Proceedings of the 1999 Winter Simulation Conference
P. A. Farrington, H. B. Nembhard, D. T. Sturrock, and G. W. Evans, eds.

HOW i2 INTEGRATES SIMULATION IN SUPPLY CHAIN OPTIMIZATION

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ABSTRACT

This paper will set out, at a high level, the methods in which i2 solutions will enable value in the 21st century enterprise. With regards to the purposes of the Winter Simulation Conference, we will show how simulation fits within our solution set and how we have extended the principles of simulation.

1 INTRODUCTION

As we end the 20th century, we are witness to change throughout the business world that is occurring with ever-increasing pace. Enterprise executives and the management systems that they depend upon continue to strive to stay ahead of changing market conditions and to rapidly evolve the offerings and capabilities of their organizations. In the face of intensifying competition, global deregulation, and customer pressure for increased service levels, companies are increasingly competing with better management of information. The future of all enterprises will be determined by the ability to understand and embrace the information technology revolution.

i2 is a market leader in the development and delivery of enterprise decision support solutions. Our progress in the Supply Chain Management arena is only the beginning of what we consider an unprecedented opportunity to bring value to our customers. In early 1999, i2 introduced the application market to "electronic Business Process Optimization" (eBPO), the next generation of enterprise applications, to provide integration across multiple enterprises and processes, high-performance under extreme conditions, forward visibility and responsiveness, the flexibility to grow through acquisition or merger, and a tight coupling to the enterprise's business strategies and goals. In doing so, this new generation of applications will allow enterprises to achieve velocity throughout their operations; that is to ***intelligently execute at maximum speed***

2 BREAKING THE TRADITIONAL MODELING PARADIGM

The fundamental nature of business processes is changing across many industries. Introduction of concepts such as Configure-To-Order (CTO) has broken the traditional product paradigm that includes rigid product specifications and production processes. Consider, for example, market demand in the personal computer industry; we can no longer measure variability of demand by variance and averages of finished goods since the bill of materials for the end product is in constant flux. This change propagates both upstream, as component suppliers adjust their production, and downstream, as the distribution channels handle changing configurations of products.

As the 21st century opens, the requirements of superior agility and process intelligence are challenging all industries. The transportation and logistics industry is effected with the rest. The race to identify and to conform to new business process models is forcing all transportation/logistics providers to critically examine their role within their customers' supply chain and the decision-making tools employed to plan and execute business.

Traditional modeling paradigms fall short of accompanying this metamorphosis because they have been constructed to mimic existing processes. This approach is fundamentally limited since it is built on the basic assumption of fixed processes on configured production units. The dynamic nature of the new business models extends beyond the variability of the demands to the agility of the supply chains required to adapt to changes in product and process. Traditional modeling paradigms do not possess sufficient flexibility and scalability to render business-feasible solutions.

3 HOW DO CURRENT SYSTEMS HANDLE BUSINESS PROCESSES?

Before the advent of eBPO, corporate planning solutions were produced by one, or a combination of, four enterprise planning methods: manual processes, proprietary planning solutions, enterprise resource planning (ERP) and Advanced Planning and Scheduling (APS). The following sections provide a brief overview of the latter two types.

3.1 Enterprise Resource Planning (ERP)

ERP applications have succeed in integrating data from multiple functional areas, resulting in an incremental addition of value over previous "legacy" point solutions. However, their scope is limited to the single enterprise, they are typically slow (especially when asked to scale, such as when extending to encompass web-based on-line ordering), and they are transaction-based, not intelligence-based, so they fail to encapsulate the complexity required in cases where multiple courses of action are available.

Table 1 provides a summary of some of the major ERP gaps. For a further examination of ERP shortcomings, see Thomas H. Davenport, "Putting the Enterprise into the Enterprise System", *Harvard Business Review*, July-August 1998.

On balance, current enterprise applications fail to adequately reflect the reality of doing business. Information systems at most companies have a single-enterprise solution scope, focus on transaction processing (with the exception of the areas of manufacturing, distribution, and transportation), are slow, and cannot deal well with complexity. As a direct result of these failures, companies that have adopted such systems:

- do not maximize their profitability, and
- do not compete effectively.

3.2 Advanced Planning and Scheduling (APS)

In contrast to ERP systems, APS systems are "intelligent" (that is, they provide modeling and analysis capabilities for intelligent decision support) and, given their memory-resident and exception-based nature, quite fast, but they, too, are hampered by their single-enterprise focus, as well as their focus on the "supply-chain", i.e. manufacturing, distribution and transportation functions.

While this could be acceptable in traditional slow moving environments, the current metamorphosis of the business environment requires a broader scope of any planning effort. In an era where customization and perfect delivery are becoming the price to get business, the whole delivery process, typically represented by the "supply-chain", is affected, if not driven, by the customer interactions. On the other side, with an acceleration of the pace of innovation, the management of the product

Table 1: Enterprise Resource Planning (ERP) Shortcomings.

1. Historical, not planning, orientation	ERP systems are built for recording what already happened, rather than planning for what will be. These systems can process orders, but they do not analyze business situations to provide insight into future courses of action. Transaction systems are good at monitoring events, but they do not take into account present and future constraints to aid in intelligent decision-making.
2. Rigidity	They allow an enterprise to design complex and sophisticated workflows, but are far too rigid in their ability to continually reshape and restructure workflows as business challenges and opportunities arise.
3. Lack of Scalability	They lack the ability to scale to large numbers of users and transaction volumes. For example, if a company were to attempt to extend their ERP system's order taking capabilities to the Internet, they would quickly find that the system is unable to handle the large volumes necessary.
4. Single-enterprise focus	While ERP systems integrate multiple business functions, they lack the ability to expand their scope to multiple enterprises. Clearly, in a business climate where collaboration with ones customers and suppliers is critical to success, this is a severe gap.

lifecycles becomes critical to the profitability, and even in some cases, the survival of the organization.

4 ELECTRONIC BUSINESS PROCESS OPTIMIZATION (eBPO)

eBPO is a new class of software that is distinctly different from ERP and other types of transaction systems. It provides the intelligence and speed to make the right decisions in real time to enable optimization across core processes of the enterprise, while powering eBusiness initiatives such as collaboration with suppliers, partners, and customers. It derives raw data from transaction systems or any other existing data source such as a legacy system; engages an integrated set of planning engines to analyze the data and produce an optimal solution based on a complete view of the enterprise; and feeds the optimal solution data back into the transaction system for execution.

Designed to unify a heterogeneous environment of multiple systems, applications and data sources, its high-performance architecture helps the enterprise interact with suppliers and customers with more efficiency and responsiveness than ever before, connecting them to the business planning and execution processes.

Specifically, eBPO provides value in these areas:

Forward Visibility and Responsiveness – Unlike traditional systems, eBPO allows enterprises the forward visibility necessary to identify opportunities and avoid costly mistakes. It achieves this by focusing on planning (modeling and analysis for decision-support), and execution (e.g. dynamic order scheduling and fulfillment). By contrast, ERP systems focus on processing business transactions (e.g. inventory movements) and generating the associated financial statements.

Flexibility to Cope with Changes in Organizational Structure – The industry consolidation (e.g. mergers, acquisitions, and down-sizing) that characterizes numerous sectors necessitates that enterprises' information systems be flexible enough to allow for the sharing of data and workflows between two previously distinct systems.

Support of Business Goals – eBPO supports the strategic objectives outlined by a company's executive management by creating competitive advantage in one of three ways: operational excellence, product excellence, or excellence in customer service. Its core processes strongly support the execution of those strategic approaches.

Global Integration and Optimization

- **cross-functional integration** – by integrating and optimizing major enterprise functions at the planning and execution level.
- **multi-company integration** – through leveraging the power of the Internet to link together enterprises with their trading partners, their customers, and finally, the end consumer. APS and ERP systems are inherently single-enterprise focused by design.
- **integration with enterprise systems** – eBPO provides data and workflow integration with transaction systems, and with other APS systems. It keeps the Total Cost of Ownership (TCO) of a business system low by offering leading-edge integration tools, which can integrate eBPO applications to leading ERP and APS solutions.

Scalability in Ultra-High-Volume Environments – eBPO scales to accommodate the massive volume of information created by the extension of enterprise systems to the Internet, such as product merchandising and order management -- without sacrificing system performance.

"Next-Generation" eBusiness Capabilities - Current electronic commerce applications have allowed companies to leverage the World Wide Web as a new channel for selling products, managing their customer service, and communicating with trading partners. However, many of these applications are limited in overall value because they have inefficient manual processes or transactional systems on the back-end. eBPO delivers "next-generation" eBusiness by integrating the web front-end applications with planning and optimization across all major business processes on the back end.

eBPO is uniquely qualified to deliver all these benefits, because only eBPO maximizes an enterprise's operational velocity by integrating and optimizing the five core business processes: Product Lifecycle Management, Supply Chain Management, Customer Management, InterProcess Planning, and Strategic Planning (see Figure 1).

5 INTELLIGENT E-BUSINESS

The Internet has radically transformed the way corporations attract and keep their customers. Without a doubt, corporations have a tremendous opportunity to quickly enter new markets, establish competitive dominance and solidify customer and partner relationships. But the promise of eBusiness has just begun to be realized.

Although there are a number of companies that use the Internet as a sales channel, few have been able to match Dell's record of sustainable growth with profitability. The main reasons for this type of growth lie in a holistic approach that fully leverages all aspects of the Internet.

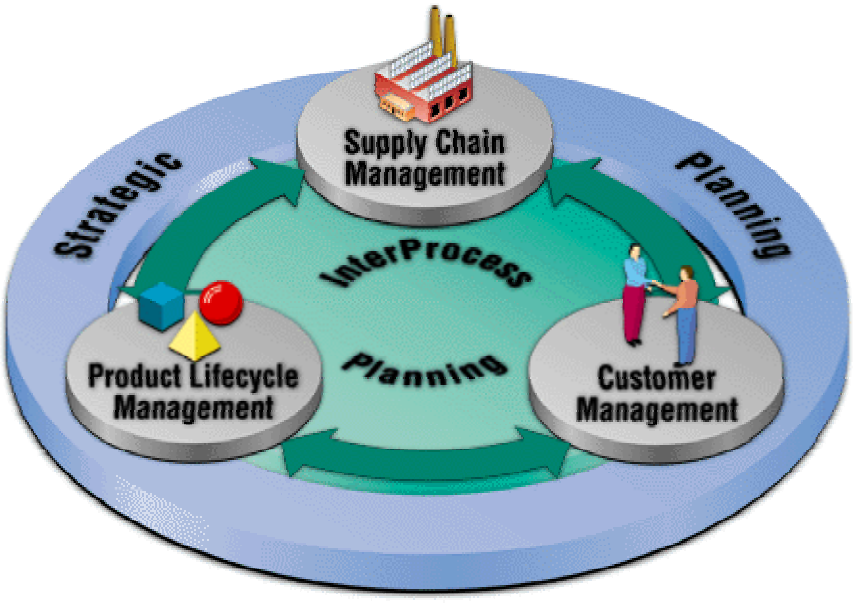

Figure 1: eBPO Integration of Core Business Processes

What are the components needed for this holistic approach? First, you must understand your customer and their needs while providing them with the information and tools to remain loyal. This **Customer-Centricity** is achieved through tools and services such as: smart store fronts, multiple product configurations, cataloging & catalog search engines, real-time Available-to-Promise, customer care services and comparative shopping tools.

Secondly, you must be able to deliver on your promises while remaining profitable. This **Operational Excellence** is achieved with end-to-end, scalable optimized supply chain management including: real-time quoting and reservations, optimized supply chain planning, advanced collaboration with trading partners and profit mix validation.

Thirdly, you need to link customers to one or multiple supply chains in order to get optimal customer service through visibility into the fulfillment process. This customer linkage is done through **Internet Fulfillment** that provides features such as: on-line, real-time quoting and reservations, integrated with logistics to support merges in transit.

Finally, you need to work within your trading communities to share as much information as possible to anticipate actual demands. These **Collaborative Communities** can either be Private (e.g., automotive network) or Public (e.g., semiconductor manufacturing outsourcing). However, hosting services need to be provided to have the IT resources available to fully participate in these communities.

6 WHAT IS THE SOLUTION?

The solution, illustrated in Figure 2, is to provide customer-centricity married with operational excellence, providing collaborative communities that form an integrated, scalable, intelligent eBusiness package. How is this possible? By providing scalable, platform-independent integrated components for the front-end that meet the customer facing needs, along with the back-end, intelligent operational planning solutions, it is possible to make your company growth oriented, in a sustainable manner. At the same time, integrating your company with your trading partners, including end-consumers, can be done through collaborative communities or markets, whereby both strategic information and spot transactions can be exchanged.

i2 has all the components and partnerships to deliver a complete end-to-end solution including the features necessary to support customer-centricity, operational excellence, Internet fulfillment and collaborative communities. These components, built during the last six years, have been field-tested and are able to meet the most demanding needs of clients, including 24 x 7 availability.

7 WHERE DOES SIMULATION FIT IN?

To support an increasingly complex analysis associated with extended enterprises, decision support tools have to lead key strategic decisions at each stage of the supply

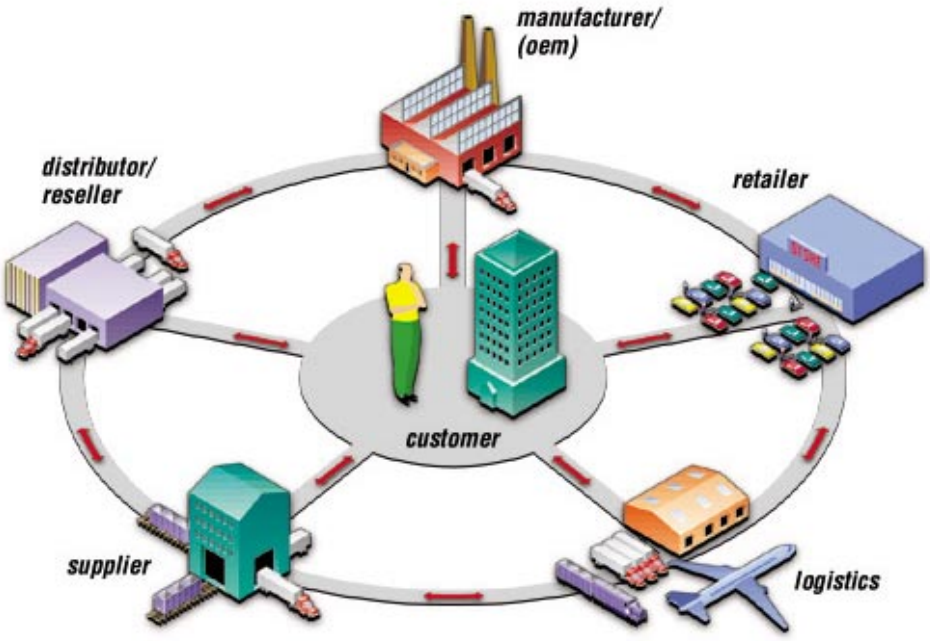

Figure 2: Solution is Customer-centricity Married with Operational Excellence

chain from raw materials procurement through finished goods distribution. The tools have to provide insight into the tradeoffs among alternative strategies regarding site location, facility missions, transportation strategies, inventory deployment strategies, and supply chain operations.

Typically, Supply chain design systems suppose a transient state and deal with aggregate data, accounting at best for some basic form of transit variability. In fact, the primary source of uncertainty in a supply chain is demand. In addition, operating policies for procurement, production and distribution all affect the performance of a strategic design. An enterprise attempts to provide a buffer against uncertainty and variability by keeping inventory, both in the form of materials and finished goods, at several locations along the supply chain. However, excess inventory reduces return on an enterprise's assets by tying up capital; and the level of mastery of this trade-off is actually the measure of success of an organization.

In Strategic Planning environments where senior executives set company performance objectives and make longer-term decisions of revenue planning, product portfolio management, and supply chain design, it is all the more important to have a good handle on all the variants in their systems. While optimization allows substantial performance improvements over the manual decision process it often needs to be complemented by off-line analysis and correction validate results obtained for complete feasibility. Meanwhile, traditional simulations merely stop at the replication of the model and push the burden of the scenarios to the user.

Using a unique blend of simulation and optimization technology, i2's solutions enable modeling of stochastic processes within the supply chain network and gives consideration to variability in demand, variability in lead-time, inventory strategies, service requirements, production capacities, and total network cost. It provides a set of analysis tools that utilize the "Discrete Event System Simulation" concept to account for variability and uncertainty present along any logistics supply chain. These tools let users design a robust supply chain with realistic estimates of the system behavior under varying market conditions.

8 CONCLUSION

i2 solutions enable value creation by enabling a unique holistic approach. By linking our simulation based strategic planning solutions with the tactical and operational solutions, we can enable substantial improvement of business processes within the enterprise and hence drive dramatic incremental value to their bottom line. True business process optimization, however, can only be achieved when the entire business process is considered. This necessitates inclusion of other enterprises, upstream suppliers and downstream distributors, within the planning process.

REFERENCES

Davenport, Thomas H. 1998. "Putting the Enterprise into the Enterprise System," *Harvard Business Review*, July-August.

AUTHOR BIOGRAPHIES

BILL HUBBARD is the Director for i2's Transportation Business unit. Prior to joining i2 he started the Operations analysis group for VZM-Transystems formerly VZM Viickerman-Zachary-Miller). It was the first group to apply simulation to intermodal facilites & ship wharfs. They simulated the England side of the Chunnel , along with dozens of rail and port facilites. The simulations were used to improve the operations and design of the facilites. He was also Director of Business process & systems for American President Lines, the largest trans-pacific carrier. He holds B.S. in Industrial and Systems Engineering from the University of Florida.

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