ESP (Enterprise Simulation Planning) for the Supply Chain

Enterprise simulation planning (ESP) enables businesses to see how the supply chain will perform under future demand and potential alternate supply chain structures and policies to reduce the risk inherent in strategy changes and to encourage continuous supply chain improvement and innovation.

Executive Overview

Wouldn’t it be great to know how your supply chain will perform in the future? To know how a strategy change will impact your service levels or costs? To predict when you will stock out or be late with a shipment?

To do this you need ESP.

Not extra-sensory perception (though that would be nice), but the next best thing, from a supply chain analyst’s point of view: Enterprise Simulation Planning.

In this white paper you will learn:

- How simulation technology is used today for advanced supply chain analytics
- The four distinct “quadrants” of simulation use cases that deliver four unique benefits to an organization. Supporting these definitions are real-life examples of how companies have used simulation to help steer their supply chain strategy and avoid the perils of poor or under-analyzed decisions
- How the equation ESP + ERP = ROI is being proven by numerous leading supply chain companies around the world

The Four Quadrants of Supply Chain Simulation

Axis 1 – The Network

The Network refers to the structure and policies under which the supply chain operates. Structure includes elements such as suppliers, manufacturing/distribution locations and capacities, customers and transportation assets. Policies include things like sourcing decisions, transportation modes selection, inventory stocking levels and replenishment frequencies.

Axis 2 – The Demand

The Demand is what drives the supply chain network. It includes customer orders that need to be filled, store stock that needs to be replenished, manufacturing components that need to be delivered or merchandise that needs to be sourced.
When referring to the Network, the Current State represents the way in which the supply chain is currently structured and the current policies that the supply chain follows. When referring to Demand, the Current State typically means the most recent past such as the last 12 months of orders or shipments.

The Future State represents a potential new supply chain structure or a new policy, such as a new manufacturing footprint, a new supplier, new inventory targets or new transportation modes. The Future State also represents projected or “forecasted” demand, such as annual growth, sales into new markets or sales of yet-to-be released products.

When plotted into quadrants, these elements can help clarify the distinct use cases of simulation in supply chain analytics.

The Four Quadrants of Enterprise Simulation Planning

- **State 1 – Current**
- **State 2 – Future**
Four Applications of ESP for Four Distinct Business Use Cases

Baselining: Current Network / Current Demand

Context

Modeling and simulating the Current Network using the Current Demand (i.e. the most recent historical supply chain transactions) is an essential starting point for all other forms of analysis, and is typically referred to as the “baseline”.

Business Value

The baseline is like the control in a scientific experiment. Once the baseline simulation has been validated to show that the behavior, flows and costs match those that happened in the real world, the analyst achieves confidence in the model’s behavior and can use the model to compare against new simulations that explore changes to structure, policy, or demand.

- Visualization: The baseline gives analysts the ability to visualize the structure and behavior of the current supply chain. Maps, flowcharts, graphs and reports can help you see how products flow through the supply chain network, identify where there are inefficiencies, detect capacity constraints and determine where there are cost imbalances.

- Communication: Seeing a simulation of the supply chain including the visuals described above can help analysts communicate what is actually happening in the supply chain to all the varied stakeholders, creating consensus and confidence in the model data and assumptions and minimizing people’s ability to challenge the results of future what-if experiments.

Case Example: Using Simulation for Railcar Fleet Sizing

Challenge: A company needed to understand their current railcar utilization, then determine how many railcars would be required based on numerous forward-looking scenarios.

Solution: First, a baseline simulation model was built with key inputs including historical demand and shipments, railcar assets and capacity levels, travel times, load/unload and delay times and maintenance records. This model was simulated and validated against historical records. Then, new information was added to create analysis scenarios including forecasted demand, variability of lead-times and transportation travel times and rail car fleet size options.

Results: The initial baseline simulation presented the team with a visual and data-driven look at their current rail-car utilization, actual movements, service levels and costs. There were multiple immediate and obvious improvements that were identified just through the visualization of the historical fleet moves.

Graphic showing the trade-off between railcar availability (green bars) and utilization (red bars)
Numerous new scenarios then showed the team what their fleet would need to look like under a variety of future assumptions such as different demand forecasts, different lead-times or different service level agreements. The graphic shown is taken from one such study that evaluated the trade-off between railcar availability (green bars) and utilization (red bars). More railcars in the fleet would lead to higher service but lower utilization. Other analyses identified the lowest-cost fleet size that would still meet target service levels under acceptable delivery time variability.

**Quantification: Future Network / Current Demand**

**Context**

Simulating the Future Network using Current Demand can help an analyst to quantify a theoretical change to the supply chain structure or policies before implementing such a change in the real world.

**Business Value**

Simulating different what-if configurations of the supply chain network can help quantify the cost and service level impact for questions such as: What if we change to twice-weekly replenishment? What if we source from Mexico instead of China? What if we change our inventory targets?

- **Validation:** Often business leaders will have ideas regarding new operating strategies. Typically, the leader with the most seniority or experience or simply the loudest voice will convince the team on the merits of his/her strategy and set about implementing the plan. A well-run simulation analysis can provide data-driven proof of how such a strategy will actually play out—predicting at a detailed level metrics such as on-time deliveries, capacity utilization, stock-outs and end-to-end costs—thus validating the value of a new operating strategy.

- **Cost Avoidance:** The cost of a bad supply chain decision can take months or even years to fully manifest. Improper placement of a new DC, selection of the wrong manufacturing location or sourcing from the wrong country can cost a company millions of dollars and cannot be easily changed. Running detailed simulations of these decisions can help companies avoid the costs associated with bad decisions by predicting these costs ahead of time and comparing the results versus other, more appropriate network decisions.

**Case Example: Using Simulation to Smooth Production Planning and Order Variance**

**Challenge:** A consumer goods company wanted to get better performance out of their manufacturing plant. Instability in ordering patterns combined with ad-hoc scheduling led to inefficient use of machines in the plant.

**Solution:** Managers thought efficiency could be improved by segmenting fast and slow moving inventory and initiating regular schedules for their manufacture. They used simulation to test out the improvements from this new network strategy before implementing them.

**Results:** The simulation suggested that these strategies could result in a 40 percent improvement in stock levels together with dramatic improvements in workcenter change-overs and adherence to production plan.
Detailed simulation predicted lower stocks and stable production, with improved service. Graphic on left shows simulated inventory levels for individual SKUs; graphic on right shows total system inventory.

**Forecasting: Current Design / Future Demand**

**Context**

Simulating the Current Design using Future (Forecasted) Demand can help an analyst predict operational challenges such as capacity limitations, product stock-outs, delayed deliveries or supply shortages.

**Business Value**

Companies spend an enormous amount of time and effort to forecast future demand. These forecasts have varying levels of accuracy, but can be extremely useful when coupled with enterprise simulation planning models. Running simulation scenarios with different potential forecasts can identify the limits a supply chain can handle before running into operational difficulties. For this reason, leading companies often incorporate these simulation models into their corporate S&OP or capacity planning processes.

- **S&OP/Capacity Planning:** The corporate S&OP process brings together sales and operations to help determine where resources should be allocated, or to proactively manage potential capacity challenges. Simulating the production process using different variations of forecasted demand can identify where bottlenecks or capacity limitations will be hit, helping determine where and when to add more manpower, pre-build product, or pre-position inventory.

- **Sensitivity Analysis:** Even the best demand forecasts are wrong in varying degrees. The challenge is to still make use of these forecasts by determining how sensitive your supply chain is to different demand volumes. If the forecast calls for a 20 percent increase in demand over the next three months, savvy analysts will run multiple simulation scenarios, varying the demand up or down (i.e. -100%, -50%, +50%, +100%) to determine the point in which a new operational strategy is required or where a capacity constraint will be hit.
Case Example: Using Simulation to Support S&OP

Challenge: A global pharmaceutical manufacturer had been using SAP APO for tactical production planning, but this solution lacked capability for scenario analysis on potential network and sourcing configurations.

Solution: First, the company built a network optimization model to analyze alternate production plans under multiple conditions, including demand growth and contractions in various regions, different pricing plans (profitability analysis) and new suppliers for critical raw materials. Simulation was used to introduce business logic, lead time variability and demand variability in order to quantify how susceptible the “optimal” production plan was to unexpected changes.

Results: Simulation results showed the actual predicted on-time rate for customer orders, work center utilization including changeovers and down time and lost sales caused by raw material delays and production plan deviations.

Simulation showed actual work center utilization and adherence to production plan given lead-time and demand variability
Innovation: Future Demand / Future Structure

Context

Modeling new supply chain network strategies with new projected demand is required when trying to innovate and proactively move the business forward.

Business Value

Transformational decisions often do not have a historical reference or transactional history, nor do they always have an existing supply chain network from which to create a model. However, simulating Future Networks with projected Future Demand is incredibly useful in testing transformational ideas and validating theories prior to making these often risky moves.

- Strategic Planning: Strategic business initiatives such as mergers and acquisitions, new product launches or the entry into new geographic regions carry a great deal of risk. These decisions require changes—often drastic—to the corporate supply chain network. Simulating the supply chain network under these new conditions and testing multiple scenarios can help predict key performance metrics and significantly mitigate the risk in strategic business decisions.

- Gamification: Numerous leading-edge supply chain leaders give their analysts the encouragement and time to be entrepreneurs and innovators, to test new network strategies under new market conditions to find the “next big idea”. They even go so far as to make games out of finding the most promising strategy for reducing costs, improving service or increasing revenue through simulation models.

Case Example: Using Simulation to Predict Effectiveness of Nearly 100 Network Improvement Ideas

Challenge: A large U.S.-based retailer needed to simulate multiple scenarios for entire regions of their network at the SKU-level to determine the effects of their stocking decisions.

They were interested in analyzing key metrics such as trips per order, prime fill rate, transportation cost and margin.

Solution: The retailer created a realistic, high-fidelity simulation model at the SKU and order level to enable it to prove out the effectiveness of nearly 100 network improvement ideas to the North American delivery network. The model was created to include an auto-model building query to translate raw data into the model. Simulation used to test the business logic to identify the best shipment method to customers; including from a fulfillment center, “drop ship” from vendor to customer or from the vendor and cross-docked at the fulfillment center.

Results: Using this simulation tool, the retailer is now able to evaluate detailed service, transportation cost and inventory metrics for different network configurations. This allows them to evaluate multiple future network configurations and demand scenarios before implementing any changes in the real world.
ESP + ERP = ROI

Many companies have adopted simulation technology as part of an integrated supply chain design technology platform. This platform enables automated model building and analysis using data pulled directly from the ERP system, enabling continuous improvement and innovation using the most current operating and reference data. Components of this system include:

- Automated access to ERP and other enterprise data through data analytics tool, where disparate data is cleansed and blended, ready for modeling use
- Cloud-based reference and benchmarking data and repeatable-use optimization and simulation models
- Web-based access to models and data for use by multiple stakeholders within the company, including executive dashboards and short-term planning

This enterprise supply chain design platform gives businesses the ability to:

- Quickly and easily build models to visualize and analyze the current network
- Continuously test what-if scenarios using current and future network and demand
- Quickly validate potential network changes against real-world variability
- React rapidly to unplanned supply chain events

- Simulating new production strategies
- Playing ahead future demand
- Experimenting with new routes
- Running forecasted operational tests
- Corporate master product data
- Site and supplier locations and lead times
- Historical orders, shipments and costs
- Production capacities and flows
- Rapid validation of new strategy decisions
- Early prediction of future capacity challenges
- Location of supply chain risk points
- Prevention of costly mistakes
LLamasoft ESP Technology

**Proprietary SimServer™ Engine**

LLamasoft was built on deep simulation domain expertise applied to the corporate supply chain. Over the years, LLamasoft has continuously updated its proprietary simulation technology, SimServer. SimServer is the only discrete-event simulation engine specifically designed for the enterprise supply chain, and architected from the ground up to scale with hardware to tackle SKU and transaction level detail.

LLamasoft® Supply Chain Guru® is a market-leading supply chain design application that integrates numerous optimization and simulation technologies into a single user interface and data model, including the SimServer engine. By integrating these different analytical techniques into a unified application, Supply Chain Guru enables rapid iterations between optimization recommendations and simulation testing.

The Supply Chain Guru scenario manager further improves the analysis process by enabling users to quickly adjust multiple variables and create dozens of what-if scenarios and sensitivity analyses. These scenarios can be run locally or in the LLamasoft cloud for faster and parallel solving.

Having the power to generate and solve what-if scenarios quickly and easily has changed the way businesses look at supply chain design. Rather than evaluating individual solutions, businesses are now using LLamasoft technology to evaluate ranges of options and test them under real-world variability for better decision making.