

SUPPLY CHAIN SIMULATION: STAYING COMPETITIVE

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ABSTRACT

Supply Chain Management has emerged as the competitive mantra in today's business. The speed of delivery of products to market and the cost of achieving that delivery are increasingly evaluated simultaneously. The tools that are currently available for performing that evaluation use various methods of problem solving such as linear or integer programming, or spreadsheet analysis.

These tools lack, however, the fundamental capability of evaluating variability in demand, supply time, or transit time. These factors are key differentiators in competitive performance comparison and analysis.

Simulation technology is an emerging as a new tool and its basic strength is in evaluating system variation and interdependencies. This key component allows a decision-maker to evaluate changes in part of the supply chain and visualize the impact those changes have on the other system components and ultimately the performance of the entire supply chain.

1 INTRODUCTION

Simulation has long been used in manufacturing and assembly operations and has grown to become widely accepted as a "tool of the trade" in basic manufacturing environments. The growth of simulation in the 1980's and the availability of simulation packages helped push the tool into many other application areas and thus exposed new groups of simulation to people. Many companies began to expand the use of simulation beyond manufacturing and assembly and began looking at the start and finish to these processes which represent raw materials in and finished goods out. Once financial reward was demonstrated in main-line operations, new areas were being investigated. The new areas effected

by simulation began to expand into warehousing projects and projects that began to tighten up both the delivery of raw materials and the shipment of finished goods. With the increased focus on competition and market survival during the 90's, many companies were pressed to make improvements to shipping systems in order to provide customers with finished goods in shorter amounts of time. All of this needed to be done without increasing the overhead of the product and potentially leading the vendors to price themselves out of a market and out of business.

Many tools began to surface that dealt with the logistics surrounding the shipping process. The introduction of Supply Chain Management became a huge focus in the mid 90's and created the market place for tools that could address basic issues surrounding the flow of product from vendor to customer. These tools are able to gather all of the valid information regarding the four basic processes involved in a supply chain: Plan, Source, Make and Deliver. These systems attempt to use algorithms to determine the configuration of raw material supply and resource constraints to fulfill their customer demand. Similar to the success of the simulation market, the supply chain management software market has been able to provide a tool that can assist in the once time consuming process of scheduling the entire supply process from order to delivery and all things in between.

These two technologies represent tremendous savings potential for every company that provides products or services to a customer base. Because of the history and inherent similarities between these technologies, there is tremendous potential to take the analysis and variability focus of computer simulation and add it to the heuristic algorithms of supply chain tools. The ability to not only come up with a solution to the problem but to also come up with the best solution with respect to system's constraints and its real-life

fluctuations is the difference in becoming a leader or a victim in today's business world.

2 THE APPLICATION OF SIMULATION

When approaching simulation technology, it's always a positive sign when the user has in mind a definitive use for the simulation software. Building a simulation model is only a small portion of a simulation project. It is very important for a project team to understand all logistical aspects of a system in order to build a comprehensive model and thus complete the project. Pinpointing this information and involving the right people in the project will undoubtedly provide new insights into the processes involved.

It is important to keep in mind the basic steps of a simulation project to better understand how this technology can increase the effectiveness of a supply chain. The basic steps behind a successful simulation project involve Problem Definition, Data Collection and Manipulation, Model Formulation, Validation and Verification, Analysis and Experimentation, and Conclusions and Implementation.

While various tools can be used to help enhance the effectiveness of the model, it's vital to use the information provided through the supply chain analysis tool that you're using. While the goal may be to validate the supply chain implementation, the data you'll collect and use in the initial solution with that tool will be vital to the success of your simulation project. Once you've been able to understand the exchange of information between the supply chain tool and the simulation tool, you're more prepared to begin using the simulation model as a method for improving the supply chain implementation. This also assures the solution is as accurate as possible with respect to your initial goals. It isn't until the project team understands that the simulation tool is a method of looking for an optimal solution that the two tools begin to act as one. It may take multiple iterations to find a supply chain implementation that makes sense according to corporate constraints as well as from a logical perspective

3 THE SUPPLY CHAIN MARKET

Change and change management have been key components of many of today's industry leading companies. Only the companies that look for new and better methods survive. Although it is a trite expression, Process Reengineering is still a vital part of management's daily struggle to maintain market share. Increasingly, the ability of companies to operate at lower costs while still delivering goods and services to

customers on time and sometimes even sooner, has become the focus of strategic planning meetings. So, how is it that managers go about finding ways to cut costs and improve their processes?

One of the most costly and most difficult to manage parts of a business is the supply chain. The supply chain consists of a company's network of suppliers, production processes, warehousing and distribution methods and customers. The goal is to manage all aspects of the supply chain in order to meet customer demand without driving up costs or inventory. How do we do that? In the past, methods such as Linear Programming and Scheduling and Inventory Control systems were utilized to manage the variability that exists in these systems. Although time consuming and often stabs in the dark, these methods were all that was available to managers. It wasn't until recently that the algorithms and processes behind these methods were automated and packaged for ease-of-use. Companies like i2 and Manugistics have created supply chain management applications that incorporate all of the logistics behind the supply chain and attempt to create methods that will find "optimal" balances between costs and customer satisfaction. Would a product such as the ones these two companies offer find a market and replace the existing tools? Do a search on "Supply Chain" on the Internet or track the stock performance of these and other supply chain software vendors. The indicators in many of these sites point to increased stock prices and increased focus from many of today's business journals.

The basic function behind the application of these tools is to find the interdependency of the system constraints that minimizes cost and maximizes profit. There exists a "Critical Path" and a "Shortest Path" that achieve the min/max idea while looking at the variability behind Production Allocation, Expansion and Consolidation, and Resource Planning. Is there one answer? If demand is a constant and there is zero percent chance that it could change then we can find one optimal answer. But, because we live in the real world and have no way of predicting demand in the future 100 percent of the time, we need to include an aspect of variability in our solution. If we use a demand constant and it ends up being too high, we have added unnecessary costs to our system and have obviously raised our inventory levels with no place to put the end product. If we undershoot our demand we end up with dissatisfied customers and will likely lose points on our stock price and overestimate our earnings for the time period and perhaps lose a portion of our market share. So the key in a supply chain solution is to have a solution that accounts for system variability and isn't greatly effected by sudden shifts in customer demand.

4 A MARRIAGE OF TECHNOLOGIES

When working through a maze puzzle in the back of the Sunday paper, is it easier to start at point A and move through the maze without looking where you're going or is your chance of success increased by looking ahead and eliminating the bad routes? The same scenario holds true in supply chain management. Certainly we could take one solution from our system and implement it in the software where we just spent 110 percent of our quarterly budget. Will the solution work? We'll have to wait until our customers begin calling because they haven't received their shipments. Would it be better to create a flexible solution that has been tested over the course of time and has been built with the ability to react to unexpected changes in system variables? By using simulation, we are able to create a model of our supply chain system and then test various levels of input that can emulate real life inconsistencies without forecasts. What if our forecast is off by 25 percent? With too many companies, that could mean disaster. Either we undercut our customer's demand or we end up building new warehouses to store the excess. However, if our methodology was able to adjust to this type of fluctuation and readjust our process, we can alter our processes to negate the effect of these swings.

The key to simulation is that it doesn't give you an answer of "5". Instead, simulation models give you ranges of results and allow you to improve the statistical accuracy of those results to build a robust and predictive system. In fact, simulation is the only tool that can keep track of all your system metrics and predict the interactions between those metrics based on changes to the system inputs. By adding the chance that our forecast could change by a certain percentage, we can better predict the reaction of our key constraints: Stock, Labor, Shipping Costs, Spatial Constraints or Resource Allocation. Simulation also provides a key tool for weighing costs vs. revenue. We're able to find ways of cutting costs without decreasing revenue or finding ways to maintain costs while increasing revenue. The simulation model now becomes a component of your analysis methodology and becomes a great partner with your supply chain management software. By taking the scenarios created by the supply chain tool and running them through the simulation model to test for flexibility, you're able to eliminate unrealistic solutions and pinpoint a defined set of "preferred" solutions. By ranking the preferred set of solutions, management is able to weigh their own criteria for success and implement a solution that they know will account for any variability that could occur over the next planning period. Once this interaction is established, the simulation tool and the supply chain tool become one

and there is a win-win aspect to system reengineering. It's always better to implement a system that reacts well to variability and is able to accurately predict performance within a certain range than to implement one "optimal" solution based on a fixed set of input.

5 SUPPLY CHAIN FORMULATIONS

The previous section addressed the benefits of using simulation technology and supply chain tools in a project. The question is what formulations do we need to create in our simulation model to allow us to predict the reaction of our supply chain to uncontrollable variation? When formulating simulation models in order to better determine the flow of materials through the various components of the supply chain, a great deal of care must be taken in understanding the interdependencies of the supply chain.

The series of dependent actions that make up the supply chain begins with the parent activity, the demand forecast. The demand forecast is based on some time period (usually weekly or monthly) and typically represents the company's entire family of products. The forecast is then compared against the available inventory, the inventory is promised to the forecasted demand and then a series of activities continues downstream in the supply chain in order to maintain the required levels of finished goods. The next portion of the process that is evaluated is the production or manufacturing process. It's important to understand the capacity of the process to produce sufficient levels of product to replace those products that were removed from the supply chain.

As alluded to in an earlier section, the manufacturing process typically is constrained by raw material (or in-process goods) and resource availability. These processes may include sub-assemblies that originate from other supplier organizations in our supply chain. Nonetheless, this becomes a major constraint because those suppliers, like us, have a finite ability to supply products to the process. Additionally, raw material providers have constraints on their ability to deliver raw materials to the process. With this we begin to see some of the interdependencies that exist in our system and the need for simulation to better understand the effects of those interdependencies.

This leads us back to the point made earlier that the fluctuation in the demand forecast, and the ripples that it causes through the supply chain, is the single most important variable in our supply chain. Each modification to the demand forecast causes a knee jerk reaction through the supply chain as it attempts to adjust to the new demand. Because the downstream "child"

activities in the supply chain must be initiated prior to the upstream “parent” activities, reductions in the actual demand at the very start of the supply chain result in oversupply and excess or product shortages that can’t be recovered from in time.

The nature of demand forecasting is that it happens on a periodic basis. The supply chain model formulation takes into account the periodic updating of all aspects of the supply chain. In this fashion, the supply chain is constantly changing and viewed as a dynamic process; constantly reflecting the activities generated by the policies by which it operates. In fact, if we look at the activities in the supply chain, they basically translate into products and those products generate revenues and expenses. One principal performance measure in the supply chain is the net profit calculation. In a simulation model, these types of metrics can be measured easily. Revenues can be measured based on the number of units shipped at a unit cost and expenses can be calculated by understanding the relationship between the raw material costs, carrying costs, transportation costs, and of course the fixed and variable production costs. Through the use of the simulation tool it is easy to graphically display these dynamic calculations and view the status of these metrics as time progresses in the supply chain.

The true strength in the simulation portion of the supply chain project is the concept of incorporating system variation into the model. Based on what we’ve mentioned so far, key variants are forecasted demand, forecast error, processing rates, processing yields, material and finished goods delivery times, product fail and return rates, and storage capacities. Each of these variables can cause ripples in our supply chain and thus need to be monitored and checked in order to understand the interdependencies in our supply chain. Once we’re able to incorporate these formulations into the simulation model, the results, and decisions made based on those results, become more accurate in more representative of our true system performance.

6 THE FUTURE POTENTIAL

Many companies today are taking advantage of simulation technology and supply chain tools that are available. Many of today’s visionaries and thinkers are using the tools together in order to stay one step ahead of the competition. Although it is a new topic in the engineering world, Supply Chain simulation is becoming the industry’s new brainchild. Supply Chain companies are beginning to see this potential and starting to incorporate simulation engines and technology into their solution packages. Manugistics’ purchase of Tyecin is a clear statement of their attempt

to capitalize on the potential boom in the supply chain simulation market [Tyecin is a developer and owner of a wafer fabrication simulation engine]. Many simulation companies have seen rapid growth in the amount of inquiries into the ability of their products to “work with” supply chain products. In fact, some simulation companies have added technology like Visual Basic for Applications and ActiveX capabilities in their products to allow customers to “Plug-In” with existing software to create better solutions. If you polled many of today’s leading consulting firms and asked them the most popular type of project their consultants are working on the answer would be supply chain management projects. The hourly rates charged by consulting firms for this type of project are displayed on the web and the want-ads for supply chain consultants are taking up most of the space on the web job postings.

Have we reached the end of the supply chain buzz? Many experts feel that we’ve only just begun and that there will be major alliances formed in the future to bring more robust solutions to industry managers. Whatever the future holds for the supply chain market, simulation will play an increasing role in the success of the market leaders and will become a key component in most supply chain reengineering efforts. The growth and acceptance of simulation in the business world is another component that will drive the success of this technology. The emergence of simulation from the basement of today’s market leaders to the desktop of middle management shows that this technology has a place in the decision- making process. Cheaper and easier to use simulation tools that work with business process mapping tools are taking the business world by storm and showing managers that there are better solutions to everyday questions and that they’re not difficult to find. Industry experts believe that simulation technology is a key component of any process redesign project, including supply chain. The marriage of supply chain tools and simulation technology shows that the pressure to remain competitive is higher than ever before and that as long as there are tools available to find better solutions there is a place for them in today’s business world.

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