

Problems



- 1 One of your Taiwanese suppliers has bid on a new line of molded plastic parts that is currently being assembled at your plant. The supplier has bid \$0.10 per part, given a forecast you provided of 200,000 parts in year 1; 300,000 in year 2; and 500,000 in year 3. Shipping and handling of parts from the supplier's factory is estimated at \$0.01 per unit. Additional inventory handling charges should amount to \$0.005 per unit. Finally, administrative costs are estimated at \$20 per month.

Although your plant is able to continue producing the part, the plant would need to invest in another molding machine, which would cost \$10,000. Direct materials can be purchased for \$0.05 per unit. Direct labor is estimated at \$0.03 per unit plus a 50 percent surcharge for benefits; indirect labor is estimated at \$0.011 per unit plus 50 percent benefits. Up-front engineering and design costs will amount to \$30,000. Finally, management has insisted that overhead be allocated if the parts are made in-house at a rate of 100 percent of direct labor cost. The firm uses a cost of capital of 15 percent per year.

What should you do, continue to produce in-house or accept the bid from your Taiwanese supplier?

- 2 Your company assembles five different models of a motor scooter that is sold in specialty stores in the United States. The company uses the same engine for all five models. You have been given the assignment of choosing a supplier for these engines for the coming year. Due to the size of your warehouse and other administrative restrictions, you must order the engines in lot sizes of 1,000 each. Because of the unique characteristics of the engine, special tooling is needed during the manufacturing process for which you agree to reimburse the supplier. Your assistant has obtained quotes from two reliable engine suppliers and you need to decide which to use. The following data have been collected:

Requirements (annual forecast)	12,000 units
Weight per engine	22 pounds
Order processing cost	\$125 per order
Inventory carry cost	20 percent of the average value of inventory per year

Note: Assume that half of lot size is in inventory on average ($1,000/2 = 500$ units).

Two qualified suppliers have submitted the following quotations:

ORDER QUANTITY	SUPPLIER 1	SUPPLIER 2
	UNIT PRICE	UNIT PRICE
1 to 1,499 units/order	\$510.00	\$505.00
1,500 to 2,999 units/order	500.00	\$505.00
3,000+ units/order	490.00	488.00
Tooling costs	\$22,000	\$20,000
Distance	125 miles	100 miles

Your assistant has obtained the following freight rates from your carrier:

Truckload (40,000 lbs. each load):	\$0.80 per ton-mile
Less-than-truckload:	\$1.20 per ton-mile

Note: Per ton-mile = 2,000 lbs. per mile.

- Perform a total cost of ownership analysis and select a supplier.
 - Would it make economic sense to order in truckload quantities? Would your supplier selection change if you ordered truckload quantities?
- 3 The McDonald's fast-food restaurant on campus sells an average of 4,000 quarter-pound hamburgers each week. Hamburger patties are resupplied twice a week, and on average the store has 350 pounds of hamburger in stock. Assume that the hamburger patties cost \$1.00 a pound. What is the inventory turnover for the hamburger patties? On average, how many days of supply are on hand?

- a. Find the solution that minimizes moving costs using Microsoft Excel.
- b. What would you have to do to the costs to assure that A always sends a car to D as part of the optimal solution?
- 5 Sycamore Plastics (SP) is a manufacturer of polyethylene plastic pellets used as a raw material by manufacturers of plastic goods around the U.S. SP currently operates four manufacturing centers in Philadelphia, PA; Atlanta, GA; St. Louis, MO; and Salt Lake City, UT. The plants have different capacities and production costs as indicated in the table below.

PLANT	MAXIMUM CAPACITY (x 100,000 LBS.)	PROD. COSTS (PER 1,000 LBS.)
Philadelphia	7.5	\$325.00
Atlanta	9.0	\$275.00
St. Louis	12.0	\$305.00
Salt Lake City	10.3	\$250.00

SP currently has six contract customers located in New York City; Birmingham, AL; Terre Haute, IN; Dallas, TX; Spokane, WA; and San Diego, CA. Transportation costs between the plants and various customers, as well as contracted demand from each customer, are shown in the table below.

FROM/TO	TRANSPORT COSTS PER 1,000 LBS.					
	NYC	BIRMINGHAM	TERRE HAUTE	DALLAS	SPOKANE	SAN DIEGO
Philadelphia	\$45	\$52	\$56	\$62	\$78	\$85
Atlanta	\$55	\$42	\$58	\$59	\$80	\$82
St. Louis	\$57	\$60	\$50	\$54	\$65	\$70
Salt Lake City	\$72	\$71	\$67	\$57	\$52	\$60
Total Demand (x 1,000 lbs.)	525	415	925	600	325	400

- a. Create a solver model and find the optimal solution to help SP develop a distribution plan that will minimize costs to supply the customers' demand.
- b. Comment briefly on your solution. Beyond the obvious, does your proposed solution have any other implications for SP?

Analytics Exercise: DISTRIBUTION CENTER LOCATION

Grainger: Reengineering the China/U.S. Supply Chain

W. W. Grainger, Inc. is a leading supplier of maintenance, repair, and operating (MRO) products to businesses and institutions in the United States, Canada, and Mexico with an expanding presence in Japan, India, China and Panama. The company works with more than 3,000 suppliers and runs an extensive Website (<http://www.grainger.com>) where Grainger offers nearly 900,000 products. The products range from industrial adhesives used in manufacturing, to hand tools, janitorial supplies, lighting equipment, and power tools. When something is needed by one of their 1.8 million customers it is often needed quickly, so quick

service and product availability are key drivers to Grainger's success.

Your assignment* involves studying U.S. distribution in Grainger's supply chain. Grainger works with over 250 suppliers in the China and Taiwan region. These suppliers produce products to Grainger's specifications and ship to the United States using ocean freight carriers from four major ports in China and Taiwan. From these ports, product is shipped to U.S. entry ports in either Seattle, Washington, or Los Angeles, California. After passing through customs, the 20- and 40-foot containers are shipped by rail to Grainger's

The data in this case have been developed for teaching purposes and do not represent the actual situation at Grainger. The data, though, are representative of an actual problem that Grainger and similar companies must address to efficiently run the supply chain.

central distribution center in Kansas City, Kansas. The containers are unloaded and quality is checked in Kansas City. From there, individual items are sent to regional warehouses in nine U.S. locations, a Canada site, and Mexico.

Grainger: U.S. Distribution

In the United States approximately 40 percent of the containers enter in Seattle, Washington, and 60 percent at the Los Angeles, California, port. Containers on arrival at the port cities are inspected by federal agents and then loaded onto rail cars for movement to the Kansas City distribution center. Variable costs for processing at the port are \$5.00 per cubic meter (CBM) in both Los Angeles and Seattle. The rate for shipping the containers to Kansas City is \$0.0018 per CBM per mile.

In Kansas City the containers are unloaded and processed through a quality assurance check. This costs \$3.00 per CMB processed. A very small percentage of the material is actually sent back to the supplier, but errors in quantity and package size are often found that require accounting adjustments.

Items are stored in the Kansas City distribution center, which serves nine warehouses in the United States. Items are also sent to warehouses in Canada and Mexico, but for the purposes of this study we focus on the United States. The nine warehouses each place orders at the distribution center that contains all the items to be replenished. Kansas City picks each item on the order, consolidates the items onto pallets, and ships the items on 53-foot trucks destined to each warehouse. Truck freight costs \$0.0220 per CBM per mile. The demand forecasts for the items purchased from China/Taiwan for next year in cubic meters and shipping distances are given in the following table.

WAREHOUSE	DEMAND (CBM)		DISTANCES		
	AVERAGE	% OF DEMAND	MILES FROM KANSAS CITY	MILES FROM LOS ANGELES	MILES FROM SEATTLE
Kansas City	20,900	11%	0	1,620	1,870
Cleveland	17,100	9%	800	2,350	2,410
New Jersey	24,700	13%	1,200	2,780	2,890
Jacksonville	15,200	8%	1,150	2,420	2,990
Chicago	22,800	12%	520	2,020	2,060
Greenville	15,200	8%	940	2,320	2,950
Memphis	17,100	9%	510	1,790	2,330
Dallas	22,800	12%	500	1,430	2,130
Los Angeles	34,200	18%	1,620	0	1,140
Total	190,000				

Although a high percentage of demand was from warehouses either south or east of Kansas City, the question has surfaced concerning the 18 percent that will be shipped to Kansas City and then shipped back to the Los Angeles warehouse. This double-transportation could potentially be eliminated if a new distribution center were built in Los Angeles. The idea might be to ship material arriving at the Seattle port by rail to a new Los Angeles distribution center, which would be located at the current location of the Los Angeles warehouse.

It is estimated that the Los Angeles facility could be upgraded at a one-time cost of \$1,500,000 and then operated for \$350,000 per year. In the new Los Angeles distribution center, containers would be unloaded and processed through a quality assurance check, just as is now done in Kansas City. The variable cost for doing this would be \$5.00 per CBM processed, which includes the cost to move the containers from the Los Angeles port to the distribution center.

After the material is processed in Los Angeles, the amount needed to replenish the Los Angeles warehouse (approximately 18 percent) would be kept and the rest sent by rail to Kansas City. It would then be directly stocked in the Kansas City distribution center and used to replenish the warehouses. They expect that very little would need to be shipped back to the Los Angeles warehouse after the new system was operating for about six months.

Grainger management feels that it may be possible to make this change, but they are not sure if it would actually save any money and whether it would be a good strategic change.

Specific Questions to Address in Your Analysis:

- Relative to the U.S. distribution network, calculate the cost associated with running the existing system. Assume that 40 percent of the volume arrives in Seattle and 60 percent in Los Angeles and the port processing fee for federal processing at both locations is \$5.00 per CBM. Assume that everything is transferred to the Kansas City distribution center by rail,

where it is unloaded and quality checked. Assume that all volume is then transferred by truck to the nine existing warehouses in the United States.

- Consider the idea of upgrading the Los Angeles warehouse to include a distribution center capable of processing all the volume coming into the United States. Assume that containers coming into Seattle would be inspected by federal officials (this needs to be done at all port locations) and then immediately shipped

by rail in their original containers to Los Angeles. All volume would be unloaded and quality checked in Los Angeles (the quality check cost \$5.00 per CBM when done in Los Angeles). Eighteen percent of the volume would then be kept in Los Angeles for distribution through that warehouse and the rest transshipped by rail to the Kansas City warehouse. The cost to transship to Kansas City would be \$0.0018 per CBM. The material sent to Kansas City would not need to go through the "unload and quality check process," and would be stored directly in the Kansas City distribution center. Assume that the remaining volume would be transferred by truck to the eight remaining warehouses in the United States at a cost of \$0.0220 per CBM.

3 What should be done based on your analytics analysis of the U.S. distribution system? Should the new Los Angeles distribution center be added? Is there any obvious change that Grainger might make to have this option be more attractive?

4 Is this strategically something that Grainger should do? What have they not considered that may be important?

Source: Based on scenario developed in Gary Scalzitti and Amitabh Sinha, "Grainger: Re-engineering an International Supply Chain," Case Study No. 1429084, Tauber Institute for Global Operations, University of Michigan, Ann Arbor, MI, 2010.

Super Quiz

- 1 This is the art and science of obtaining, producing, and distributing material and product in the proper place and quantities.
- 2 A company that is hired to handle logistics functions.
- 3 A mode of transportation that is the most flexible relative to cost, volume, and speed of delivery.
- 4 When large shipments are broken down directly into smaller shipments for local delivery.
- 5 Sorting goods is the main purpose of this type of warehouse.
- 6 A place where foreign goods can be brought into the United States without being subject to normal customs requirements.
- 7 The main cost criterion used when a transportation model is used for analyzing a logistics network.
- 8 The Microsoft Excel function used to solve the transportation model.
- 9 For the transportation model to be able to find a feasible solution, this must always be greater than or equal to demand.
- 10 The "changing cells" in a transportation model represent this.
- 11 This is a method that locates facilities relative to an X, Y grid.
- 12 A technique that is useful for screening potential locations for services.

1. Logistics 2. Third-party logistics company 3. Highway 4. Cross-docking 5. Hub 6. Free trade zone 7. Cost of shipping 8. Solver 9. Total capacity 10. Allocation of demand to a plant or warehouse 11. Centroid method 12. Regression analysis

Selected Bibliography

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Footnote

¹ M. E. Porter, "The Competitive Advantage of Nation," *Harvard Business Review*, March–April 1990.