and acceptance. Virtual visualization will grow as that type of interface becomes more normal, less specialized, and more capable on improved platforms. Further integration with CAD systems and process-modeling systems is also inevitable as companies continue to integrate technologies and disciplines.

Also in the future is the development of "learning" simulation models – among the many topics that Lanner is researching is the use of expert systems to develop model rules. Models will be used more operationally too – this will require certain "modeling" constructs to be more specific for particular industries, as more exact behaviors will need to replace the "art" of abstraction.

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