Introduction to Strategic Supply Chain Network Design

Perspectives and Methodologies to Tackle the Most Challenging Supply Chain Network Dilemmas

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ABSTRACT

In today's dynamic business environment, manufacturing and distribution companies are revisiting supply chain network design decisions to ensure that they optimally balance the various costs involved in providing the level of customer service required by the overall business strategy. Analysts claim that 80% of supply chain cost is predetermined in the design of the product and supply chain network. Given the significant business impact driven by such a fundamental decision as how a supply chain is designed, Spinnaker's client experience has found that the ROI of such analysis is often many, many times the cost and effort involved.

In this paper we provide a brief introduction to supply chain network design, discuss how Spinnaker approaches such problems, provide an overview of the software solutions typically used to solve such problems, and discuss the value that can be realized.

At Spinnaker, we specialize in providing supply chain expertise, including supply chain network design solutions, to help clients solve key business problems.

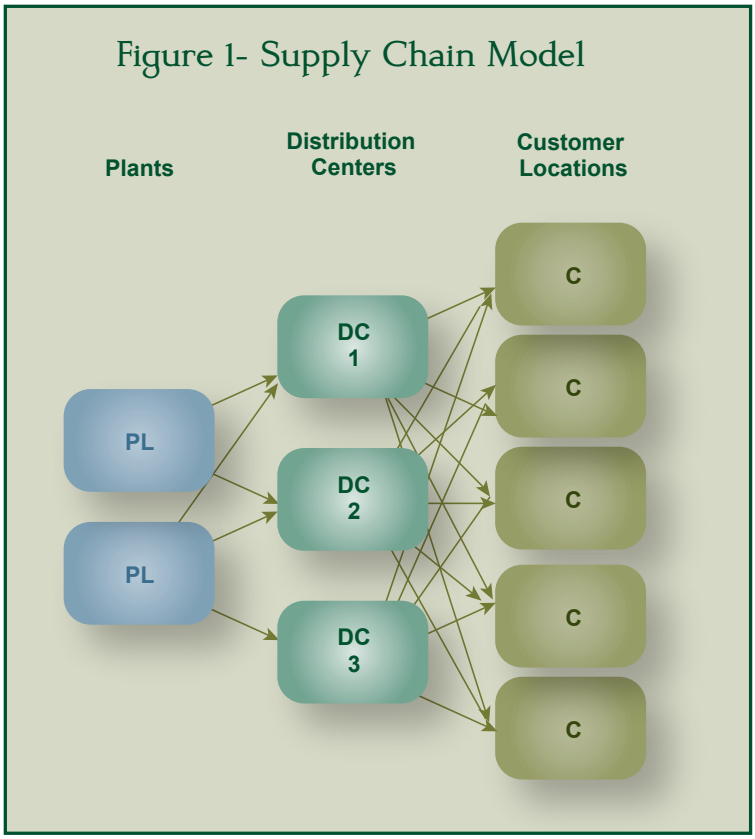
INTRODUCTION TO SUPPLY CHAIN NETWORK DESIGN

Supply chain network design is the practice of locating and rationalizing the facilities within the supply chain, determining the capacity of these facilities, determining how to source demand through the network and selecting modes of transportation in a manner that provides the required level of customer service at the lowest cost.

In the supply chain model depicted below, a product may be sourced from either of two plants and flow through three different distribution centers to reach any given customer. Even in this fairly simple model, the complexity grows quickly when one considers any meaningful number of products on top of the various sourcing options, transportation modes, capacity constraints, leads times and costs that must be considered.

Supply chain network design models provide the most effective and efficient way to solve such problems. These models provide powerful decision support functionality to understand and evaluate complex supply chain relationships.

Figure 1- Supply Chain Model



DIFFERENT TYPES OF NETWORK DESIGN PROBLEMS

Broadly speaking, supply chain network design modeling can help organizations answer three types of questions, ordered below from the most strategic in nature to the most tactical. While the focus of this paper is primarily on the first question, these different problems are described to provide context on the scope of problems that can be addressed using similar approaches.

Question #1 - Strategic Supply Chain Optimization

How do I design my supply chain network to deliver the required service at the lowest possible cost?

These problems address balance sheet and capital asset management decisions over a multi-year strategic planning horizon and, starting with the current state of the supply chain, focus on determining the best location and capacity of facilities to match demand and supply.

Question #2 - Distribution Strategy Optimization

Given a fixed network, how do I determine optimal product sourcing and inventory deployment rules to meet anticipated customer demand?

Distribution strategy problems address monthly or quarterly tactical planning horizons and focus on balance sheet resource allocation decisions related to inventory and working capital. The key objective is to understand the tradeoff between customer service and inventory investment and develop the best sourcing and inventory strategy for servicing customers while effectively managing risk.

Question #3 – Transportation Strategy Optimization

Given a logistics network and a defined distribution strategy, how can I best use my available transportation resources?

Transportation strategy addresses monthly or weekly tactical/operational planning horizons and focuses on optimizing operating expenses and gross profit from an income statement perspective.
This analysis focuses on optimizing material flow, transportation mode selection, carrier selection, and capacity utilization to develop a cost-effective transportation strategy.

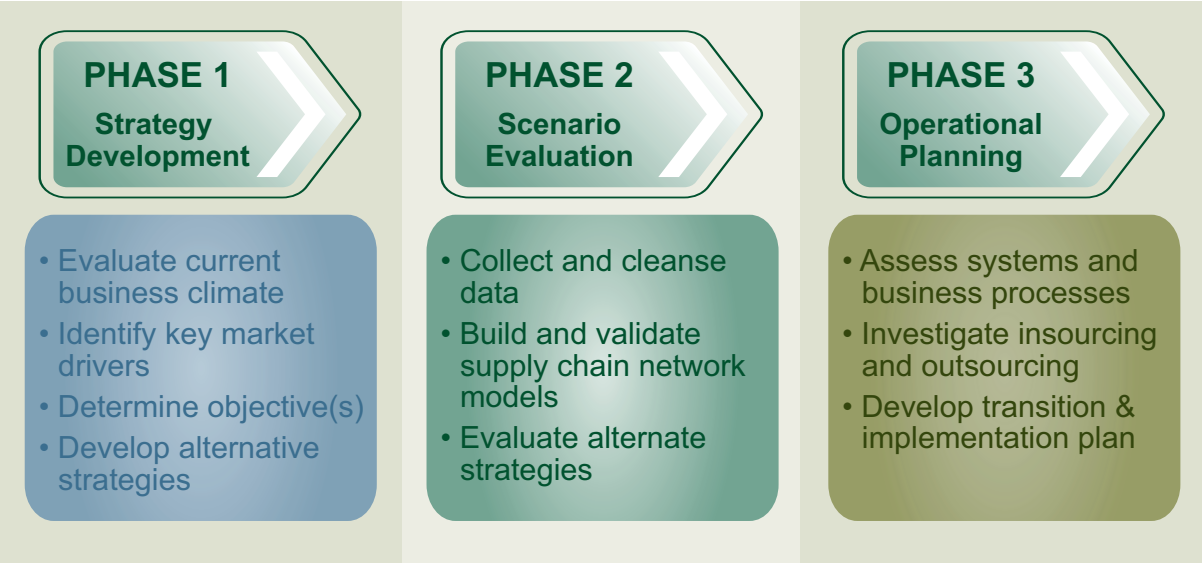
SUPPLY CHAIN NETWORK DESIGN BUSINESS CASE

The potential savings from a supply chain network design study can be enormous – in some cases the payback period for such an effort is a matter of months. Companies often find that revisiting their supply chain design decisions uncovers facility location or sourcing decisions that, if left unchanged, would have resulted in supply chain cost structures millions of dollars more expensive than they needed. Opening and closing facilities is not a trivial matter, but the use of network design software ensures that operational impacts of such decisions are effectively analyzed.

SPINNAKER'S NETWORK DESIGN APPROACH

The Spinnaker approach to executing a supply chain network design assessment is to understand the strategic business objectives, define and analyze the multiple strategies to achieve these objectives, evaluate the options and trade-offs involved and develop the implementation plans required to translate decisions into reality. The graphic below illustrates the different steps in this process.

Figure 2- Spinnaker Supply Chain Network Design Methodology



Phase 1: Strategy Development

The development and communication of an overall supply chain strategy is the responsibility of corporate management. The role of the project team is to research and suggest potential strategies, and assist in the evaluation and detailed analysis of the strategic alternatives presented. Models help to visualize and communicate ideas, capture complex relationships and study the impact of various decisions, but they do not create strategy. With this in mind, there are several key issues to keep in mind when developing a corporate supply chain strategy.

Strategy development is both an art and a science. "Art" is required in the evaluation of market trends, forecasting competitive drivers and creating an effective organizational structure. Science is applied in the effective use of modeling tools to develop and evaluate potential strategies (though the effective and creative use of models is often an art itself).

During the initial phase of strategy development, it is important to remove oneself from the numbers and think conceptually. There will be adequate time later to get into detailed analysis.

The primary focus at this point should be to develop a list of critical issues and identify how each will change over next 3-5 years. Some questions to guide the process are:

- Who are our customers? What do they expect from us? How well do we meet their Z expectations?
- What are our deficiencies?
- What do our competitors have and/or do that we don't?
- What do we have and/or do that our competitors don't?
- What functions/roles/services are crucial to our business and should be kept in-house?
- What functions/roles/services could potentially be outsourced?

A good template for discussion starts with a review of the current market trends, competitive and financial pressures and operating environment. Then develop a vision of estimated future market needs and the operating environment necessary to meet those needs. The strategy to be developed must close the "gap" between current and future operating environments. Issues identified at this stage drive the development of an integrated strategy.

Note that this strategy is not carved in stone. It must be updated annually as current events re-shape the future. A good strategy evolves over time. The most important goal is to lay a foundation of processes and culture so that strategic planning becomes an integral part of the business.

Phase 2: Scenario Evaluation

Once a set of potential strategies has been developed, these alternatives must be evaluated according to an objective and measurable set of key factors. These values will be used to determine the relative "goodness" of each solution.

Since one alternative is to do nothing, the first step is to collect operational and costs data on the current network. These baseline costs and service measures will be used as the benchmark against which all other options will be compared. It is important to closely evaluate the use of averages within the model. Markets, product mixes and logistics costs change over time and from region to region. Averages may bias the models for or against a particular solution. However, high-level averages are still useful for comparing one solution to another.

Typical data requirements for a modeling effort will include:

- Demand (as indicated by customer demand for each particular product group).
- Supply (as indicated by supplier and/or manufacturing capabilities and capacities).
- Facility capacity (maximum units of production/flow per day).
- Costs (fixed and variable manufacturing, material handling and transportation costs).

The next step is to build and validate high-level models that will be used to test each alternative and calculate the appropriate cost and service measures. Focusing first on the baseline solution, we create a network model, verify that the model behaves as we expect it to and validate the model output against known cost and flow measurements. Note that the more precise a model must be,

the greater the amount of data that must be collected, the greater the accuracy required of that data and the more difficult it will be to solve the model. We make every effort to create flexible, reusable models that may be re-applied for future studies and strategic planning.

Because we are evaluating long-term strategy, the models typically focus on annual demand, not short-term figures. Depending on the complexity of the network, it may be necessary to partition or regionalize the network along natural geographic or business divisions. Each long-term strategy being evaluated may potentially be accomplished through millions of possible combinations of facility locations, transportation plans and stocking policies. The goal of network optimization is to rapidly evaluate this multitude of alternatives and select a few top contenders for further analysis.

After the baseline model has been approved, we then can build and evaluate alternative strategies using the same core assumptions used to build the baseline. Our goal at this stage is to optimize a given network to meet market needs. The primary components of a solution are the number, location, size and inventory stocking policies of each facility and the associated transportation plan. The primary measure of each solution is its net operating cost.

For each contender selected, it is important to adjust key assumptions to determine the sensitivity of the solution. This sensitivity analysis is useful for evaluating the robustness of the solution to changing market forces, as well as for identifying key factors that must be tightly controlled.

The total cost of a supply chain strategy is not completely captured within a high-level network model. After a solution has been identified as a contender, it must be evaluated within the broader environment of information systems, inventory policies, personnel and operating procedures. This involves a more detailed look at routing and transportation assumptions, inventory stocking policies, facility operating procedures, enabling technologies and changing roles for the workforce. Furthermore, regulatory, tax and other economics factors outside of the model's purview are often relevant. A complete evaluation must also incorporate the costs to transition from the current state to the new solution, such as closing or moving facilities, retraining the workforce and updating computer systems.

Phase 3: Operational Planning

Once a strategy has been selected, it is time to move into detailed planning. Because this stage is very time consuming, it is crucial that only the best strategy (or perhaps 1-2 alternatives that are seriously being considered) be evaluated during this time. Since the network models were solved at an aggregate level of planning, we now must determine how to run the solution on a day-to-day basis. This includes defining specific operating procedures, material flow policies, inventory stocking policies and load plans.

At this point it is important to perform a complete needs analysis covering all components of the supply chain: systems, staffing, facilities, transportation, communication, processes, etc. A fundamental question which must be addressed is the degree to which certain activities or operations will be outsourced to third parties versus being executed in-house. Also occurring at

this time is the development of a detailed implementation plan. This plan must define all tasks, dependencies and resources required to transition from the current state to the proposed solution.

SUPPLY CHAIN NETWORK DESIGN SOFTWARE AND TOOLS

The key methodology used to perform supply chain network design is quantitative modeling and optimization. The advantage of models is that they can evaluate the complex relationships and trade-offs of the overall system by tying together large numbers of variables in a conceptual framework that makes it much easier for the user to define relationships. Utilizing quantitative tools to perform analysis also makes the translation of an operational strategy to a financial business case a much more straightforward task. Some types of models used in network design include:

- Spreadsheets
- Regression and Statistical Analysis
- Simulation
- Linear Programming
- Mixed Integer Linear Programming
- Expert Programs / Heuristics

In general, the trade-offs between these different approaches involve speed versus complexity and the need to achieve "good" versus optimal solutions.

The typical methodology used by commercial network optimization solutions is to consider a long-term demand forecast, supply chain facilities and capacities, lead times and fixed and variable costs to identify the most cost effective supply chain network. These decisions typically involve where to locate facilities, what modes of transportation to use and long-term sourcing decisions.

As the name implies, network optimization tools seek to optimize performance across an entire supply chain network. Depending on an organization's needs, these tools can be used either as an integrated part of a suite of Advanced Planning and Scheduling (APS) tools or as a stand-alone application created solely to analyze supply chain design decisions. The advantage of an integrated approach is that the modeling constructs used in network design are often very similar to the modeling used for day-to-day supply chain planning activities. These integrated models also tend to be better maintained over time and in addition, they can be used to analyze each of the three types of network design questions discussed previously in this document. However, this approach also requires more durable integration models between the various systems and it may take longer to obtain results than would be achieved using models based on manually manipulated data loads.

NETWORK OPTIMIZATION MODELING AND DATA

Network optimization tools typically model the entire supply chain and include forecast information, product and facility information, manufacturing, storage & distribution rates, capacities and costs.

While other planning tools almost always model a supply chain at the SKU/location level, this is not always the case for network optimization models. While integrated network optimization tools used to evaluate detailed sourcing to customer locations and location-specific inventory builds sometimes model individual SKUs and customer locations, many models to evaluate strategic decisions use aggregated data. Aggregated data is used because it reduces the difficulty of adding new plants, distribution centers or demand for what-if scenarios; and because aggregating data reduces model size and solve times therefore allowing what-if scenarios to be easily solved and evaluated.

OTHER NETWORK OPTIMIZATION SOFTWARE CONSIDERATIONS: USER INTERFACE AND REPORTING

The user interface and reporting features of network design tools are an important consideration when selecting a network optimization tool. The interface must allow a user to set up what-if scenarios, solve the scenarios and then evaluate the results – ideally this should all be possible without IT support. Output reports should be user configurable to provide comparative data that can be used to develop business cases. In addition to numerical reports, network design tools also provide maps and graphical representations of the supply chain that illustrate different network configurations for presentation purposes.

CONCLUSION

The success of an organization is heavily dependent on its supply chain effectiveness and the most innovative business strategies can be derailed by poor alignment with supply chain design. Companies today face shortening product life cycles, lengthening global supply chains, increasing product complexity and rising logistics expenses. Modern supply chain network design methods enable organizations to quickly and efficiently evaluate alternative supply chain strategies and select the one that maximizes shareholder value.

Spinnaker leverages deep technical expertise and broad industry experience to help our clients align their supply chain strategy with their business goals in this challenging environment. Our practical approach blends sophisticated modeling and analysis with creative thinking and years of experience to deliver pragmatic, effective solutions to your supply chain challenges.

Working side-by-side with our clients we build a detailed road map for the future by aligning supply chain strategy, optimizing the global logistics network and integrating the supply chain organization, processes and technology. We take into account the operational and technological considerations to ensure that the strategy can be implemented successfully. Whether you are focused on expanding into new markets, reducing cycle time or increasing margins, Spinnaker

can help you develop a supply chain strategy and network design that enables you to compete effectively in your market. The result is an effective supply chain design that keeps your business strategy on track.

CASE STUDY SPOTLIGHT – SUPPLY CHAIN NETWORK OPTIMIZATION

The Challenge

Faced with a complex manufacturing network and large number of distribution centers across North America, a leading industrial manufacturer lacked an effective method to evaluate the options available and make sound business decisions with regard to the correct number and location of facilities. In a market driven by extreme competition between small numbers of known competitors, the client also sought to model competitors' supply chains and perform scenario analyses to evaluate how customers' sourcing and buying behavior might change in different industry-wide supply and demand situations.

The Approach

Spinnaker was engaged by the client to help design and implement a network design analysis tool that could be used to model and analyze different what-if scenarios using Oracle's Strategic Network Optimization (SNO) supply chain modeling software. This solution utilized data from the client's production systems as well as information for what-if scenarios that could be created and maintained outside of the production systems.

The network design model provided a tool that can be easily used to evaluate the follow changes in the client's supply chain and market environment:

- The addition or removal of warehouses / production facilities.
- Changes in manufacturing capacities at existing facilities.
- Increases/decreases in demand by product line and/or geography.
- Changes in cost.
- Change in total market demand.
- Changes in current and potential competition sites.
- Increases and decreases in competitors' capacity.

Additionally, the tool allows the client to optimize the what-if scenarios based on full-cost for manufacturing and distribution, variable-cost, or zero manufacturing cost.

The Results

Prior to this effort, supply chain scenario analysis took either weeks to complete manually or did not occur due to the effort required. In the six months following the project, the client evaluated over 50 what-if scenarios with the average scenario taking less than a day to model, solve and analyze.

Based on the analysis, significant supply chain design changes occurred including the opening and closing of facilities. The modeling effort has led to supply chain cost reductions generating more than 20x return on investment while providing an increase in customer service.

For more information on Spinnaker's Supply Chain network design services or other supply chain solutions, visit **www.spinnakermgmt.com**.

SPINNAKER

Spinnaker is a global leader in supply chain consulting, execution, and support. We deliver Supply Chain Excellence with world-class people, processes, technology and operational know-how.

Our staff possesses the highest levels of industry knowledge, service-offering expertise and technology capabilities to assist clients in identifying process improvements, new business & technology trends and develop solutions that deliver results for their organization, customers and shareholders.

Spinnaker has worked with entrepreneurial start-ups to Fortune 100 enterprises in industries such as High Tech/Semiconductor, Energy – Oil & Gas, Renewable Energy, Telecommunications, Consumer Products, Pharmaceuticals and Industrial Products. We combine our vast supply chain and business process knowledge with industry leading practices to deliver solutions that drive tangible results for our clients.

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Spinnaker's supply chain operations and strategy services include:

- Supply Chain Design
- Supply Chain Opportunity Assessments
- Supply Chain Capability Roadmaps
- Mergers and Acquisitions Integration
- Organizational Design and Change Management
- Metrics and Objectives Definition