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WHITE PAPER

Designing A Superior Distribution Network

A Roadmap to Success

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Finding solutions to distribution network issues can be elusive and costly if the proper approach is not taken towards accurately evaluating and analyzing the impact of any potential changes to a firm's distribution network. Recommendations for change made without understanding their impact on cost and service could result in unnecessary operating and capital investment costs throughout a supply chain, as well as a potential decrease in service to key customer accounts. Following a proven roadmap for distribution network design and strategy will enable a company minimize operating costs and tax burden, maximize customer service, and improve flexibility to adjust to changes in business strategy and growth.

Determine the Scope and Constraints of the Distribution Network Design Strategy

Determining the scope of design in a distribution network strategy is crucial. One reason is that the distribution network needs to realign with shifts in business. The following illustrates some of the shifts against which a distribution network might need to realign itself:

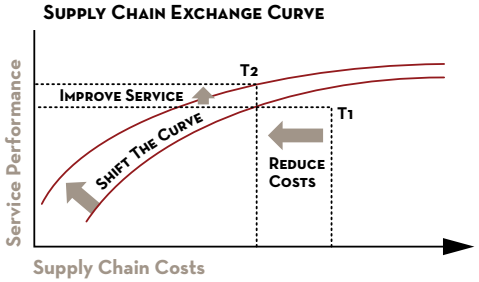
Also, a company may be trying to shift their cost versus service curve if they are experiencing customer service problems, or if they are trying to reduce costs. Some of the areas where a distribution network strategy may be concentrated in order to shift the cost versus service curve include:

Likewise, outlining the constraints under which the network currently operates has significance so that the design provides implementable results. Constraints that need to be understood can include:

- Distribution throughput and storage capacity
- Expansion potential at existing sites
- Material handling requirements for products being manufactured and distributed
- Budgetary constraints on capital investment
- Production line capacities
- Remaining lease timeline and remaining life on facilities and equipment
- WMS and WCS constraints for distributing a SKU out of multiple facilities versus a single facility
- Customer service requirements (next-day, two-day, standard, etc.)
- Order characteristics
- Limitations on transportation carrier availability
- Private fleet capacity
- Limitations on labor availability in current locations (to potentially expand operating shifts)

Determine the Benefits to be Achieved

In order to align a distribution network with recent business shifts or long term growth plans, real, quantifiable benefits must be shown in order to justify capital to make the distribution alignment a reality. While the level of importance of these potential benefits will vary depending upon the situation, the fundamental goal of all distribution network strategies is to find methods that will shift the cost versus service curve shown in the following diagram (B) in a beneficial manner:
Some of these benefits may work against each other; for example, improving customer service levels could result in expanding the number of facilities in a distribution network. While operating costs may increase as result of this initiative, improved customer service resulting in increased revenues may offset any increased distribution costs.



Gather Data Outlining the Current Network Situation

Understanding the current network is the most difficult and time-consuming step associated with any distribution network strategy. Volumes of data must be collected, analyzed, and verified for accuracy. The resources that maintain this data may be spread throughout an organization. When this step is done properly, it allows informed decision-making and confidence that all modeling tools have accurate information driving them. The types of data that need to be collected and verified for distribution network design can include:

- Description of all items distributed or manufactured – dimensions, weight, classifications, units/carton, units/pallet, unit of measure, unit cost, etc.
- Physical addresses of suppliers, customers, and facilities being studied
- Historical line-item demand by SKU by customer for a 12-month period
- Historical line-item supply by SKU by vendor for a 12-month period
- Historical line-item production and/or throughput by SKU by facility for a 12 month period
- Historical transportation costs and modes (LTL, parcel, truckload, rail, etc.) for all shipments being analyzed
- Historical facility labor and operating costs for each facility in the network being analyzed
- Historical inventory level snapshots by SKU or product category
- Historical storage and production utilization rates
- Current productivity measures for each facility or process being studied
- Current throughput and storage capacities for each facility being studied
- Transportation rate tables for any mode of transportation being used in the network
- Service level requirements by customer and product category
- Growth forecast information for a planning horizon, including:
  a. SKU growth
  b. Sales demand growth
  c. Unit demand growth
  d. Customer growth
  e. Regional/local growth trends differing from overall growth
  f. Inventory growth and goals

Depending upon the type of network design being conducted, other data may be required, such as production line rates and capacities, retail store locations, private fleet information, etc.

If some of this data is not available, a couple of approaches can be taken to bridge these gaps. The first is to make assumptions about the required information. For example, vendor ship-from addresses might be unavailable. However, a state or region where the product comes from might be known. A centrally located point in each state where product is supplied can provide an approximation so that an understanding of inbound costs and volumes can be established.

Another approach is to conduct field tests or measurements. For example, product weight and dimension information is unavailable for the analysis. Products can be split into categories, and a couple of representative SKUs within each category can be measured and weighed to provide a basis for all of the products in a particular category. Whenever assumptions are made about data, it is always a good idea to conduct sensitivity analyses around that information to determine the impact on a network if the assumptions were not accurate.

Cleanse and Verify the Data

Once the data has been collected, it must be cleansed, verified for accuracy, and formatted to work with the tools that are going to be used to model the network. While it will be virtually impossible to ensure that every piece of data gathered for this design is 100% correct, there are some quick and easy steps to determine if there are glaring errors that might change the design recommendations if they are not corrected:

- Cleanse the data — look for text entries in numerical fields and vice versa, make sure zip codes have leading zeros, determine cause of blank fields or line items in data, and make sure line item information is properly aligned with the correct field designator. Do this for every data file required by the design.

- Look for anomalies in historical databases: Examine shipments to the top 10-20% of customers and verify that the data totals match historical totals. Do the same for inbound shipments from top vendors.
  - Determine the timing of the peak demand and supply periods for these top customers and vendors and make sure that these are correct
  - Make sure that units supplied and distributed plus the unit delta in inventory levels equals units demanded for the time period
  - Examine production and distribution by SKU or product category at each facility being studied
  - Examine quantities of units shipped by transportation lane and mode between facilities, to customers, and from suppliers. Check top product categories and SKUs as well.
  - Examine historical inventory information by product category and by location for accuracy.
- Make sure location addresses are correct for vendors and customers. If billing addresses are inadvertently used instead of shipping addresses, a completely different set of incorrect recommendations could result.
- Examine transportation and operating cost tables for accuracy. A slight error in cost per unit or pound calculations can change a location recommendation and result in misstated savings due to that recommendation.

All inconsistencies in the data need to be rectified with the assistance of the source closest to the data. After the data has been verified for accuracy, it needs to be formatted to the specifications required by the design tool(s) being used. Each tool has different specifications that may require between no formatting and several days of formatting depending upon the design requirements.

Select Design Tools

There are several tools that can be used that will shorten the time required to conduct the network design, provide greater insight into the current network situation and how changes will impact the network, and allow a company to be better informed before investment decisions need to be made. Tools that can be used in network design include:

- Database analysis software and spreadsheet software – These tools can be used to cleanse and verify data and to analyze alternatives for simple networks or small segments of large networks.
- Mapping software — This tool provides a great way to illustrate changes in network structure without relying solely upon tables and graphs. Software that can illustrate product flow and costs from location to location within a network provides valuable insight into the impact of changes within the network.
- Transportation rating packages — There are tools available that rate thousands of shipments at once for different transportation modes. Parcel and LTL rating packages are particularly useful as different weights impact the cost of a shipment, unlike truckload, rail, or container shipments that operate primarily on a cost per mile or a cost per shipment basis.
- Mileage calculation software — There are many tools available that provide distance calculations between addresses, zip codes, or cities. These are extremely helpful in determining the impact on overall transit time with a network realignment and transportation cost if lane costs are provided on a cost per mile basis.
- Supply Chain Optimization software — There are a wide variety of optimization tools at varying price and complexity levels available for studies such as this. Optimization tools are strategic in nature and do an excellent job of providing an optimal answer at different time snapshots for a network depending upon the criteria being analyzed under the constraints outlined for the network study (minimize cost, maximize revenue, improved customer service, etc.)
- Dynamic Supply Chain Simulation software – The purpose of this software is to simulate the day-to-day operation of a distribution or manufacturing network. Simulation software goes a step beyond optimization software by using randomized order profiles that are dependent upon network constraints. Network costs, volumes, inventories, production capacity, distribution capability, and customer service can be evaluated at a tactical level with this type of software.

Build Baseline Model and Compare to Historical Results

The most time-consuming task during the distribution network design process is to build a baseline model that accurately reflects the current operation and capabilities of the distribution network. A baseline model is typically constructed using data from the previous 12 months of operations, and when it is complete, should provide results that match historical results within a pre-determined confidence level. This step is actually a continuation of data verification, as any significant errors in the data that were missed during previous activities will show up during this process.

Once the baseline model for the previous 12 months has been completed, it needs to be run for at least the last year of the forecast planning horizon being studied, if not for several intermediate years as well. This will show the impact of growth upon existing operations and capabilities. This is typically the first alternative network scenario, also known as the "do nothing" scenario.

The next scenario that has to be developed is the "Optimized Baseline" scenario. This is created so an understanding can be gained of how a distribution network would operate under perfect conditions with current capacity constraints – inventory is always in the right place at the right time, cheapest transportation carrier is always available, no unscheduled downtime in production lines or distribution centers, labor pool is optimized for the daily workload, etc. There will be operating cost savings in this scenario; however, all of the savings cannot be attained due to real world conditions. It will provide indicators on how the current network's service and operating cost might be improved. The results generated from this set of model runs serve as the basis for comparing potential cost reductions found in other network scenarios.

Develop and Model Potential Strategic Network Scenarios

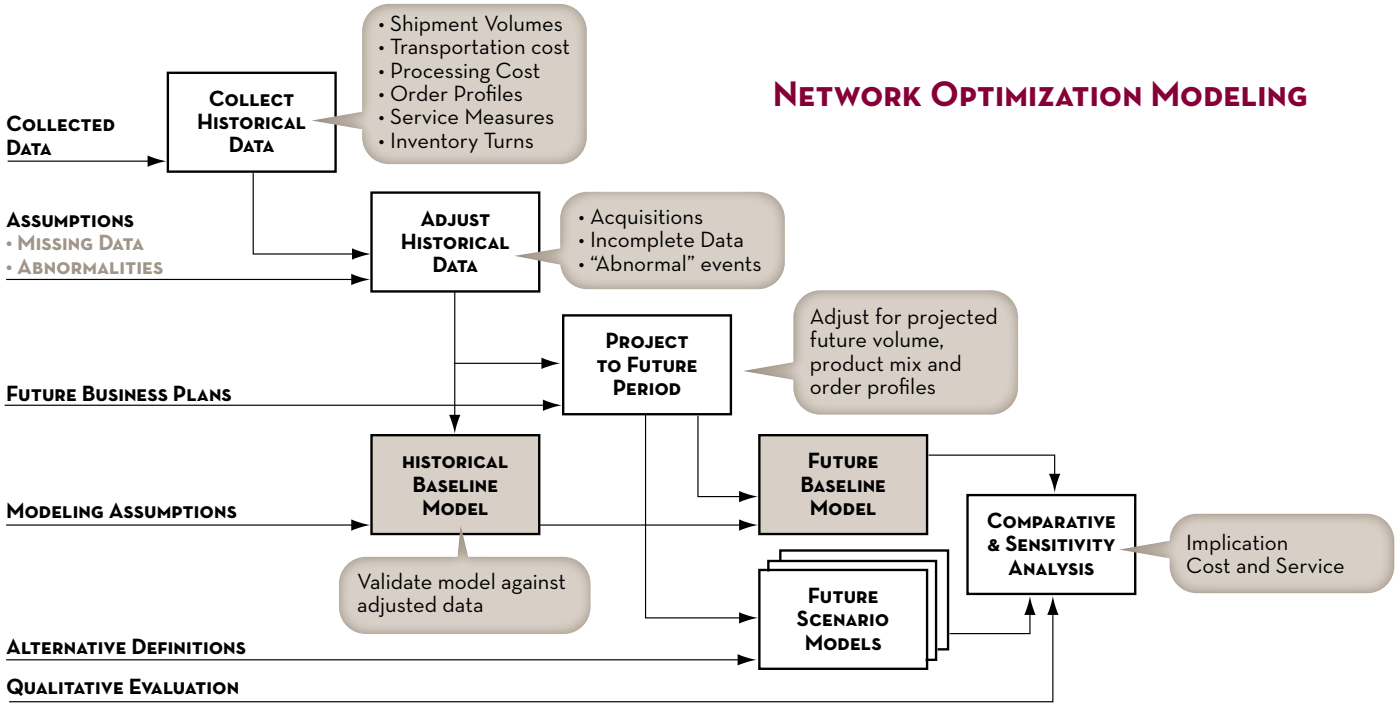
Once the baseline model has been constructed and verified, modeling alternative network scenarios is the next step to understand the impact of network change on operating costs, service levels, and transit times. While the scenarios required to properly evaluate a network will be different for every situation, the following option sets will provide guidance as to the types of scenarios that should be examined:

- Varying the number and location of distribution points
- Varying the location and capacity of production lines
- Altering the sourcing for product families, service markets, or specific customers
- Varying the strategic use of distribution locations
- Changing inventory deployment practices
- Varying transportation modes
- Altering growth and acquisition strategies
- Changing customer service level requirements – number of weekly or monthly deliveries, order size, etc.
- Impact of tax burden upon a distribution network configuration – theoretically, tax could be minimized by shipping all products from states without corporate income taxes. However, this runs counter to basic logistics principles – serving customers within their desired timeframe at lowest logistics costs...a balance is required
- Impact of eliminating certain constraints on the network

Once the set of scenarios has been developed and evaluated, the top 2-5 scenarios should be selected for further analysis. This further analysis consists of determining capital investment and transition cost requirements for alternative networks, financial and qualitative justification of recommended networks, and design recommendations for future supply chain processes.

Sensitivity analysis should be conducted on critical variables to understand their impact on the costs and service levels of the network. Also, sensitivities should be conducted on assumptions made where data was unavailable. Typical variables studied during a sensitivity analysis can include growth, seasonality of demand, freight cost, freight mode profile, wages, inventory levels, tax burden, and facility operating costs. Diagram C illustrates the overall modeling process:

Diagram C



The "Art" to this science is making the correct assumptions and verifying the data within the model on the front end of the process then correctly applying the results of the model on the back end of the process.

Determine Capital Investment Requirements for Potential Networks

Everything that has been done to this step involves understanding how network changes impact operating costs, service levels, and inventory requirements. In most circumstances, capital investment will be required to realize any reduction in operating costs. The following information must be developed and analyzed in order to provide a budgetary capital estimate for financial justification:

- Throughput and storage capacity requirements of each facility in the network based upon modeling tool outputs.
- Facility size and equipment requirements based upon those capacities.
- Inventory requirements for a new network alignment compared against existing inventory levels. This step can be done at a high level during the network design, or a separate initiative can be undertaken to optimize inventory levels by SKU at each facility.
- Costs associated with facility acquisition or expansion and material handling equipment procurement to feed into a financial model. Systems costs associated with network changes — this can be order management, warehouse management, warehouse control, demand planning, labor management, and transportation management, among others.

Another set of costs that has to be taken into account is transition costs that are incurred during implementation of the recommendations. Some of these costs are:

- Site acquisition costs — commercial real estate provider, site selection services, site engineering, etc.
- Facility construction costs
- Facility modification or up-fit costs for existing facilities
- Relocation packages
- Severance packages
- Recruitment and training cost
- Inventory relocation expense
- Lease break costs for existing facilities
- Sale of existing facility and equipment
- Revenues generated from a facility sale should also be incorporated into financial justification of the implementation of a distribution network strategy.

Prepare Justification of Recommended Network Structure

Every company has a methodology that is followed in order to allocate funds for capital projects. By this point in the distribution network design, all financial inputs should be ready for a financial model to evaluate the top network strategies developed during this process. This step can be an iterative one, as changes to the network structure may have to be evaluated if financial results do not meet minimum acceptable levels.

Financial justification may not be the only requirement to move forward on any proposed network changes. There may be political implications within the firm if a facility function is changed or if a facility is shut down altogether. Cultural impact of network changes may have to be evaluated. The ability to consolidate operations with another division might need to be evaluated. During the scenario development phase, these issues should be listed, and the quantitative results of the network design should be paired with the list of issues to make sure that an insurmountable conflict between the new network structure and these issues does not arise.

Finalize Network Recommendation and Implementation Plan and Timeline

Once justification of the scenarios is complete, a single scenario or a couple of scenarios may rise to the top. If two scenarios are close, or if one scenario is best under certain constraints and another is best under a different set of constraints, it may be prudent to move forward into design and implementation with a dual recommendation, and eliminate one during a future phase of the implementation.

As part of a recommendation, an implementation plan and timeline must be developed in order to provide structure to the implementation process and start getting company resources involved who weren't involved during the network design process. Several questions need to be answered while developing the implementation timeline:

- Does a building have to be constructed, or can an existing building be used? This can alter the timeline by 6-12 months, if a building has to be constructed.
- What systems upgrades and implementations are required?
- Are radical changes required in operations? This can affect the length of time required for facility material handling equipment design v and equipment installation.

During implementation plan development, time must be set aside for site selection, facility construction or up-fit, facility equipment design, material handling equipment installation, systems development and installation, organizational development, hiring and training of personnel, and inventory strategy and relocation. If a facility has to be constructed, it typically can take 12-18 months from the conclusion of a network design until a facility is operational. If an existing facility can be used, the timeline typically ranges from 9-15 months from the conclusion of a network design until a facility is operational.

Conclusion

While this paper outlines the general roadmap of a distribution network design, it does not cover every example of how a network design evolves depending upon certain constraints or situations. Assumptions surrounding missing data can radically change how a design is approached or the toolset that might be used to complete the design. Certain types of scenarios may not be relevant in a particular network strategy. There are many pitfalls and delays that can occur if one does not completely understand the process or how the data is used within the process. This roadmap should be accompanied by professional advice and direction as a firm's experience dictates. These professionals will follow this roadmap and be able to work with a team to complete a network study that will achieve or exceed the goals established at the start of the design. There are few shortcuts available, so beware of assistance that does not incorporate all of these steps, as it will enhance the chance of failure and incomplete or incorrect recommendations.

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