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THE FUTURE OF SIMULATION SOFTWARE: A PANEL DISCUSSION

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ABSTRACT

Panelists present their position on the question, "Where do you see simulation software headed?" The panelists are given five areas as suggestions for their response.

1 INTRODUCTION

At WSC 97, the same panel was convened to discuss the future of simulation software in seven areas. The topic was of great interest to the panelists, all representatives of simulation software vendors, as well as the audience. The panelists have agreed to restate their positions after more than a year has passed. One year is quite some time in the software business, so the topic is certainly not redundant. The panelists were asked the question: Where do you see simulation software headed in the following areas?

Internet applications
Enterprise resource planning applications
Embedded simulation
Optimization
Object-oriented simulation

It should be noted that only two of the areas are carryovers from WSC 97! The response of the panelists is given in the following sections.

2 WILLIAM LILEGDON, Symix, Inc.

2.1 Internet Applications

The internet, in most modern business environments, represents information and collaboration. Both of these attributes are attractive to the providers of simulation technology. On the information side of the equation, being able to share the contents of a model and the predicted performance of a system at internet speed will enhance the value of a simulation project in a large organization. The products must make these outputs or views easily accessible through the standard internet interfaces. Very shortly, products that provide direct "browser" access to model inputs and outputs will be available. On the collaboration front, access to the simulation and the domain expert is being dramatically reduced through the collaborative features of the internet. Many project steps that required days are now being completed in hours through the use of the internet. Joint or team model building with team members in diverse geographic locations is possible now and will become increasingly more feasible in the near future.

2.2 Enterprise Resource Planning Applications

Simulation in a manufacturing environment has required a significant amount of data that is generally available in ERP systems. Direct interfaces to these systems are available today and will continue to become more robust. The use of financial data from these systems will provide a direct decision support capability that surpasses the current strategic planning techniques. In combination with other technologies, simulation technology will continue to grow in its ability to create a detailed schedule or sequence in these integrated environments.

3 C. DENNIS PEGDEN, Systems Modeling Corporation

Simulation is continuing to change and expand at an amazing pace. From the suggested list of topics, I have commented on three: Internet applications, enterprise resource planning (ERP) applications, and optimization. I have also added a fourth topic that I see as a key trend in the industry - enterprise-wide applications.

3.1 Internet Applications

The internet is changing the entire information technology field, and simulation is no exception. The internet will play an important part in building and viewing simulation 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 the user.

3.2 ERP Applications

Many companies either have or are in the process of replacing their information systems with an enterprise-wide resource planning system. The scope of these systems is expanding to include the entire supply chain from suppliers to final customer delivery. These are complex systems with many interacting and random elements. In the future, simulation will play a key role in the design, analysis, and operation of these systems.

3.3 Optimization

Simulation vendors have historically focused on making it easier for users to build models. However model building is only one aspect of a simulation project. In the future, much greater focus will be placed on making it easier for the user to make decisions using the model.

One area that is receiving a lot of attention in the market is the incorporation of optimization with simulation. There are two key challenges that need to be addressed to make this work: One is having an efficient search strategy for exploring the decision space, and the second is having a valid statistical framework for creating credible answers. Simply marrying a deterministic search engine with a stochastic simulation model is a very dangerous approach. Development of a valid statistical framework for marrying simulation and optimization will be an important area of research to unlock the true potential of optimization with simulation.

3.4 Enterprise-Wide Applications

During the past 40 years, 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 easier to buy, learn, and apply. In my view this is one of the most significant trends in the simulation market today.

4 GEOFF HOOK, Lanner Group

The themes listed can be viewed in two distinct categories, application areas (enterprise resource planning applications, embedded simulation) and enabling technologies or approaches (internet, optimization, object-oriented). We at Lanner see the future of simulation going in two particular application directions; modeling tools and embedded solutions.

4.1 Modeling Tools

The majority of simulation products are currently modeling tools aimed at the professional, skilled user. Traditionally this user has provided a service to management on a project basis. Naturally this has meant an alignment with major projects in the corporation. The market place is now demanding simulation-modeling products that are aimed at a wider user base so that their knowledge can be better exploited in making the organization more competitive. Simulation has been recognized as a powerful technique, which can and should be applied much more frequently. The supplier who can successfully break into this area with an easy to use, yet powerful tool, will be well placed. A step change in terms of ease of use is what is required, rather than incremental improvement.

The market for “solutions” based on simulation is growing due to business pressures and the increased awareness and understanding of simulation, availability of data and suitable computing infrastructure providing the means to deliver. That these solutions contain embedded simulation models, termed SIMBA (SIMulation Based Applications) by Lanner, may not even be apparent to the user, but will provide a significant move forward in many areas. Enterprise resource planning in manufacturing companies and service organizations looking to use resources most effectively are natural applications for the SIMBA approach. The ARC Advanced Planning & Scheduling report, published in 1998, identified trends which will affect the deployment of simulation including:

Daily scheduling will move to dynamic
Finite capacity planning will move to constraint based planning
General solutions will move to vertical industry solutions
Moves towards integration with execution systems

These trends point strongly at the attractiveness of the SIMBA concept in these fields.

2.1 Enabling Technologies

Optimization tools which are currently available and illustrating some success will continue to develop, helped by increasing computing power. Optimization will be important in both traditional modeling applications but even more so in embedded solutions where in-built intelligence will aid the user.

Object-oriented simulation fits well with the solutions environment. It helps provide maintainability as well as ease of mapping of data from existing sources. An object orientation also provides an obvious base for the creation of a whole suite of desktop modeling tools tailored by industry or application.

The internet provides an exciting medium for using simulation-based solutions within a company or collaborative modeling between companies as “E commerce” grows.

The Lanner Group foresees an exciting future for simulation, as at last simulation begins to become established as a mainstream technique for helping to improve the running of the organization.

5 JIM HENRIKSEN, Wolverine Software Corporation

The monolithic simulation package has become a dinosaur. Three forces are leading us away from the world of large, black-box simulation packages and into a world of flexible, connected components. First, the functionality expected of simulation software by simulationists has grown to a point where it is no longer reasonable to expect that a single company can muster the expertise to implement all required simulation components at an acceptable level of quality. Second, computing in general is conducted in distributed, networked fashion. Modern simulation software must be able to communicate with other software. Third, the ascendancy of the PC has greatly encouraged users’ tendency to pick and choose what they feel are the best tools to do a given job. Users like to assemble their own toolkits. Not even Microsoft can supply all tools for everyone. Can a single company produce the best basic simulation software, distribution-fitting tools, output analysis tools, animation tools, database tools, editors, etc.? No!

The forces for change are like lava bubbling below the tectonic plates of traditional simulation tools. Much of the architecture of present simulation tools is based on ideas dating back to the 60’s. Fortran still casts a long shadow over a lot of simulation software. For example, there are simulation packages in widespread use in which all objects carry all attributes of all object classes. Thus if a car has a gross vehicle weight, and a ship has a tonnage, both cars and ships have a gross vehicle weight and a tonnage. This is a symptom of array-based, Fortran-like implementation, not exactly what you’d call object oriented. Sooner or later, the lava is going to erupt, and we’re going to enter a new era of simulation.

While progress is being made, we are also seeing mistakes of the past being repeated. Nowhere is this more apparent than with DoD’s high level architecture (HLA) for distributed simulation. While HLA is an excellent step forward, in that it promises to become the most widely used standard for distributed simulation, it is also a step backward, insofar as it encourages users to build event-based world-view simulations “from the ground up,” with the most frequently chosen tool being C++. Over the years we’ve seen Fortran, PL/I, Pascal, ADA, and even APL advocated as language X in papers whose titles proclaim “You can do simulation in X!” These languages all lack the capability to express parallelism, and they lack time-aware, simulation development environments. Furthermore, the superiority of the process-oriented world-view for most applications has long since been demonstrated.

A great opportunity exists for whomever can fill the void and bring forth next generation simulation software.

6 RON LAUGHERY, Micro Analysis and Design, Inc.

6.1 Software Usability

There are several fronts where we see simulation software heading. The top of the list is the same item that has been on top since computer capacity ceased to be a constraint on model size and complexity – software usability. Models of virtually any size or complexity can now be built on a desktop PC. The constraint on the use and scope of models is the usability of the software for building, running, and analyzing data from simulation models. While tremendous strides have been and continue to be made on this front, the growth of the market and user base of simulation will be directly proportional to the ease of use of the tools. This is old news, but it is still the most critical software design issue that the simulation vendor community must face. In our flagship, simulation product, Micro Saint, enhancing usability is still consuming the lion’s share of our investment dollars.

6.2 Dynamic Data Exchange

The second most important direction that we will head in the next few years will be in the development of tools and technology to support the dynamic exchange of data between distributed simulations running simultaneously. The concept of simulated pilots flying simulated aircraft, all controlled by simulated air traffic controllers, *all operating on different computers in different parts of the country* is a near-term reality. Our job in the simulation software industry is to modify and enhance the powerful simulation tools that we have created to allow our users to take advantage of these opportunities.

6.3 Internet Applications

As the internet becomes faster, the concept of distributed simulations becomes increasingly feasible for everyone. Rather than a simulation residing on a single processor, there can be many processors running parts of a simulation, all of whom exchange data over a network which will, in widely distributed applications, inevitably be the internet. This is already occurring in the US Military with the decade-old use of distributed interactive simulation (DIS) and the evolving higher level architecture (HLA) protocols.

6.4 HLA Applications

While most HLA applications to date have involved man-in-the-loop simulation, the HLA concept supports model-to-model data interchange equally well. As this trend continues to grow and evolve, the challenges to the simulation software community are to 1) develop standards of inter-model communication and 2) design software to support adherence to this standard. Given the wide number of types of software and data interchange options available (e.g., OLE, TCP/IP), the selection of a standard set is certainly technically feasible. Furthermore, given the HLA standard under development by the US Military, our standards work may already have been largely done for us. We must now develop the model authoring and execution technology to support exploitation of these standards.

We are working towards simulation development and execution software that adheres to the HLA protocols. We will be upgrading our commercial product, the Integrated Performance Modelling Environment (IPME) with these capabilities. Our goal is to provide IPME users with a model development and execution environment that permits easy interchange of data between widely dispersed simulations. We see this as a significant wave of the future in terms of making simulation a more powerful and widely used tool.

7 MATT ROHRER, AutoSimulations, Inc.

7.1 The Future of Simulation – Continued Evolution

Darwin's theory of evolution describes how species adapt to new environments, and likewise simulation software has "evolved" over the years to become more useful and powerful. The future of simulation will be one of continuous improvement and evolution rather than revolution. One of the reasons is that simulation software providers have a legacy of customers that they need to support with new features and enhancements. Simulation software providers need to balance their current customer needs with the needs of the market of new users.

A look back at the history of simulation will help illustrate how simulation technology has evolved. We first started with simulation languages like GPSS that are powerful and flexible. A person needs to be a strong programmer to tap the power of the simulation languages. Because simulation technology was only in the hands of a few with these languages, and was in danger of becoming extinct, a new generation of simulators was born.

The simulator products are much easier to use, take advantage of graphic user interfaces and other software technology, and allow more individuals to practice simulation. Many new "species" of simulator were born in the 1980s, each directed at different kinds of problems in manufacturing and material handling. One problem with so many different simulators is that the market can get confused about which simulator is best for them. Another issue is that model building, which simulators address, is only part of the simulation process. Users need to know the other aspects of simulation in order to be successful.

The continued evolution of simulation technology is difficult to predict. A given is that simulation tools that have been around for more than ten years will balance current user needs with new developments.

7.2 Internet Applications

Simulation applications will evolve to tap into the power of networks. The internet provides the conduit for use of distributed simulation as well as a medium for communication of simulation results. Java has provided the programming interface to allow more applications to run over the internet. But Java is not without it's deficiencies. The latest press describes Netscape dropping its Java browser. This points to dark times for Sun's multi-platform tool. Look for Java to evolve along with simulation to provide a better environment for internet applications.

7.3 Enterprise Resource Planning Applications

In the manufacturing world MRP and MRPII have evolved into ERP for planning and operating the enterprise. Simulation fits in with two components of ERP, capacity planning and scheduling. With a properly built model, simulation based scheduling can give the most accurate scheduling answer, but is not always practical at the enterprise level. Simulation based scheduling makes more sense at the factory floor level. Enterprise level scheduling models are very large and discrete event simulation can be too detailed an approach to be practical.

A possible new approach to ERP planning and scheduling is a combination of algorithmic models and simulation. As both the algorithmic approaches and simulation evolve, a hybrid solution will emerge that is well suited to tackling the ERP related problems at various levels of the enterprise.

7.4 Embedded Simulation

Simulation has already achieved success as an embedded application. Simulation technology that is helping solve the scheduling problem is a good example. Additionally, template models that address a specific area of application can be considered as examples of embedded simulation. The idea is that the end user of the technology has no knowledge or needs no understanding of the underlying simulation technology.

Software engineering principles will provide an avenue for increased modularity of simulation applications.

This evolution in the software industry will provide for more adaptable simulation libraries that can be included in other applications. If the marketing people grasp the idea, one might even see "AutoMod Inside" someday.

7.5 Optimization

Getting the best result has always been the goal of the simulation practitioner. Some simulation software has recently (last 1-2 years) evolved to include capabilities of optimization. However, for many applications the model is too large to iterate all the possibilities.

From the software engineering point of view, including optimization is not a difficult task. What is more difficult is providing ways of actually completing all of the runs. Look for simulation software in the future that utilizes other CPU's on a network, and performs a type of distributed simulation. In this way, optimization can be used with larger models.

7.6 Object-oriented Simulation

Because of the process of evolution in simulation software, it is a challenge to build object orientation into software products. The idea of rewriting a piece of software is countered by the existence of many current users who have "living models." Instead, a simulation package must evolve more slowly, carrying its existing users along while moving the software into new areas of application. A good analogy would be remodeling a house instead of building from scratch. The successful simulation software provider will be the company that can fold the concepts of object orientation into its product "room by room." This will provide benefits to existing users, the software developers themselves, and to new customers.

7.7 Summary

Simulation will continue to evolve into the next century. We will see an acceleration of this evolution. Two forces will increase the speed of evolution. One force is the advance of software engineering technology. Better tools for software development, as well as more standard software libraries, will allow software developers to put more effort into simulation features.

Another force will be a consolidation of the simulation market. Through mergers and acquisitions, simulation companies will become more vertically focussed. This will leave fewer software vendors in the traditional simulation market.

The outlook is bright for those simulation software companies that can adapt quickly to change. This is the definition of evolution.

8 DAVID KRAHL, Imagine That, Inc.

8.1 General Comments

Historically, the principal factor defining the future of the simulation software industry was the increase in performance of the desktop computer. This allowed software developers to include user interface and animation features that would not have been practical on the computers available just a few years ago. In the near term, improvements will continue to be keyed to the same factor. Technologies such as optimization, object-oriented programming, embedded models, and enterprise resource planning models all require significant computing power to achieve their goals. Continued advances in computing power will give simulation developers the opportunity to fully develop these features and devise others which were previously unimagined.

8.2 Object-oriented Programming

Simulation and object-oriented programming have been linked for decades. The primary benefits of object-oriented programming in the simulation world are code reuse and encapsulation. Code reuse allows developers to easily use the same code for a variety of similar purposes. By using encapsulation, the programmer can refer to program components by their methods (the code that they contain) and their data (information associated with an object).

Code reuse will allow developers and modelers to easily build vertical market applications by leveraging existing development efforts. This should drive down the cost, decrease development time, and improve the quality of process simulators and purpose-built models.

Encapsulation allows for a more natural view of real-world process modeling. It is easy to think of a process step as a collection of data (capacity, resource requirements, processing times) and code (general behavior, batching logic, queue ranking rules). This object-oriented feature will continue to make simulation modeling tools easier to use.

8.3 Embedded Simulation

Developing simulation tools and models that communicate well with other systems is a feature of object orientation. Embedded simulation is another feature that should improve the accessibility of simulation models to non-traditional markets. End-users will be able to use tools and systems with which they are familiar to drive simulation models. A key component for success will be the response time of the model. In real-time applications, simulation models will have to provide results almost immediately to be acceptable.

8.4 Optimization

Optimization will help automate the process of identifying the best configuration of the modeled system. Many simulation software vendors have already included this feature in their products. It is rapidly becoming a “must have” feature, much as animation was in the 1980’s.

9 DONALD A. HICKS, PROMODEL Corporation

9.1 Object-oriented Simulation

Object oriented design approaches makes programming easier for software engineers and harder for everyone else. Simulation, as a technology that maps real systems and objects into data objects, naturally fits well with object-oriented paradigms. The task is to harness the powerful nature of object-oriented simulation and make it accessible to the non-programmers who know the details of real systems problems. All simulation software in the future will likely use object-oriented techniques for modeling systems, but the users interfaces will become less focused on looking object oriented, and more focused on matching up with the kinds of problems that the user is likely to be thinking about.

9.2 Internet Applications

The internet is a big network. Until computer science can make effective use of the inherent calculation power of distributed computing, the network will mainly serve as a communication backbone, used for e-mail and information transfer. Distributed computing, when it happens, will make all applications run many times faster than anyone thought possible. It will be years before we really make use of that power, but when it happens, simulations will be more important than anyone currently realizes.

9.3 Enterprise Resource Planning Applications

ERP systems facilitate control over all of the data flying around in a business. Once you have the data, however, you need to do something with it. Much of the investment currently seeking “data management” systems such as ERP will swing towards applications that use all of the newly available data, that transforms the data into new information. In the future, nearly all simulation applications will plug directly into corporate data sources, and will serve as advanced calculators and data visualization tools.

9.4 Embedded Simulation

Modeling as a stand-alone activity will always exist, and will always be only marginally relevant to the mainstream of corporate decision making and operations. Users of supply chain management and scheduling systems today do not look at the math and data models that are used to represent their problem. They are not asked to build a constraint model from scratch each time they want to recalculate next month’s transportation shipments. Applications with embedded simulation capabilities are the real future of the technology.

9.5 Optimization

Users are becoming sick and tired of vendors who manipulate language for their own politically motivated ends. Every simulation study uses optimization, in that a user is trying to “optimize” their problem. The user may only run a single simulation, but the information is used to optimize the future he or she is facing. PROMODEL Corporation is proud of its leadership in helping put simulation squarely in the answer finding business.

A great deal of research remains to be done in the area of improving simulation software analytical capabilities. However, as solution finding techniques improve and computing speed improves, simulation-optimization will solve many problems for users that currently are considered impossible to solve. If you could run a simulation model as fast as you could evaluate a math model, and the simulation model produces more accurate answers than the math model, you’d always use the simulation-optimization approach.

10 CONCLUSION

Simulation software is dynamic. Changes are occurring rapidly. In virtually all areas suggested to the panelists, large strides are forecasted. If this panel is reconvened in one year, the responses will evolve greatly since the hardware, networking, and software are moving forward at such breakneck speed.

AUTHOR BIOGRAPHY

JERRY BANKS was General Chair of WSC’83 and was IIE representative to the Board of WSC for eight years, including two years as Board Chair.

PANELIST BIOGRAPHIES

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DONALD A. HICKS is Senior Vice President of Software and Business Development for PROMODEL Corporation. He received his B.S. in Systems Engineering from the United States Military Academy and an MBA from the University of Michigan. He is a frequently invited speaker and author, and columnist on software technology and strategy issues. His current research topics include simulation-optimization and simulation based enterprise applications.

GEOFF HOOK is Product Director at the Lanner group, specializing in WITNESS. He has been involved in applying simulation in a wide variety of circumstances since 1980. Geoff has held a number of positions within Lanner including world wide Customer Services Director. He holds a B.Sc. in Management Sciences from the University of Warwick U.K. and a Masters in the Social Aspects of Science & Technology from the University of Aston in Birmingham U.K.

DAVID KRAHL is a member of the technical staff at Imagine That, Inc. Mr. Krahl has performed consulting, development, technical support, and training for a wide variety of simulation products. Currently, he performs, development, sales support, and technical support for the Extend product family. He received a MS in Project and Systems Management in 1996 from Golden Gate University and a BS from the Rochester Institute of Technology in 1986.

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C. DENNIS PEGDEN received his bachelors in Aeronautics, Astronautics, and Engineering Sciences from Purdue University in 1970. He worked in the aerospace industry at the National Aeronautics and Space Administration and the Matrix Corporation. He returned to Purdue in 1973 and received his Ph.D. in mathematical optimization from the Industrial Engineering Department in 1976. After graduation, he taught at the University of Alabama in Huntsville where he began his work in simulation and led in the development of the SLAM simulation language. In 1979, he joined the faculty at the Pennsylvania State University where he completed the development of the SIMAN simulation language. He is currently the CEO of Systems Modeling Corporation which markets SIMAN and Arena simulation products; the Tempo scheduling product; and vertical market products in the areas of call centers, business processing, manufacturing, high-speed processing, and real-time control.

MATT ROHRER, Vice President of Simulation, joined AutoSimulations, Inc. in 1988. Serving as a Simulation Analyst for five years, Mr. Rohrer completed simulation projects in distribution, manufacturing, and material handling. As a user and developer of AutoMod, he has contributed to the enhancement of the product. His main interest is in extending the use of simulation technology beyond its traditional application in planning and design. Mr. Rohrer received a B.S. in Engineering from the University of Utah in 1983.