White Paper



Network Optimization: Don’t Fall Into the “Single Best Answer” Trap

Custom modeling offers maximum flexibility to account for any scenario, rule or constraint in choosing the optimal distribution center network.

Introduction

Network optimization programs help management strategically decide the best configuration of their supply chain networks along with the optimal number, location, and size of distribution centers to effectively support their business models and growth projections. Ultimately, the optimized network model is the one that generates the maximum amount of flexibility and cost savings while at least meeting, if not exceeding, required service level expectations. Sophisticated software analysis cannot do this alone. Often there are several future-state scenarios that project significant savings on paper, but may not be realistically attainable. A creative quantitative analyst and an experienced supply chain management practitioner are critical to the process of systematically identifying and evaluating which proposed solutions are practical in terms of real-world logistics, i.e., the constraints a standard out-of-the-box software system cannot incorporate.

This paper will discuss the relative efficacy of standard network analytics software packages vis-à-vis the custom-configured optimization model with its inherent adaptability and flexibility.

Two Sides of the Network Optimization Coin

Off-the-Shelf Software

Off-the-shelf supply chain network optimization and design software is often equipped with a powerful optimization engine to solve linear, quadratic and discrete programming problems. This optimizer is accessible through an independent modeling system – an algebraic modeling language for describing and solving high-complexity problems for large-scale mathematical computation, such as DC optimization and scheduling-type problems. It is typically characterized by a user-friendly interface, an assortment of built-in databases, data analysis and preparation options, extensive reporting capabilities and solution generation scenarios. And it is conceived to address the classic network design questions, including the number, location, size, ports, etc.

> *"As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality."*
>
> – Albert Einstein

By their very nature, however, standard network analytics software packages have their limitations. These programs are built to address average or "typical" case DC optimization scenarios. Therefore, data input is restricted to standard constraints and categories. There is very little allowance for complexity or DC operator-specific business rules or operating constraints, i.e., customization, without "tricking" the system. Neither flexible nor adaptable,

these out-of-the-box packages will offer a single best network optimization solution for any given set of parameters. While this may be the ideal mathematically driven solution, it may or may not be the "optimal" solution for a DC operator's unique situation and his specific constraints. As Einstein pointed out, optimization algorithms may "not refer to reality" without the inclusion of nuanced constraints, or even rules of thumb, tempered by the expert judgment and insight of deeply experienced supply chain practitioners.

The "Single Best Answer" Trap

The off-the-shelf software approach to network optimization primarily focuses on generating one single best answer or solution for each set of defined inputs based purely on mathematical outcomes. It is reminiscent of Ford Motor Company's Whiz Kids and their management-by-numbers philosophy. They certainly brought analytical discipline to the company and restored its profitability, albeit at the expense of research and development, innovation and capital equipment investment. Ultimately, this led to the prolonged decline of the company, culminating in the Ford Edsel and the lesser known Mercury Turnpike Cruiser disasters.

They have universally been accused of three errors which analytically minded managers should heed:

1. When quantifying key drivers, we have to make sure we are selecting the ones which give us the most insight into the overall problem. The classic design network questions posed in standard optimization packages are common to all supply chain operations, but they are largely unable to effectively address the unique constraints of each operator's business model.
2. We should be aware of our limits to quantify certain key drivers, such as service quality, customer loyalty, competitive response, etc. Some factors, e.g., transition costs, can be estimated, but others like business upset and the ever-lurking "unintended consequences" costs are more difficult to discern.
3. When we can quantify the most meaningful key drivers, we have to include in our calculations forecasts of their effects well into the future. Network optimization is a dynamic rather than a static process. It is not a one-time event, but an ongoing process of planning for and adapting to change.

So the question persists: Is there a single best network optimization solution based upon the certainty of mathematical modeling? Is there a "canned" program which the DC operator can rely upon to relieve him of his managerial decision-making duty? The short answer is, "no." No off-the-shelf software optimization program can account for all the relevant data. To say it perhaps more clearly: You can't model everything, especially with a standard package. And here is the frightening reality: The "optimal" network solution may be selected over a second or third best "sub-optimal" solution literally on the basis of mere pennies in savings; the DC operator may never have visibility to these alternative solutions or the opportunity to evaluate them in terms of their operational advantages/disadvantages. And keep in mind that transition costs, shut-down and ramp-up costs, business interruption expenses and myriad unintended consequences (e.g., personnel relocation issues) are not accounted for in standard optimization models, at least not in a very accurate way. Perhaps an example will clarify the point.

A European-based consumer products company had a network of five DCs serving the U.K., Scandinavia and the continent. Company management hired FORTE to conduct a network optimization in order to determine how many DCs were needed and where they should be

located. The optimal mathematical model offered this solution: Five DCs was ideal, but four of the facilities needed to be relocated.

With FORTE's custom modeling approach, however, a family of proposed "best solutions" was concurrently generated to more comprehensively account for the company's specific business rules and constraints. The company's DC operator was able to compare and contrast the optimal mathematical solution with a family of better informed best alternative solutions, an option not available to him with standard off-the-shelf network optimization analytics software.

The alternative best solution determined that five DCs was indeed the correct number of facilities, but only one DC needed to be relocated. The difference between the optimal mathematical model and the alternative best solution was an annual operating cost differential of less than 1 percent with much lower transition costs and risk. With FORTE's assistance, this company avoided two potentially calamitous decisions: Staying with the status quo while customer service and profitability declined; or relocating four DCs while incurring significant and unnecessary relocation expenses as well as operational disruption.

To summarize: Standard network optimization analytics software packages address average DC system and design issues. They rely on standard categories of statistical data input and generate the single best answer based on absolute mathematical outcomes, which may prove to be ephemeral if not illusory. They are incapable of accounting for customer-specific constraints and may ignore or undervalue highly relevant decision criteria such as transition costs. They offer no second or third best options for consideration.

Custom Modeling

> *"Mathematics may be compared to a mill of exquisite workmanship, which grinds your stuff to any degree of fineness; but, nevertheless, what you get out depends on what you put in …"*
>
> – Thomas Henry Huxley

The alternative to standard network optimization programming packages is the highly flexible and adaptable custom model approach. Built to include the business objectives and constraints of an individual enterprise, its customer-configured algorithms applied to standard software engines produce tailored results with cost-effective, re-run capabilities for "continuous improvement" of the DC network. Like the canned packages, this approach also uses rigorous mathematical modeling to generate the best optimization solution. Unlike those packages, however, custom modeling is buttressed by the flexibility to include constraints outside the standard model which management may want to factor into the overall decision. The practical results are that management obtains richer, more salient data to make an informed decision, and he can generate families of solutions to select the "near optimal" solution that accounts for both the standard and the organization's specific constraints.

Custom modeling can reveal a more effective supply chain or logistics network that delivers an optimal balance of required service levels with the most affordable operational and logistics costs. Its powerful algorithmic software and expert modeling scenarios are enhanced with

extraordinary adaptability. In a brief amount of time, a programmer can write a custom model taking into consideration business rules specific to the DC operator, whereas a canned package will have inherent limitations because it is written for the "average" case. With an off-the-shelf package, attempting to force-feed non-standard constraints into the model is like trying to fit square pegs into round holes. On the other hand, customizing the models will yield more accurate and effective data, more and better informed scenarios, and a greater degree of decision-making agility by quickly and easily formulating families of solutions for consideration.

One further point regarding custom modeling: It requires expertise to generate meaningful data which, in turn, must be tempered with experience and intuition to interpret and select the best overall optimization solution. For many organizations, the most efficient and effective course of action is to hire consultants who can provide: program-writing support for model customization; expert statistical analysts to augment data analysis software programs; and supply chain management practitioners with the breadth of knowledge and depth of experience to guide an organization through the families of solutions to the one that best balances required service levels with ongoing network operating costs, transition costs and risk. The following network optimization project utilizing custom modeling will help illustrate these points.

A Midwestern retail corporation serving more than 4,000 independent retailers across the U.S. wanted to position itself for continued profitable growth while maintaining extremely high service levels, i.e., 100 percent delivery within two days. The company needed to identify the optimal U.S. distribution network, including port locations. With more than 100 different inbound source locations and 1.5 billion pounds per year shipped through 14 regional distribution centers and six freight consolidation centers, the company wanted to explore opportunities to improve efficiency, reduce costs, increase capacity and maintain service levels through network optimization.

The Science of Custom Modeling in Network Optimization

Applying computer programming languages to supply chain challenges

Custom modeling in network optimization is based on logistics network modeling and an iterative decision methodology. It progresses to the optimal network recommendation through multiple cycles of analysis, incorporating the outcome of previous scenario(s) in the design of each subsequent model. And it combines key ingredient standard optimization packages with custom modeling software.

- CPLEX – An optimization engine used to solve linear optimization problems. Can be used on anything from scheduling workloads on a space shuttle mission to routing trains in a subway station (application neutral)
- AMPL – Modeling language for mathematical programming. Feeds CPLEX and lets the practitioner describe the network algebraically
- CPLEX and AMPL – Together, comprise the engine used to create custom network models. Conditions can be wholly user-defined to generate mathematical representations (i.e., models) of various network scenarios.

Among the benefits of custom modeling are:

- Built to reflect the specific business objectives and constraints of an enterprise. No need to "trick" the software to try to emulate functionality that is not intrinsic within a standard network optimization package
- Flexibility to explore out-of-the-box solutions
- Complete control of software engine enables the generation of multiple "best case" possible solutions (best, second best, third best, etc.).
- Model can be modified for future network optimization audits (re-runs) and changes

Custom modeling deliverables include:

- Construction and use of a baseline model approximating current network and cost structure
- Optimized baseline scenario, enabling the low-cost implementation of short-term savings
- Creation of multiple network scenario models and families of solutions from which to choose
- Report of recommendation and conclusions on location for distribution operations, five-year scenario, prioritized action plans, summary of DC requirements and gap analysis with current systems

The company hired FORTE, who deployed custom modeling mathematical programming language to best-in-class optimization software. (See sidebar.) To meet the company's objectives, FORTE's custom model was specifically designed to:

- Identify optimal locations for regional distribution centers, import warehouses and freight consolidation centers, including multi-operational facilities
- Identify optimal locations to build new facilities and expand existing facilities
- Identify application and location for seasonal regional distribution centers
- Identify the cost of opening, operating and transitioning to the new network, taking into consideration automation levels, leases, capacity constraints and exit costs

After extensive modeling, FORTE determined the company could maintain its existing network of regional distribution centers and freight consolidation centers by establishing an East Coast port of entry in addition to its existing West Coast port. Strategic re-routing of a portion of the inbound flow to the East Coast port permitted a realignment of customers to the regional distribution centers for much greater transportation efficiency and cost effectiveness. Although travel through the Panama Canal to the East Coast port added time and ocean freight cost, the company was still able to affect net annual transportation cost savings of greater than 3 percent while maintaining their extremely high customer service level commitment. Importantly, the impact on inventory carrying costs was negligible.

Summary

Distribution network optimization is a complex business. Off-the-shelf packages built for the average case are often too imprecise and inflexible for either confident accuracy or specific enterprise applications. Moreover, they encourage management-by-numbers decision making with their reduction of a bewilderingly dynamic environment and process into a single mathematically driven "single best" answer.

"I have hardly ever known a mathematician who was capable of reasoning."

– Plato

In the hands of a skilled practitioner, custom modeling with its flexibility to include enterprise-specific business rules and constraints generates information and families of constraint-based solutions. As a result, management can weigh more informed options and decide which course of several "best case" scenarios is most appropriate or optimal for their businesses. A key ingredient to successful DC network optimization is the selection of a consultant with the technical expertise, business acumen, and the supply chain management experience to assist and guide the organization through the process.

Why FORTE

Single-Source Accountability

Whether we're helping you develop a strategic plan, design and build a distribution facility, or optimize a distribution operation through performance metrics and analytics, FORTE provides a true single point of contact responsible for the complete performance of your distribution network. No finger pointing. No fragmentation of responsibility. No multiple suppliers for technical support. You have performance goals, and it's our job to make sure they're met on an ongoing basis.

Total Objectivity

We don't manufacture equipment. We don't develop WMS software. We don't have commercial arrangements with any suppliers for expected volumes of business. We're simply interested in delivering the most efficient distribution solutions at the lowest total cost. Our client-side service approach means our only allegiance is to our customers. So with every engagement, you know we'll choose the most appropriate level and blend of technologies integrated into an effective operational system.

Expertise

Our team is deeply rooted in the hands-on implementation of distribution center design and warehouse automation. FORTE's engineers and technicians integrate today's best practices in supply chain management and distribution center operations while developing next-generation technologies. As a result, our solutions employ the best combination of practical advice, data-driven analysis and technology-enabled systems. With FORTE, you get:

- More accountability than a consultant
- More experience than a systems integrator
- More objectivity than a manufacturer

That's why the world's fastest-growing companies are making distribution their FORTE.

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