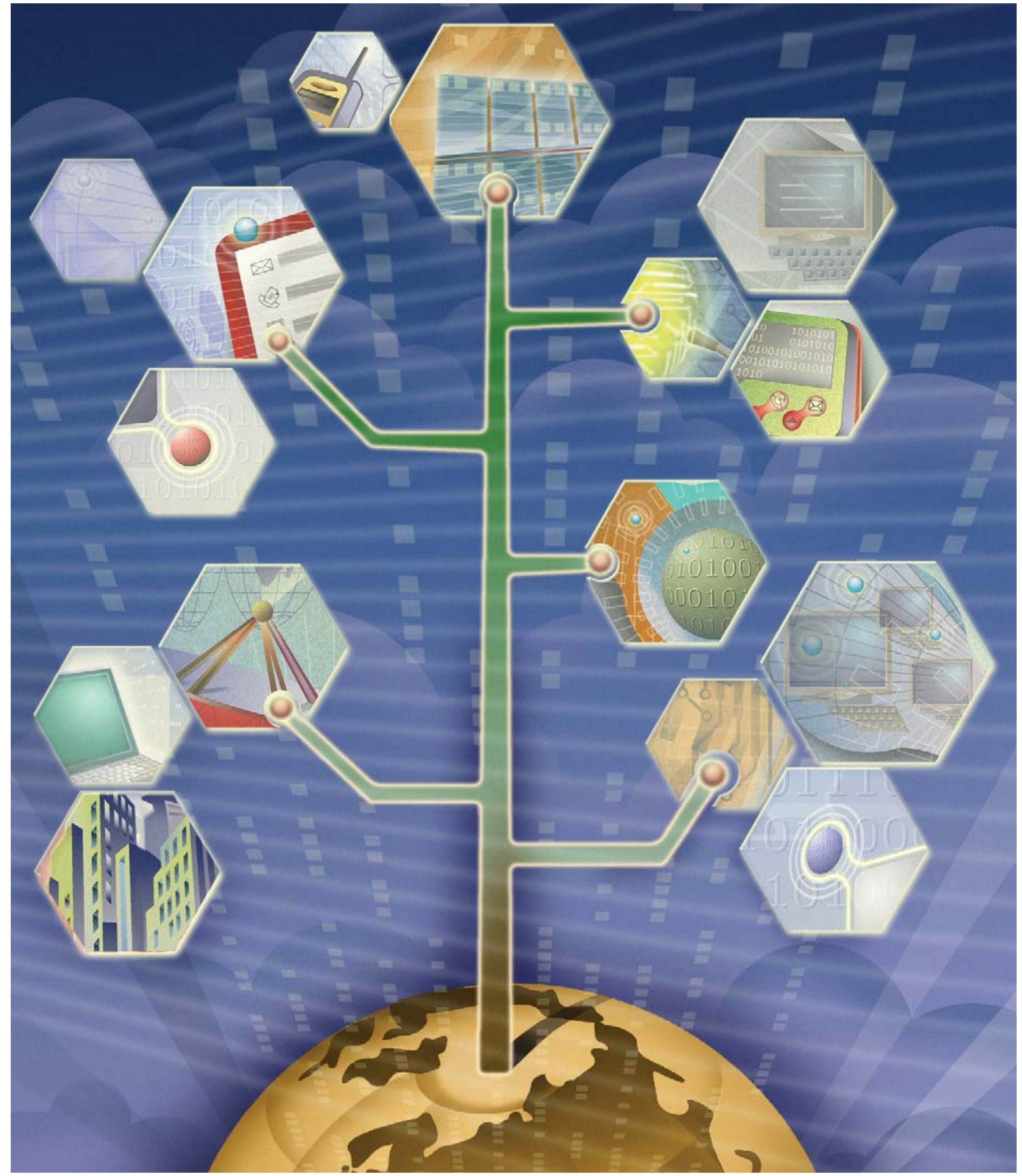
6 steps to effective network planning

For the best results, planners should follow a standardized approach. Systematic Network Planning provides a step-by-step guide.



GENNADY KURBAT/IMAGEZOO/AGE FOTOSTOCK

SUPPLY CHAIN NETWORK PLANNERS DON'T HAVE IT EASY. Their job is to evaluate complex tradeoffs among supply chain components, maximizing profits and minimizing costs within the limits of relevant constraints and intangible considerations.

Because that is such a complex task, many planners use network-modeling software. But having good software is just a first step, not a complete solution. For one thing, modeling results and recommendations are only as good as the user's problem formulation, assumptions, and data. Furthermore, if key decision makers cannot see or understand what was done during the modeling process (a distinct possibility when planners rely heavily on software) they may not accept the results and recommendations.

Network planners can avoid such problems by following a standardized, step-by-step planning process that is explicit, well documented, and visual. One approach we strongly recommend is Systematic Network Planning (SNP), a standardized methodology for conducting network-planning projects. SNP uses the High Performance Planning model developed by consultant Richard Muther. This model has been used in Muther's well-known methods for systematic planning of supply chain facilities and material handling systems since the 1960s.

[BY CHANDRASHEKAR NATARAJAN AND LEE HALES]

SNP rests on the three fundamental components of every network plan:

1 *Variables*—aspects of the network plan that can be changed in a model (for example, facility location, product type, and demand);

2 *Sensitivities*—the degrees to which modeled costs and performance vary in response to changes in variables; and

3 *Scenarios*—sets of possible changes to the network that is being planned.

The simplified, or short form, of SNP is presented in this article. The simplified procedure improves planners' effectiveness on projects that use an existing model to address problems of modest scope, such as:

- the best existing location at which to add capacity
- the impact of a change in inventory policy
- the effect of adding or closing a warehouse
- inventory and resource planning for seasonal or peak periods
- contingency planning for supply interruptions or loss of capacity.

For larger-scale network-planning projects, a fuller version of SNP adds phases and additional steps but still rests on the same fundamentals of variables, sensitivities, and scenarios.

For those who already have modeling software and know how to use it, the six steps of Simplified SNP can be mastered in less than a day; the steps simply standardize sound modeling and project-management practices. (It is important to note here that while appropriate optimization software must be used, Simplified SNP is not dependent on any specific algorithm or software product.)

For companies that are just developing modeling capabilities, SNP's standardization assures consistent service and results. Moreover, because SNP makes the modeling process more visible and its steps more explicit, even experienced modelers can benefit from the improved communication and explanation of results that it offers. For users at all levels of expertise, SNP can help avoid the pitfalls, oversights, and rework that are all too common in the day-to-day use of network modeling tools.

The six steps

The article presents and explains a key document for each of the six steps of Simplified SNP.[1] These steps include:

1. *Orient the project*. The objective of this step is to understand the scope of the project and schedule important deadlines and milestones. The related document is the Orientation & Issues Worksheet.

2. *Define the variables*. The purpose of this step is to create a modeling framework for the variables and tradeoffs. These are recorded on the Variables Summary Sheet.

3. *Analyze the sensitivities*. The output of this step is a validated baseline model that replicates the compa-

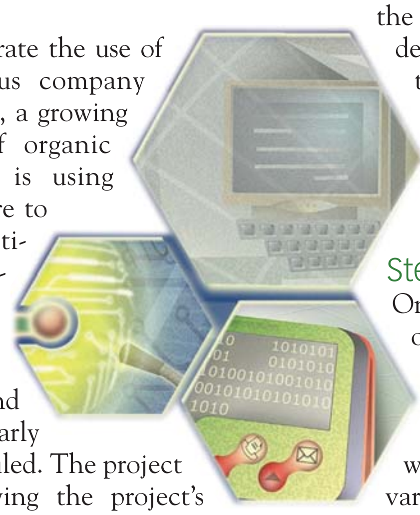
ny's current performance. This is recorded on the Baseline Validation Worksheet.

4. *Create scenarios*. In this step, the company models the results for alternative network plans relative to the baseline. These results are summarized on the Scenario Summary Worksheet.

5. *Evaluate the alternatives*. During this phase, the project team will select a network plan from among the alternatives. All of the analysis for this step is summarized on the Alternate Analysis Worksheet.

6. *Detail and do*. In this last step, the team creates a detailed protocol for implementing the selected network plan, which is represented on the Detail and Do Worksheet.

In the following pages, we illustrate the use of Simplified SNP by the fictitious company Mountain Trail Tonic Inc. (MTT), a growing manufacturer and distributor of organic juices. In our example, MTT is using Simplified SNP to determine where to add manufacturing capacity and justify the cost of the additional manufacturing line.



Step 1: Orient the project

Step 1 organizes the project and ensures that it is well defined, clearly understood, and realistically scheduled. The project team members begin by identifying the project's objectives and scope. They then try to understand all of the issues connected with the problem to be solved and identify the elements to be modeled. Finally, they document and rate the significance of the planning issues, and then create a schedule for the network analysis, complete with deadlines.

SNP uses a standard, one-page form called the Orientation & Issues Worksheet to capture all of this information. This form typically is completed during a meeting with the sponsoring executive, appropriate subject-matter experts, and representatives from finance and from each of the operating units that may be affected by the project. To help planners remain focused on the critical network-planning issues and assure that the project resolves the most important ones, the worksheet also lists and rates the issues' significance or importance as follows:

- A – Abnormally high
- E – Especially high
- I – Important
- O – Ordinary
- U – Unimportant

Issues or factors that are beyond the planners' control or are outside the project's scope are flagged with an "X."}

Figure 1 shows this worksheet for MTT. The worksheet includes a sample of the company's key planning issues, actions required for addressing those issues, and a project schedule.

In our MTT example, only one facility produces 32-ounce plastic bottles. Because of increasing sales volumes and product proliferation, this facility will not be able to meet expected demand. MTT's network planners have therefore been asked to cost-justify upgrading an existing line to add a second "big bottle" manufacturing line. The planners must also determine which of six existing plants will be the best location for the upgrade. The planners will use an existing sourcing model and software to find the location with the lowest total cost. In addition, the decision must also consider other, less tangible factors such as capacity relief, ease of implementation, and risk of line shutdown. For MTT, these factors are as important as cost, and they vary by plant location.

Step 2: Define the variables

Once the project has been defined and outlined, the planners diagram the network to be modeled and gather the information required for constructing the model, which will weigh different tradeoffs among the variables. In applications of Simplified SNP, the planners typically adapt an existing model rather than developing an entirely new one. In our MTT example, the company has already developed a sourcing model using a popular demand-planning software package and will adapt it for the "big bottle" analysis by substituting relevant data.

Step 2 also involves defining relevant constraints, documenting assumptions, and writing any formulas or algebraic expressions that will be used to model the network. Constraints are physical limitations or policies that restrict the capacities and capabilities of locations and lanes and their resources. Assumptions are descriptions of typical or anticipated conditions that are used to clarify the model's scope, simplify the model, and/or describe the manner in which some variables will be treated. For example, MTT's model is simplified by assuming that transportation and raw materials are always available. Formulas used to express costs or resource performance also are listed.

All of this work is summarized on the Variables Summary Sheet, as seen in Figure 2. This summary assures that planners and the ultimate decision makers agree on all aspects of the modeling exercise *before* it begins.

The upper left corner of the Variables Summary Sheet defines the scope of the network model in

[FIGURE 1]

An Orientation & Issues Worksheet is completed at the outset of each planning project to capture the project's objectives, scope, issues, and schedule in a single document.

ORIENTATION & ISSUES WORKSHEET

Company *MTT* Project Name *Big Bottle Analysis*
By *CSN* With *LH*
Date *9/23* Sheet *1* of *1*

Objective(s): *To cost-justify a second, up-graded production line for 32-oz. (big) bottles. To identify the best location for the second line among six existing plants.*

Implication: *Existing big bottle line at Sommersville is at capacity. Sales will be lost without additional capacity.*

Situation & Motivation: *Sommersville is the only source of 32 oz. production. Another line is needed but could be added at a different plant location, depending upon costs and other factors. A second location will lower transportation costs.*

Scope and Form of Output: *Use the current sourcing model built in M2's Strategy software to find the best location. Evaluate intangible considerations as risk and ease of implementation, in addition to optimization of network costs.*

	PLANNING ISSUES			Action to Resolve	Resp	Proposed Resolution	√ ok
1.	*Understanding the new transportation lane costs.*	*E*		*Decide how to evaluate costs.*	*CSN/BF*	*Meet with Peter*	√
2.	*Impact of raw material supplies?*	*I*		*Determine if costs change.*	*CSN/LH*	*Meet with Debra*	√
3.	*What is the cost of conversion at Jonesville?*	*I*		*Develop cost per case.*	*CSN/LH*	*Meet with Cathy*	√
4.	*Are there any backhaul opportunities?*	*O*		*Determine potential and impact.*	*LH*	*Meet with Peter*	√
5.	*Are there any new products to be launched?*	*O*	*X*	*Obtain forecast and mktg. plans.*	*LH*	*Meet with Michael*	√
6.	*How to split the customer demand since 32 oz. only appears on Sommersville PO's?*	*A*		*Decide how to allocate demand to plants.*	*CSN*	*Meet with Henry*	√
7.	*Which bottle lines can be upgraded to 32 oz.?*	*E*		*Assess line flexibilities.*	*CSN*	*Meet with Don*	√
8.	*Bessemer line cannot be upgraded.*	A	X	*Keep it in the model but exclude from alternatives.*			
9.							

Dominance / Importance Rating Mark "X" if beyond control or scope of project

Notes: *1. - Additional volume available to consume excess big bottle capacity will be analyzed later, after selecting the line location.*

Distribution *CSN* By *CN* With *DH* Status of *10/01 Active*

PROJECT SCHEDULE

No.	Action Required	Who	*9/23-9/28*	*10/01-10/05*	*10/08-10/12*	*10/15-10/19*	*10/2210/26*	Notes & Further Schedule
1.	*Project plan and Schedule*	*CN/DH*						
2.	*Problem statement and clarification*	*DH/DS*						
3.	*Formulate Variables*	*CN/KW*						
4.	*Sensitivity Analysis*	*KW/BF*						
5.	*Baseline validation*	*CN/BF*						
6.	*Create Scenarios*	*CN/DS*						
7.	*Run and compile scenario results*	*DS*						
8.	*Evaluate alternatives*	*KW/BF*						
9.	*Present recommendation*	*CN*						
10.	*Implementation plan*	*CN*						

Notes: *2. - Meeting of subject matter experts to validate the model results against current network performance indicators.*

terms of the following design characteristics:

- Locations and lanes included
- Products included and product hierarchy
- Resources included
- Demand data type and duration
- Time buckets
- Unit of measure

For MTT, the locations include all of its manufacturing plants, outside bottlers, and distribution centers (DCs). These consist of one raw material supplier, six other (contract) bottlers, six MTT manufacturing plants, and 42 branch distribution centers. These are represented in the diagram that appears under the heading "Visualization." This diagram uses an adaptation of industry-standard, operation-process charting symbols. (Note that in our example, the manufacturing plants are located in fictitious towns in a six-state area of the Eastern United States, and DCs are identified by number rather than by location name.) Lanes include all transportation routes between those locations. All of them are potentially active. Products are manufactured in certain plants and are cross-docked through other plants. In this way, a branch DC can receive product from any of the plants.

The resources to be modeled are manufacturing lines, transportation, and storage for all juice products, whether purchased or manufactured. The model's results will be based on 12 months of historical demand data in weekly time buckets, measured in cases. The 12-month historical horizon makes sense, as management wants to know what MTT's reported financial results would have been with an additional

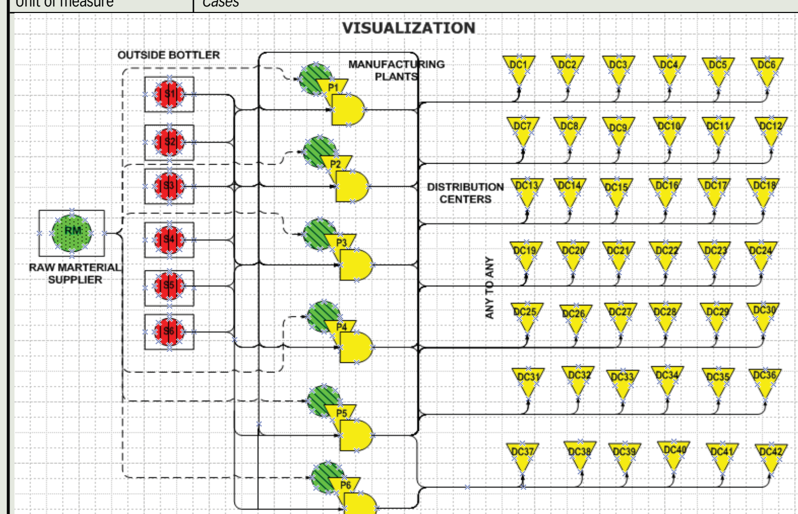
[FIGURE 2]

The Variables Summary Sheet defines the scope of the network model and summarizes the constraints or limitations on the resources being modeled.

VARIABLES SUMMARY SHEET

Company: *MTT* Sheet *1* of *1* By *CSN* With *KW, BF*
Project Name: *Big Bottle Analysis* Date *9/23* Project Description: *32 Oz Bottle line upgrade analysis*

MODEL DESIGN CHARACTERISTICS	
Locations included	*All manufacturing plants, outside bottlers and all distribution centers*
Lanes included	*All currently active transportation routes between included locations*
Products included	*All juices sold by MTT*
Product hierarchy	*Stock Keeping Unit*
Resources included	*Manufacturing lines, transport trucks, labor, storage equipment at the plants*
Demand data type	*Historical*
Demand data duration	*12 Months*
Time buckets	*Weekly*
Unit of measure	*Cases*



SYMBOLOGY

- MANUFACTURING WITH CROSSDOCK
- OUTSIDE SUPPLIER
- DISTRIBUTION CENTER
- RAW MATERIAL SUPPLIER
- FINISHED GOODS
- RAW MATERIAL

PARAMETERS

	P1	P2	P3	P4	P5	P6
Parameters/ Location	Jones ville	Sommers ville	Brians ville	Vicks burg	Madison	Bessemer
Lines (count)	6	10	1	1	1	1
Line speeds (cases / hr)	Demonstrated speeds					
Max capacity (hrs per week)	120	140	120	120	100	100
Min capacity (hrs per week)	100	120	100	100	100	80
Storage capacity (pallets)	5000	8000	4000	4800	4000	2500

FORMULAS

1. *Transportation cost = X_1*(2-way private fleet cost)+X_2*(One way incentive for common carrier use) +X_3*(Backhaul factor)+X_4*(Reverse Logistics factor)*
   X_1, X_2, X_3, X_4 are trip frequencies
2. *Throughput = 1/cases per hour*
3. *Min Runtimes = Batch size/throughput*
4. *Peak Capacity = 20*7 = 140 hours*
5. *Min Capacity = Budgeted capacity/52*

DATA SOURCE SUMMARY		
	DATA ELEMENTS	DATA SOURCES
DEMAND & RESOURCE RELATED		
1.	*Item data*	*ERP Demand Planning*
2.	*Location data*	*ERP Demand Planning*
3.	*SKU data*	*ERP Demand Planning*
4.	*Demand data*	*CIMMS Demand Planning*
5.	*Sourcing data*	*CIMMS Demand Planning*
6.	*Manufacturing lines*	*Manual*
7.	*Transportation*	*Manual*
8.	*Storage*	*Manual*
9.	*Cross handling*	*Manual*
10.		
COST RELATED		
1.	*Manufacturing costs*	*SAP*
	Variable overhead costs	*8111111*
	Direct labor costs	*8111112*
	Changeover costs	*8111113*
2.	*Transportation costs*	*Steve Hayes (SME)*
3.	*Cross Handling costs*	*Logistics P & L*
4.	*Storage costs*	*$1.00*
5.	*Overtime costs*	*1.5*Direct labor*
6.		
7.		

MODEL CONSTRAINTS

1. *Fixed capability of manufacturing. (line number 1 can only produce cans).*
2. *Minimum lots when producing a product.*
3. *Product costs and throughputs based on demonstrated capability.*
4. *Minimum weekly run times (80 hours per week at Bessemer) .*
5. *Maximum available weekly run times (140 hours per week).*
6. *Violation of Min capacity can happen but with a penalty of 1.5*labor costs.*
7. *Products are produced to cover for a certain duration of time.*
8. *Use existing lanes to source the products.*
9. *Infinite transport capacity; which means trucks are available when needed.*
10. *Storage constraints at the manufacturing plant.*

MODEL ASSUMPTIONS

1. *Inbound logistics will not be considered.*
2. *Raw materials available in infinite capacity.*
3. *Fixed cost of manufacturing will be included in the model.*
4. *Lot sizing increments will not be considered.*
5. *A flow through environment for branch, thus storage costs & constraints and will be excluded from the model.*
6. *Cross docking is doubling handling of products without storage.*
7. *Transport fleet is homogenous and of infinite capacity.*
8. *Available capacity of other bottlers will not be included.*
9. *All rules of contract will be valued and not be violated.*

[FIGURE 3]

The Baseline Validation Worksheet confirms that the network model gives results that are acceptably close to reality.

BASELINE VALIDATION WORKSHEET

Company *MTT* Project Name *Big Bottle Analysis*
By *CSN* With *KW, BF*
Date *9/23* Sheet *1* of *1*

	VARIABLES	UOM	MODEL RESULTS	ACTUALS	VARIANCE	OK	NOTES
DEMAND							
1.	*Outflow at Sommersville production center*	*Cases*	*10,985,632*	*10,916,130*	*69,502*	✓	*1*
2.	*Outflow at Jonesville production center*	*Cases*	*7,845,978*	*7,880,862*	*(34,884)*	✓	*2*
3.	*Outflow at Briansville production center*	*Cases*	*1,288,448*	*1,318,526*	*(30,078)*	✓	*3*
4.	*Outflow at Vicksburg production center*	*Cases*	*1,071,289*	*1,085,172*	*(13,883)*	✓	*4*
5.	*Outflow at Madison production center*	*Cases*	*1,405,731*	*1,442,651*	*(36,920)*	✓	*5*
6.	*Storage at Sommersville production center*	*Pallets*	*7,146*	*0*	*7,146*	✓	*6*
7.	*Storage at Jonesville production center*	*Pallets*	*4,754*	*0*	*4,754*	✓	*6*
8.	*Storage at Briansville production center*	*Pallets*	*3,849*	*0*	*3,849*	✓	*6*
9.	*Storage at Vicksburg production center*	*Pallets*	*4,319*	*0*	*4,319*	✓	*6*
10.	*Storage at Madison production center*	*Pallets*	*3,689*	*0*	*3,689*	✓	*6*
COST							
1.	*Manufacturing cost at Sommersville production center*	*Cost / Cs*	*$1.0820*	*$1.0806*	*$0.0014*	✓	
2.	*Manufacturing cost at Jonesville production center*	*Cost / Cs*	*$1.0838*	*$0.0000*	*$1.0838*	✓	*7*
3.	*Manufacturing cost at Briansville production center*	*Cost / Cs*	*$1.0801*	*$0.0000*	*$1.0801*	✓	
4.	*Manufacturing cost at Vicksburg production center*	*Cost / Cs*	*$1.0873*	*$0.0000*	*$1.0873*	✓	*7*
5.	*Manufacturing cost at Madison production center*	*Cost / Cs*	*$1.0805*	*$1.0804*	*$0.0001*	✓	
6.	*Transportation cost*	*Cost / Cs*	*$1.7309*	*$1.7256*	*$0.0053*	✓	
7.	*Cross docking cost*	*Cost / Cs*	*$0.0500*	*$0.0000*	*$0.0500*	✓	*8*
8.	*Purchasing cost (cost for finished goods from outside*	*Cost / Cs*	*$6.1600*	*$6.1600*	*$0.0000*	✓	
9.	*bottlers)*						

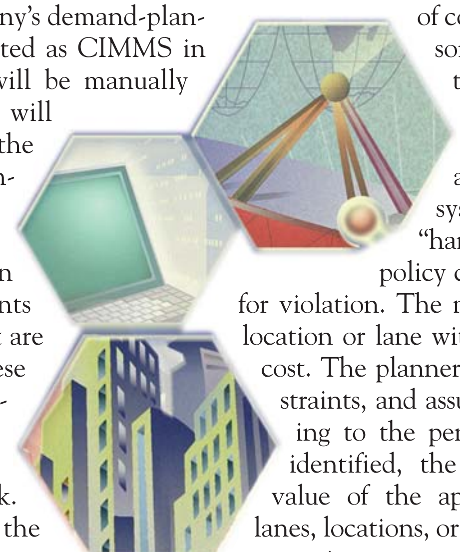
	CONSTRAINTS	OK	
1.	*Fixed capability of manufacturing. (line number 1 can only produce cans).*	✓	
2.	*Minimum lots when producing a product.*	✓	
3.	*Product costs and throughputs based on demonstrated capability.*	✓	
4.	*Minimum weekly run times (80 hours per week at bessemer) .*	✓	
5.	*Maximum available weekly run times (140 hours per week).*	✓	
6.	*Violation of Min capacity can happen but with a penalty of 1.5*labor costs.*	✓	
7.	*Products are produced to cover for a certain duration of time.*	✓	
8.	*Use existing lanes to source the products.*	✓	
9.	*Infinite transport capacity; which means trucks are available when needed.*	✓	
10.	*Storage constraints at the manufacturing plant.*	✓	

NOTES / EXPLANATION:

1. *Sommersville produced 70,000 fewer cases due to a one-week production line shut down.*
2. *Jonesville produced cases for Sommersville during the line shut down.*
3. *Briansville produced cases for Sommersville during the line shut down.*
4. *Vicksburg produced 5,000 cases for Sommersville. Remaining variance results from 2-day marketing promotion.*
5. *Madison had a promotional campaign that was not included in the model.*
6. *The variances in stored pallets are due to lot sizing assumptions.*
7. *The variances of 2 to 3 cents per case are due to purchase price variances on raw materials.*
8. *Cross docking cost was higher due to trans-shipping and double handling during the line shut down at Sommersville.*

big bottle line. Weekly buckets will detect seasonal and other demand variations, and cases are the company's common measure of output.

The data source summary in the upper right-hand corner of the Variables Summary Sheet lists the data needed for the model and where it will come from. This will include demand- and resource-related data as well as cost-related data. For MTT, data about products will come from the company's demand-planning information system (abbreviated as CIMMS in Figure 2). Data about resources will be manually entered. Manufacturing cost data will come from transaction records in the company's enterprise resource planning (ERP) system. Other cost data will come from a variety of sources.



The "model constraints" section of the sheet specifies the constraints or limitations on the resources that are being modeled. In some cases, these constraints are physical; for example, MTT's manufacturing lines must run at least 80 hours but no more than 140 hours in a week. Others are a matter of cost, such as the need to produce minimum lots.

The Variables Summary Sheet also lists formulas for expressing costs or resource performance. In our example, MTT, defines its transportation cost as:

Transportation cost = X_1* (two-way private fleet cost, for example US $900 per round trip)
+ X_2*(one-way incentive for common carrier use, for example US $600 per one-way trip)
+ X_3*(backhaul incentive factor, for example US $200 per backhaul)
+ X_4*(reverse-logistics factor, i.e. container and damaged-goods return)

Note: X_1, X_2, X_3, and X_4 are trip frequencies for each lane, and * represents "multiplied by"

This formula shows that the planners are using a weighted-average approach to estimate a single transportation cost for each lane, rather than modeling each kind of transportation as a separate resource on each lane. The latter approach would greatly increase the complexity of the model without significantly improving the precision of the results.

Key parameters for each manufacturing plant are summarized in a table at the bottom of the worksheet in Figure 2. In MTT's case, the parameters include number of lines, maximum and minimum capacities expressed as hours of operation, and storage capacity expressed as number of pallets. Manufacturing line speeds are expressed simply as "demonstrated speed"; that is, the modeler will use the line speeds in cases per hour that are normally used by the production planners when scheduling each line.

Step 3: Analyze the sensitivities

Now that the model has been constructed, it needs to be validated. In Step 3, the planners run the model using optimization software and identify any violations of constraints or infeasible (i.e., unreasonable) results. He or she then troubleshoots the model to eliminate infeasibilities.

Troubleshooting the model is an iterative process. The planners systematically relax the violated "hard" constraints to make them "soft" policy constraints with high penalty costs for violation. The model is run again to identify the location or lane with the highest cumulative penalty cost. The planners then examine all variables, constraints, and assumptions that might be contributing to the penalty cost. Once they have been identified, the planners tweak the parametric value of the appropriate resources; add missing lanes, locations, or products; or adjust constraints and assumptions as appropriate. The model is run again and the process repeated until all constraints have been honored. Following Simplified SNP Steps 1 and 2 will significantly reduce the number of iterations required.

Next, the planners run the model again and fine-tune it to establish a baseline that replicates current network performance. Fine-tuning typically involves adding additional resources and slightly changing the value of the parameters until the model's results match—either exactly or with acceptable variances—the actual network performance for the chosen baseline period. The fine-tuned results for demand variables and cost variables as well as the constraints met are summarized on the Baseline Validation Worksheet in Figure 3.

The ultimate purpose of Step 3 is to validate the model. Validation compares the model's results to the actual performance of the current network for the modeled period. This exercise builds credibility: The smaller the variance, the more accurate the model—and the greater the acceptance of the model's results. Notes and explanations on the worksheet explain any changes that were made to the model and the reasons for the variances between its results and the network's actual performance.

In practice, validation is difficult and may take several days, even when the model has been systematically defined and documented. Validation can take much longer if the planners' approach is less systematic and the model constraints are poorly documented.

Step 4: Create scenarios

In Step 4, the planners develop scenarios that represent alternative network plans. Each scenario makes one or more of the following changes to the baseline model:

- Adding or deleting products or locations,
- Adding or deleting resources,
- Adding or deleting transportation lanes,
- Changing which locations serve which customer demand,
- Changing network flows and sources of supply, and
- Adding or relaxing constraints.

The planners then collect summary statistics for each alternative plan and document the results on a series of Scenario Summary Sheets. The Scenario Summary Sheet records changes from the baseline and summarizes model results in terms of demand, resource utilization, lanes, and flow. A diagram shows what the network would look like for that particular scenario.

In our MTT example, several scenarios place the 32-ounce upgrade at different plants. Figure 4 shows the Scenario Summary Sheet for scenario 1, which places the upgrade at the Jonesville plant. As the "Setup Summary" shows, transportation lanes to branch distribution centers are set up to receive products from Jonesville or Sommersville, with an added constraint that each DC order must be for a full truckload. When the model was run, the optimizer software moved 300,000 cases of 32-ounce production from Sommersville to Jonesville. Of these cases, 200,000 formerly were cross-docked through Jonesville to its branch DCs. In terms of resources, Sommersville was relieved of 450 hours per year of production, while

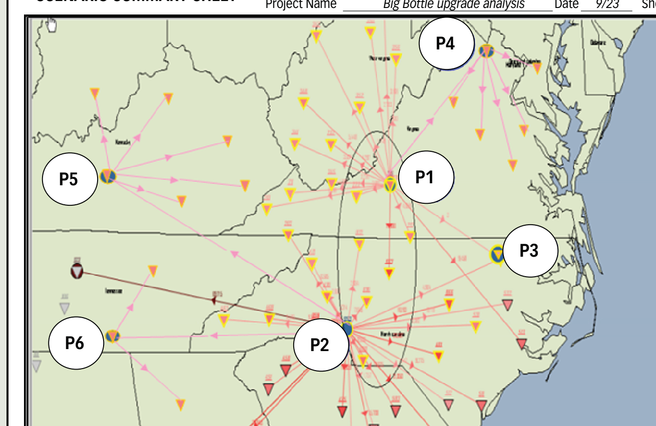
[FIGURE 4]

The Scenario Summary Sheet is completed for each alternative scenario. It records optimistic, pessimistic, and most likely costs as well as other important aspects of the scenario and its underlying assumptions.

SCENARIO SUMMARY SHEET — Company: MTT — Project Name: Big Bottle upgrade analysis — By: CSN — Date: 9/23 — With: KW, BF — Sheet 1 of 1 — Scenario: IV — Description: 32 oz. bottle capability at Madison plant (P5)

SCENARIO SUMMARY SHEET — Company: MTT — Project Name: Big Bottle upgrade analysis — By: CSN — Date: 9/23 — With: KW, BF — Sheet 1 of 1 — Scenario: II — Description: 32 oz. bottle capability at Briansville plant (P3)

SCENARIO SUMMARY SHEET — Company: MTT — Project Name: Big Bottle upgrade analysis — By: CSN — Date: 9/23 — With: KW, BF — Sheet 1 of 1 — Scenario: I — Description: 32 oz. bottle capability at Jonesville plant (P1)



COST SUMMARY

	COSTS	a	b	c
1.	Manufacturing cost	$24,404,000	$24,404,000	$24,404,000
2.	Transportation cost	$38,010,000	$38,200,000	$38,320,000
3.	Cross Docking cost	$60,000	$62,500	$65,000
4.	Reduced overtime	$102,000	$105,940	$115,000
5.	Purchasing cost	$9,440,640	$9,440,640	$9,440,640
6.				
7.				
8.				
9.				
10.				
	TOTAL COSTS	$72,016,640	$72,213,080	$72,344,640

(a, b, c: SCENARIO CASES)

SCENARIO CASES

a	Optimistic savings (No min lane constraints, Multi stops)
b	Most likely solution (product shelf life, full truckload, multi stop, lot sizing)
c	Pessimistic savings (replenishment load savings, Single stop)

CONSTRAINTS

1. Manufacturing is constrained by the current line capacities.
2. Sourcing on a lane is constrained to at least 250 cases a week.
3. Line speeds at Jonesville for the 32 Oz bottle is higher than Sommersville.
4. All the baseline constraints like lot sizes, coverage duration production are also included in the scenario.
5. 32-oz. demand from other bottlers north of Jonesville will be filled from Jonesville.
6.
7.
8.
9.

ASSUMPTIONS

1. Cost of manufacturing at Jonesville is same as cost at Sommersville.
2. Cost of the existing lanes remain the same.
3. Costs of new moves from Jonesville is determined by transportation formula.
4. Raw material is always available for production at Sommersville and Jonesville.
5. Penalty costs are applied at the same rate as the baseline.
6. Capability is already available for running the 32 Oz bottles.
7. All the branches supplied from Sommersville will be served thru existing lanes.
8.
9.
10.

NOTES

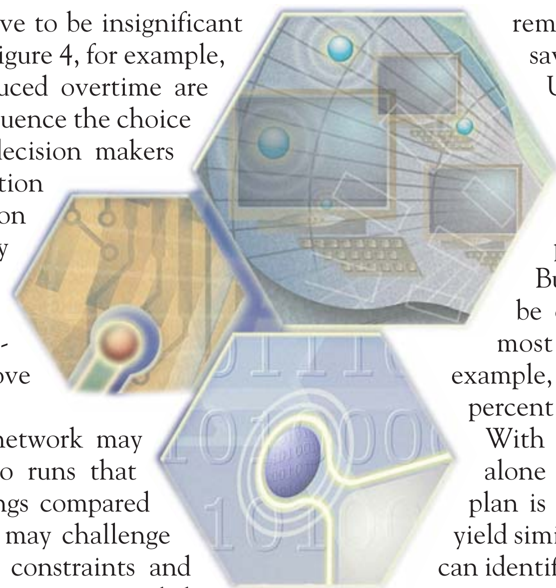
1. Transportation cost doesn't assume carrier opportunities.
2. Does not consider new demand that may be available from upgrade.
3.
4.
5.

RESULTS SUMMARY	SET UP SUMMARY
DEMAND	**DEMAND**
1. All of the Virginia and W. Virginia branches receive product from Jonesville.	1. Independent demand location is the same.
2. Other bottler customers up North receive product from Jonesville.	2. Branch bottle source demand from 2 sources.
3. Jonesville picks up 300,000 cases per year.	3. Other bottler demand moves from Sommersville to demand based on customers.
	4. 32Oz SKU's added to Jonesville for production.
RESOURCE	**RESOURCE**
1. Sommersville is relieved of 190 hrs/yr of production time.	1. Transportation resources to handle the lanes.
2. Available capacity at Jonesville decreased by 200 hrs/yr.	2. New manufacturing line with 32 Oz capability.
3. Cross docking volume was reduced by 270,000 cases.	3. Additional Resources to control minimum of truckload on a lane.
4.	4.
5.	
FLOW	**LANES**
1. Simpsons receives its product from Sommersville.	1. All branches have 2 sources or lanes.
2. Harrystown demand is met through Jonesville.	2. Lanes are set up with Minimum ship quantity.
3. Clinton receives its product from Jonesville.	3.
4. The sourcing remains intact for all the other branches.	4.
5.	5.
6.	6.

300 hours were added to Jonesville. The difference is due to the greater efficiency of the newly upgraded line in Jonesville. These results are reported in the sheet's "Results Summary" section.

This scenario also showed that the distribution network would have to be reworked. Network lane assignments were changed for three distribution centers. DC 23 could not satisfy Jonesville's full truckload constraint, so the modeling software reassigned it to the Sommersville plant. Meanwhile, DCs 11 and 12, along with all of the DCs in Virginia and West Virginia, now receive all of their 32-ounce products from Jonesville. In the baseline scenario, these DCs had been served by the Sommersville plant.

Some cost categories that are a concern at the outset of modeling often prove to be insignificant once results are in hand. In Figure 4, for example, cross-docking costs and reduced overtime are insignificant and will not influence the choice of network plan. But key decision makers frequently focus their attention on the "Cost Summary" section of the Scenario Summary Sheet, and the planners therefore have chosen to include those essentially irrelevant costs in order to remove any concerns or doubts.



Those who manage the network may also be skeptical of scenario runs that predict significant cost savings compared to current conditions. They may challenge assumptions, parameters, or constraints and ask the planners to make adjustments until the scenario run yields a more modest improvement—one that they are willing to be accountable for obtaining. The wise planner anticipates this give-and-take and budgets time to run optimistic, pessimistic, and "most likely" cases and present them to management. These savings scenarios are recorded in the "Scenario Cases" columns in the Cost Summary section.

Step 5: Evaluate the alternatives

In Step 5 the planners evaluate the alternative network plans that were developed in Step 4, and those involved in decision making compare and select the most preferred plan. Evaluation, using the Alternatives Analysis Worksheet, typically takes two forms:

- *Cost analysis*—comparing relevant costs among the scenarios and their network plans
- *Intangible analysis*—considering factors that cannot be easily modeled or measured in economic terms.

Cost analysis generally is straightforward. Modeling software typically computes each alternative's difference from the baseline for each element of the total cost. When comparing alternatives, planners must decide whether to show all costs or only those that are affected by the proposed alternatives. When the impact of proposed changes on total cost is small, it may be preferable to present and compare only the costs that are actually affected. This will magnify the cost differences among the alternatives.

In Figure 5, the four alternative plans compare what MTT's annual costs would have been if 32-ounce capacity had been added at one of four existing plants: Jonesville, Briansville, Vicksburg, and Madison. Jonesville's costs (alternative I) are the lowest and would have saved about US $700,000 per year over the current or baseline network. The remaining locations would have saved between US $391,000 and US $581,000. These savings easily justify the upgrade of a production line.

Naturally MTT would like to implement the network plan with the lowest total cost. But intangible factors must also be considered when choosing the most advantageous plan. In this example, annual costs differ by only 1 percent among the four alternatives. With such a small difference, cost alone should not determine which plan is best. When two or more plans yield similar costs, comparing intangibles can identify which is best. Examples of relevant intangibles include exposure to various types of risk, ease of implementation, ability to respond to demand changes, fit with the organization's structure, and labor- or facilities-related considerations.

To measure the importance of intangibles, SNP uses the weighted-factor approach shown in the lower portion of Figure 5. The planners list relevant factors, and managers assign weights reflecting each factor's relative importance in the evaluation.

Next, those who will implement and operate the new network evaluate and rate the likely effectiveness of each alternative in addressing each intangible factor. SNP uses the vowel code convention of A, E, I, O, U, and X in descending order of effectiveness, where A = 4, E = 3, I = 2, O = 1, and U = 0. By convention, SNP assigns a weight of 10 to the most important factor. A rating of "X" disqualifies a plan unless the objectionable feature can be fixed. (The meanings of these codes, shown in the bottom left-hand corner of Figure 5, are different from those discussed in Step 1.)

After the planners have rated all of the plans under consideration relative to all of the intangible factors, they multiply the ratings' numerical values by the factor weights and add them together to arrive at total scores for each plan. The highest score indicates the best network plan from an intangibles perspective. Ideally, the highest-scoring plan will also have the lowest total cost. But if not, this procedure will still reveal the intangible benefits of the more costly network plans. Moreover, when a cost comparison does not indicate a clear winner, the weighted-factor calculation will help to identify which plan is best and why.

In our example, the lowest-cost alternative, Jonesville, is rules out because it rates "X" on the risk of line shutdown. Of the remaining alternatives, Briansville scores highest at 84. It offers more capaci-

[FIGURE 5]

On the Alternatives Analysis Worksheet, costs are compared at the top, and intangibles are compared below. The plan with the lowest cost (Alternative III) is not nearly as good as Alternative II when intangible factors are considered. Because the difference in cost was minute, Alternative II was selected.

ALTERNATIVES ANALYSIS WORKSHEET

Company: *MTT* — Project Name: *Big Bottle Analysis*
By: *CSN* — With: *BF, KW, CN*
Date: *10/21* — Sheet *1* of *1*

COST ANALYSIS — By: *CSN* — With: *BF, KW*

	COST SUMMARY	BASELINE	I	II	III	IV
1.	*Manufacturing Costs (Std Costs)*	$24,404,000	$24,404,000	$24,404,000	$24,404,000	$24,404,000
2.	*Transportation Costs*	$38,850,000	$38,200,000	$38,315,000	$38,340,000	$38,500,000
3.	*Cross Docking*	$76,000	$62,500	$65,200	$67,500	$66,500
4.	*Reduced Overtime (Manufacturing variance)*	$143,000	$105,940	$107,900	$112,200	$111,000
5.	*Purchasing Costs (omitted since equal for all)*	NA	NA	NA	NA	NA
	TOTAL ANNUALIZED COSTS	$63,473,000	$62,772,440	$62,892,100	$62,923,700	$63,081,500
	ANNUALIZED SAVINGS OVER BASELINE		-$700,560	-$580,900	-$549,300	-$391,500

INTANGIBLE ANALYSIS — Weights by: *KW, BF, CN* — Ratings by: *CN, TT, RH* — Tally by: *CSN*

	FACTOR / CONSIDERATION	WT.	BASELINE	I	II	III	IV
1.	*Capacity relief*	10		O 10	A 40	E 30	O 10
2.	*Ease of implementation*	6		A 24	E 18	O 6	O 6
3.	*Union environment*	5		U 0	U 0	U 0	I 10
4.	*Organizational structure*	4		I 8	I 8	U 0	I 8
5.	*Condition of the line*	1		U 0	I 2	I 2	O 1
6.	*Availability (less risk of line shutdown)*	8		X	I 16	I 16	I 16
	TOTAL INTANGIBLES EFFECT			42	84	54	51

	NOTES		SCENARIO NAME
1.	*Capacity savings is due to the penalty of overtimes.*	**BASELINE**	*Current network performance*
2.	*Briansville crossdock only limited products due to space constraints*	**I**	*32 OZ Bottle capability at Jonesville*
3.	*Madison is the only unionized plant.*	**II**	*32 OZ Bottle capability at Briansville*
4.	*Risk of line shut down is a negative impact condition. High risk is given lower rating.*	**III**	*32 OZ Bottle capability at Vicksburg*
		IV	*32 OZ Bottle capability at Madison*

EVALUATING DESCRIPTION

A	Almost Perfect	O	Ordinary Results
E	Especially Good	U	Unimportant Results
I	Important Results	X	Not Acceptable

Values: A = 4, E = 3, I = 2, O = 1, U = 0, X = -1

COST DIFFERENCE FROM BASELINE

SAVINGS		INCREASED COSTS	
	-26% to -50%		0% to 5%
	-16% to -25%		6% to 15%
	-6% to -15%		16% to 25%
	0% to -5%		26% to 50%

SUMMARY

1. *Alt. III Vicksburg is best in terms of cost.*
2. *From the intangible perspective Alt. II Briansville is best.*
3. *All factors considered, the new 32-oz. line for big bottles should be at Briansville.*

ty relief and easier implementation, and its savings are somewhat greater than Vicksburg or Madison. For these reasons, MTT selected Briansville for the 32-ounce bottling line upgrade.

Step 6: Detail and do

In the final step, representatives of the affected organizations use a Detail and Do Worksheet to outline the actions that will be required to implement the network plan selected in Step 5 and schedule the implementation. (If the purpose of the network-planning project is simply to conduct an analysis and make a presentation, no actual changes will be made during this step.)

If the company does want to make changes, the planners first prepare a Gantt chart with the implementation schedule. A Gantt chart serves as a communication tool, outlining the tasks and actions needed to change the network, the individual(s) responsible for each one, and the scheduled time period for conducting each task or action. The top half of Figure 6 shows MTT's Gantt chart.

The network plan must, of course, be implemented by professionals in the field. But the network planners should be involved: first, so they can better understand what is required to implement change, and second, so they can confirm the effectiveness of their recommendations. During implementation, it is a

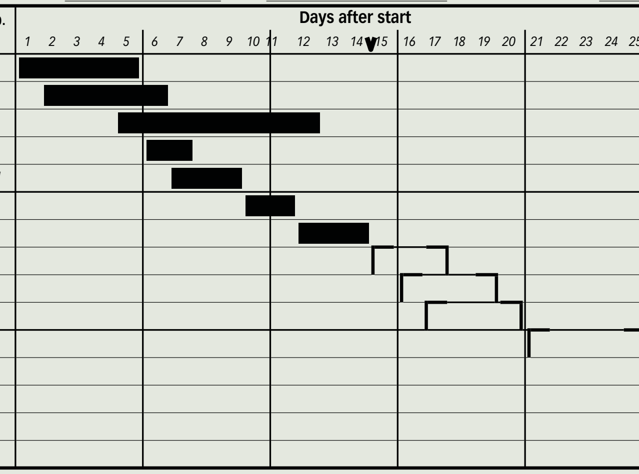
[FIGURE 6]

The Detail and Do Worksheet outlines the implementation plan, including explanations of decisions. It also provides a place to lay out the project schedule and record the results of a post-implementation audit.

DETAIL AND DO

Covering	Manufacturing, Logistics, Planning	Company	MTT	Project	SNP-106
Distribution	KW, BF, RH, CN, KL, DS,TB	Status as of	10/13	Project Description	Briansville Line Upgrade
		Reported by	CN	Date	9/23
		By	CN	With	DS, RB, TB
		Sheet	1	of	1

Task/Proj. No. and/or Description — Work to do; Action to take		Resp. of	Days after start (1–25)	Further Schedule
1.	Communicate the selection plan and schedule upgrade date	TS		
2.	Perform the vendor selection for change parts	MS		
3.	Perform the line upgrade	MS		
4.	Instruct the planning department	CN		
5.	Allocate the demand to the manufacturing location	MM		
6.	Inform the SKU committee of the changes	SB		
7.	Set up the sourcing in the system to reflect change	CW		
8.	Make changes to the ERP system to reflect the new cost	CW		
9.	Communicate the changes to logistics	DS		
10.	Change the raw material sourcing	DC		
11.	Commit the changes and begin production	TS		
12.				
13.				
14.				
15.				



POST IMPLEMENTATION AUDIT

COST SUMMARY		UOM	Projected Savings	Actual Savings	Variance	Notes
1.	Manufacturing costs	$	$0	$18,000	$18,000	1.
2.	Transportation costs	$	$535,000	$369,000	($166,000)	2.
3.	Warehousing labor costs	$	$0	($6,500)	($6,500)	3.
4.	Storage costs	$	$0	$13,000	$13,000	4.
5.	Reduced overtime	$	$28,000	see Mfg. Cost above	($15,100)	5.
6.	Raw Material Procurement costs	$	$0	$52,000	$52,000	6.
7.	Cross docking costs	$	$10,800	$10,000	($800)	7.
8.						
9.						
10.						

No.	NOTES AND EXPLANATION AND LESSONS LEARNED
1.	Reduced overtime at Sommersville is credited as a reduction in manufacturing cost. Projection was for $15,000. Actual reduction was $18,000.
2.	The full realization was not obtained because of steep increase in the fuel costs. Consider fuel price projections in future models.
3.	Warehousing direct labor costs increased because increased labor activity.
4.	Storage costs on a per unit reduced because of better absorption of the fixed costs. But trivial in terms of total cost. Correct to leave out of the model.
5.	Overtime at Sommersville was eliminated as planned but is treated as a reduction in manufacturing cost on line 1.
6.	Raw material costs reduced because MTT negotiated a contract for producing all of its big bottles in Briansville and raw material plant was in close vincinity to Briansville.
	Total savings not significant and it was correct to leave this out of the cost evaluation.
7.	Cross docking costs were 8% higher than expected but still insignificant in terms of total cost.
8.	

Date work scheduled to start — Amount of work done — Date work scheduled to finish — Reporting indicator — Total time scheduled for work (Each vertical period represents one unit of time)

good idea to periodically measure performance against the schedule and take action if needed to keep the project moving.

A post-implementation audit captures actual results and measures variances between projected and actual savings and costs. Such audits typically are performed between 90 days and one year after an implementation has been completed. During the audit, planners should seek explanations for any significant variances.

This practice provides useful lessons for future modeling and improves the overall effectiveness of network planning. The lower half of Figure 6 proves that point: Because fuel-price increases eliminated half of MTT's projected transportation savings, the planners will probably include fuel-price projections in future models of this type.

SNP: The difference between good and great

Do you need SNP, or is your current practice good enough? The 10-point Network Planning Spot Audit

[FIGURE 7]

Whenever possible, planning projects should meet the 10 objectives shown here. How well does your current or planned project match this list?

Considerations	Excellent	Very Good	Good	Fair	Poor
1. **Quick startup** on new projects without confusion regarding purpose, scope, or approach	○	○	○	○	○
2. **Finish on time** or earlier than expected without delays, excessive iterations, and rework	○	○	○	○	○
3. **Visualization of the network** being modeled with clear and explicit diagrams of lanes and locations	○	○	○	○	○
4. **Effective communication** of model inputs and elements, including data sources, assumptions, constraints, and model structures	○	○	○	○	○
5. **Effective documentation** of the analysis performed so that those not directly involved can see and explain the work	○	○	○	○	○
6. Management chooses from **multiple scenarios,** each of which is a cost-effective course of action	○	○	○	○	○
7. Formal evaluation of **intangible factors** in addition to cost, including ease of implementation, business risk, and flexibility	○	○	○	○	○
8. **Involvement of operations** personnel, especially in defining and evaluating scenarios and plans	○	○	○	○	○
9. **Ready acceptance** of model outputs by operations without disbelief, objections, or challenges of results	○	○	○	○	○
10. **Accurate results**—actual results are close to projected savings	○	○	○	○	○

in Figure 7 may help you decide. Once you have effective modeling software in place and know how to use it, these 10 considerations will make the difference between excellent results and those that are simply good or perhaps even poor.

In the authors' experience, SNP's step-by-step structure and documentation make it easy to involve operations personnel in the planning process and help to consistently achieve excellence in all 10 of the audit areas:

- Step 1 and its Orientation & Issues Worksheet assure quick start-up.
- Step 2 and the Variables Summary Sheet improve visualization and model set-up.
- Step 3 and the Baseline Validation Worksheet speed up this time-consuming task, assuring accuracy and ready acceptance of results.
- Step 4 and the Scenario Summary Sheet make sure that the right alternatives are considered and that management is offered valid choices.
- Step 5 evaluates all relevant factors in addition to supply chain costs.
- Step 6 and its Gantt chart enable timely implementation and learning from actual results.

Systematic Network Planning is designed to avoid the pitfalls, oversights, and rework that are all too common in the day-to-day use of network-modeling tools. Whether network planners are highly experienced or new to this important function, SNP assures that modeling projects will be both effective and accurate. △

Endnote:

1. Copies of these and other worksheets, all of which are proprietary and copyrighted, are available at no charge to readers of *CSCMP's Supply Chain Quarterly* at www.RichardMuther.com. Click on Downloads and then on Working Forms.

A booklet on Systematic Network Planning written by the authors will be published later this year by Management & Industrial Research Publications. For more information, telephone 770-798-7792 (Marietta, Georgia, U.S.A.)

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