foam rubber for padding, (3) wood for framing, and (4) ticking, or covering material. There are currently 20 plants located throughout the United States.

How would you propose to approach her problem?

CASE STUDIES

Usemore Soap Company:

A Warehouse Location Case Study

The Usemore Soap Company produces a line of cleaning compounds, used mainly for industrial and institutional purposes. Typical products include general cleaning compounds, dishwasher powders, rinse agents, hand soaps, motor vehicle washing compounds, and cleaning products for the food industry. The product line is composed of more than 200 products and nearly 800 individual product items. Package sizes range from 18-pound cases to large metal drums weighing 550 pounds.

Sales are generated throughout the 48 contiguous United States, with additional sales in Hawaii, Alaska, and Puerto Rico. Customers typically purchase in quantities less than 10,000 pounds, that is, less-than-truckload (LTL) quantities. A few customers purchase in truckload and bulk quantities. Annual LTL sales, which pass through the warehouses, are running at the 150 million pound level. Volume sales, which are served directly from plants, add another 75 million pounds. These sales represent approximately $160 million in revenue.

The primary marketing effort comes from a direct selling force operating under the incentive of a liberal sales commission structure. Salespeople look upon themselves as individual entrepreneurs and have a great deal of autonomy within the company. This marketing strategy has generally proved successful for the company, as the company has often been referred to as one of the most profitable divisions within its widely diversified parent organization.

In spite of the high profitability, company management is concerned about the costs of producing and distributing the product line to maintain its competitive edge. Growth and shifting demand patterns are straining the production capacity of the four existing plants. In addition, changing costs of distribution, as well as the fact that the distribution network has not been studied in 12 years, raise questions about the proper placement of the warehouses. What follows is a summary of the problem conditions being faced by management. You are to suggest an improved distribution network that meets the stated customer service policy and minimizes total network production-distribution costs.

BACKGROUND

The current distribution network consists of four full product line plants located at Covington, Kentucky, New York, New York, Arlington, Texas, and Long Beach, California. The plants are currently producing product for their low-volume customers at the level of 595,102 cwt.,[1] 390,876 cwt., 249,662 cwt., and 241,386 cwt., respectively. This output is shipped from plants either to field warehouses in the distribution network or to customers within the local areas of the plants. In the latter

[1]cwt. = 100 pounds

No.	Location	No.	Location	No.	Location
1	Covington, KY[a]	9	Cleveland, OH	17	Milwaukee, WI
2	New York, NY[a]	10	Davenport, IA	18	Orlando, FL
3	Arlington, TX[a]	11	Detroit, MI	19	Pittsburgh, PA
4	Long Beach, CA[a]	12	Grand Rapids, MI	20	Portland, OR
5	Atlanta, GA	13	Greensboro, NC	21	W Sacramento, CA
6	Boston, MA	14	Kansas City, KS	22	W Chester, PA
7	Buffalo, NY	15	Baltimore, MD		
8	Chicago, IL	16	Memphis, TN		

[a]Field warehousing as part of plant operations.

Table 1 Current Plant and Public Warehouse Locations

case, plants serve as field warehouses as well as producing centers.

Warehousing takes place at 18 public warehouses and at the four plant locations, as shown in Table 1. These warehouses are dispersed in such a fashion that the majority of the customers are within a one-day delivery time frame of a stocking point; that is, approximately 300 miles. Except for the plants serving as warehouses, the warehouses are supplied in full truckload quantities. Less-than-truckload shipments serve customers. Customer order processing takes place at each warehouse location.

In addition, two potential plant sites are being considered at Chicago, Illinois, and Memphis, Tennessee. Additional warehouse sites are considered at the locations shown in Table 2.

Potential warehouse sites are made based on sales personnel's suggestions, favorable warehousing rates, good warehousing service availability, proximity to demand concentrations, and filling out of the distribution network. Of the existing and potential warehouse sites, it is hoped that an improved mix of warehouses can be found. In addition, plant expansion, either at existing sites or at new sites, will be needed to meet future demand projections. Specifically, answers to the following questions are sought:

1. How many warehouses should be operated now and in the future?

Table 2 Possible Public Warehouse Locations

No.	Location	No.	Location	No.	Location
23	Albuquerque, NM	32	Phoenix, AZ	41	Louisville, KY
24	Billings, MT	33	Richmond, VA	42	Columbus, OH
25	Denver, CO	34	St Louis, MO	43	New York, NY
26	El Paso, TX	35	Salt Lake City, UT	44	Hartford, CT
27	Camp Hill PA	36	San Antonio, TX	45	Miami, FL
28	Houston TX	37	Seattle, WA	46	Mobile, AL
29	Las Vegas NV	38	Spokane, WA	47	Memphis, TN P[a]
30	Minneapolis MN	39	San Francisco, CA	48	Chicago, IL P[a]
31	New Orleans LA	40	Indianapolis, IN		

[a]Prefers to warehouses at additional plant sites.

2. Where should they be located?
3. Which customers and associated demand should be assigned to each warehouse and plant?
4. Which warehouses should be supplied from each plant?
5. Should production capacity be expanded? When, where, and by how much?
6. What level of customer service should be provided?

SALES DATA

Manufacturing of soap liquids and powders is an uncomplicated and easily duplicated process, which contributes to substantial competition in the marketplace. The undifferentiated nature of soap products results in keen competition in both price and service. Customer service is of particular concern because it is directly affected by the choice of warehouses. No specific dollar figure can be placed on the total value of good distribution service, as it depends on customer attitudes about service and resulting patronage. The general feeling in the company is that service should be maintained at a high level so as not to jeopardize sales. A "high" level of service is taken to mean delivery time of 24 to 48 hours or less. This generally places customers somewhere between 300 and 600 miles of warehouses.

Annual sales for the products that move through the warehousing network are 147 million pounds for annual revenue of slightly more than $100 million. Sales are distributed similarly to population centers with an average profit margin of 20 percent. Figure 1 shows the six major sales territories, with sales volume in pounds by state. The company has more than 70,000 individual customer accounts, and these are aggregated into 191 active demand centers. A demand center is a grouping of zip code areas into a zip sectional center as the focus of the collected demand. These demand centers, along with how they are currently being served, are given in Table 3. In addition, the sales territory in which the demand center is grouped is shown.

The five-year plan shows volume growth throughout the United States. This growth will not be uniform due to population and business migration patterns, competition, and varying promotional efforts. The changes in volume compared with current volume levels are projected by sales territory as follows:

Region No.	Sales Territory	Five-Year Growth Factor[a]
1	Northeast	1.30
2	Southeast	1.45
3	Midwest	1.25
4	Northwest	1.20
5	Southwest	1.15
6	West	1.35

[a]Multipliers to the current sales volume.

PRODUCTION COSTS AND CAPACITIES

The production variable costs at existing plants vary by location. This variance results from labor rate differences, volume purchases of raw materials, and inbound transport cost differences due to the proximity of the plants to major raw materials sources. These costs are listed next.

Plant	Variable Production Cost
Covington, KY	$21.0
New York, NY	19.9
Arlington, TX	21.6
Long Beach, CA	21.1

The potential plant at Chicago has an estimated cost of $21.0 per cwt.; and the Memphis plant has a cost of $20.6 per cwt. Expansion at any existing plant site would have the current variable cost. Fixed costs are not included for existing plants because these are sunk costs. However, to construct a new plant or expand an existing one would cost a minimum of

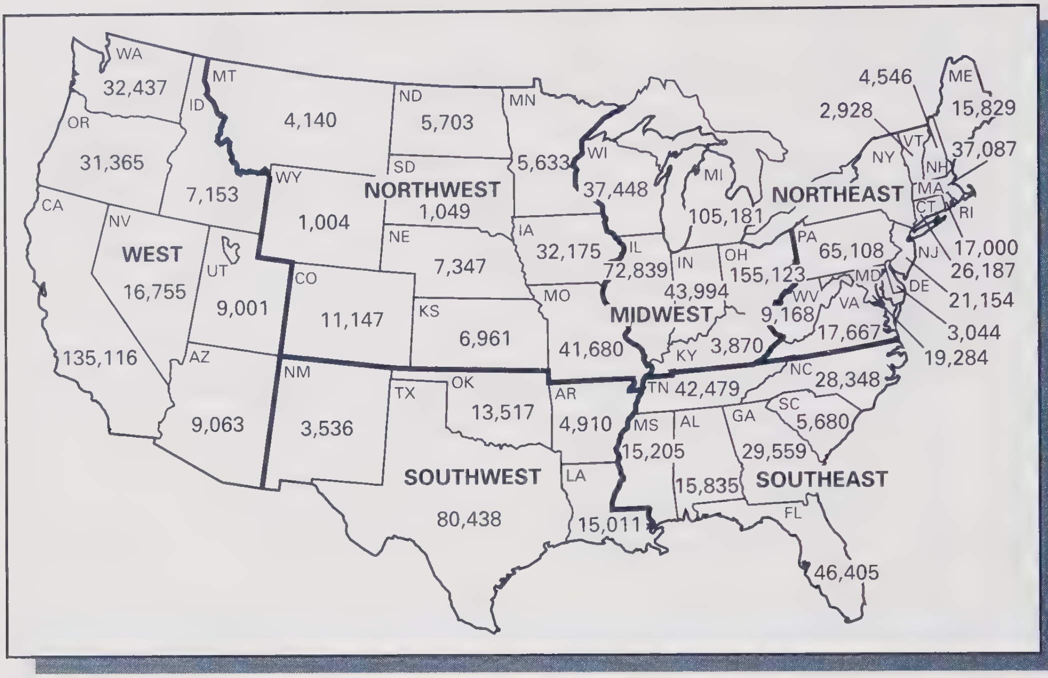


Figure 1 Usemore Soap Company Annual Sales in Cwt. by State, with Major Sales Districts Defined

$4 million. This cost would result in an output for the plant (or an output increase in the case of a plant addition) of up to 1 million cwt. per year for the near future.

According to current distribution patterns, the existing plants are producing, relative to throughput capacity (in cwt.), at the following rates:

Plant	Current Capacity	Current Production	Percent of Capacity
Covington, KY	620,000 cwt.	595,102 cwt.	96%
New York, NY	430,000	390,876	91
Arlington, TX	300,000	249,662	83
Long Beach, CA	280,000	241,386	86%
Total	1,630,000	1,477,026	91

WAREHOUSING RATES AND CAPACITIES

Company contracts with public warehousemen show that rates are categorized as storage, handling, and accessorial. Storage rates are quoted on a $/cwt./month basis of average inventory held. Handling charges are incurred whenever in or out movement of the product occurs and are assessed on a $/cwt. basis. Accessorial charges are for a number of services, such as bill of lading preparation, local delivery, and stock status reporting. Similar charges are estimated for the four plant warehouses as a fair share of production operations.

Also associated with warehousing are the stock replenishment costs. These are costs for preparing the paperwork for normal replenishment and the expediting of stock into the warehouse. Stock order costs as well as customer order costs are computed by multiplying the average cost per order by the average number of orders for the warehouse.

The warehouse-related costs and other associated information are given in Table 3. Costs for existing points are taken from company records. Those for potential warehouses are determined from quotas by warehousemen in the appropriate cities. Estimates are made of costs where such information is not otherwise available.

There are no effective capacity limits on public warehousing. Usemore's space need is a small fraction of a public warehouseman's total capacity. On the other hand, a throughput of at least 10,400 cwt. per year, or a replenishment truckload every two weeks, is the desired minimum throughput needed to open a warehouse. Available space is limited at the four current plant sites. The stocking limits in terms of throughput at Covington = 450,000 cwt., New York = 380,000 cwt., Arlington = 140,000 cwt., and Long Beach = 180,000 cwt.

TRANSPORTATION COSTS

Three general transportation cost types are important to Usemore: inbound, outbound, and local delivery transport charges. Inbound transportation costs to a warehouse depend on the volume shipped and the distance between plant and warehouse. A sampling of truck common carrier rates at various distances from the plants for full truckload shipments shows that the transport rate between a plant and warehouse (P-W) can be reasonably approximated by a linear function. That is, the truckload rate is

$$\text{P-W rate (\$/cwt.)} = 0.92 + 0.0034d \text{ (miles)}$$

where d is the distance between the two points.[2] Total inbound transport costs are determined by multiplying the P-W rate by the volume assigned to flow between the plant and warehouse.

Warehouse outbound transport costs depend on the distance that a customer is from the warehouse. If the customer is roughly within 30 miles of the warehouse, local cartage rates generally apply. These local delivery rates are shown by warehouse in Table 3. For distances greater than 30 miles, a linear function similar to that for the inbound rates can be developed. Given the average shipment size from the warehouses of approximately 1,000 pounds, the warehouse to customer (W-C) rate function is

$$\text{W-C rate (\$/cwt.)} = 5.45 + 0.0037d$$

Computation of total warehouse outbound transport costs is carried out in the same manner as for inbound transport costs.

INVENTORY COSTS

Inventory costs depend on the average inventory maintained at a warehouse and the inventory rate factors that apply to the inventory level. These rate factors include the cost of capital, personal property taxes, and insurance costs. The average inventory at a warehouse will vary by the demand on the warehouse and by the method used to control the inventory. A mathematical function to express inventory based on annual warehouse throughput is found by plotting the annual average inventory against annual throughput at each active stocking point. The resulting curve is shown in Figure 2. Knowing that the annual cost-to-carry-inventory rate is approximately 12 percent of the average product value of \$26 per cwt., the total cost to carry inventory at each warehouse is given by

$$IC_i = (0.12)(26)(11.3D_i^{0.58}) = 35.3D_i^{0.58}$$

where

IC_i = annual inventory carrying cost at warehouse i (\$)
D_i = annual demand throughput at warehouse i (cwt.)

[2]For simplicity, one aggregated relationship is shown. In practice, several such relationships would be used to reflect the rate difference caused by geographic locations of the shipment origin points.

Table 3 Stocking Point Rate and Order Size Information

Whse No.	Storage ($/$)[a]	Handling ($/cwt.)[b]	Stock Order Processing ($/order)	Stock Order Size (cwt./order)	Customer Order Processing ($/order)	Customer Order Size (cwt./order)	Local Delivery Rate[c] ($/cwt.)
1	0.0672	0.46	18	400	1.79	9.05	1.90
2	0.0567	0.54	18	400	1.74	10.92	3.89
3	0.0755	0.38	18	400	2.71	11.59	2.02
4	0.0735	0.59	18	400	1.74	11.30	4.31
5	0.0946	0.50	18	401	0.83	9.31	1.89
6	0.1802	0.75	18	405	3.21	9.00	4.70
7	0.0946	0.74	18	405	1.23	8.37	1.55
8	0.2072	1.14	18	405	1.83	13.46	1.79
9	0.1802	1.62	18	409	4.83	9.69	4.92
10	0.1442	1.14	18	410	2.74	8.28	2.23
11	0.0946	1.04	18	409	3.93	10.20	1.81
12	0.1982	1.06	18	410	3.18	15.00	1.00
13	0.0766	1.06	18	400	1.08	9.07	1.63
14	0.1262	1.22	18	423	1.56	11.72	1.17
15	0.1126	0.82	18	426	1.20	9.35	1.73
16	0.0991	0.64	18	433	1.78	8.70	0.50
17	0.1577	0.71	18	394	5.33	8.07	1.46
18	0.1307	0.79	18	398	0.91	7.66	2.29
19	0.1487	1.15	18	399	2.08	9.39	2.20
20	0.2253	0.80	18	490	1.10	7.31	1.49
21	0.1370	1.39	18	655	1.70	9.31	2.72
22	0.0991	0.83	18	400	2.46	10.14	4.17
23	0.1260	0.59	18	110	2.33	5.07	2.37
24	0.0631	0.45	18	134	1.88	6.80	1.36
25	0.0946	1.68	18	341	2.58	6.83	2.21
26	0.1216	0.88	18	149	1.83	14.32	0.80
27	0.0721	0.55	18	198	1.83	7.38	3.88
28	0.1532	0.80	18	420	1.58	9.70	2.14
29	0.1172	1.04	18	287	0.78	7.52	1.51
30	0.1080	1.46	18	408	5.33	11.46	1.70
31	0.1487	0.95	18	340	1.36	10.48	1.63
32	0.1396	0.69	18	333	1.50	6.67	1.66
33	0.1126	0.64	18	277	2.33	11.98	1.54
34	0.1712	1.35	18	398	0.93	10.13	1.84
35	0.1261	0.79	18	434	2.08	6.81	1.58
36	0.1352	0.80	18	323	0.88	7.67	1.93
37	0.2704	0.96	18	423	0.89	8.57	3.08
38	0.2250	0.80	18	425	2.88	7.61	1.43
39	0.1487	1.49	18	400	1.46	7.55	6.44
40	0.2073	1.14	18	400	2.75	10.13	2.83

Whse No.	Storage ($/$)[a]	Handling ($/cwt.)[b]	Stock Order Processing ($/order)	Stock Order Size (cwt./order)	Customer Order Processing ($/order)	Customer Order Size (cwt./order)	Local Delivery Rate[c] ($/cwt.)
41	0.2073	1.14	18	400	2.75	10.13	2.83
42	0.1802	1.62	18	400	2.75	10.13	4.81
43	0.2613	1.39	18	400	2.71	11.59	3.89
44	0.1396	0.71	18	400	2.04	9.37	3.89
45	0.1036	0.55	18	400	2.75	10.13	1.74
46	0.0946	0.55	18	400	1.74	9.31	1.89
47	0.0682	0.64	18	400	1.78	8.70	0.50
48	0.0682	1.22	18	400	1.79	9.05	1.55

[a]Annual rate in $ per $ of average inventory in the warehouse.
[b]Annualized rate for moving 1 cwt. in and out of the warehouse.
[c]A transport rate that applies to customer shipments within 30 miles of a stocking point.

WAREHOUSE OPERATING COSTS

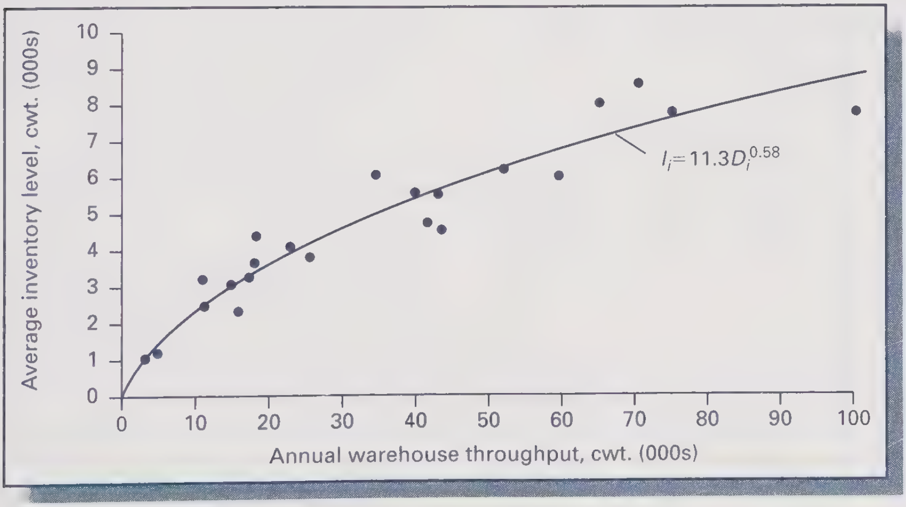
Warehouse operating costs refer to the combination of storage and handling costs incurred resulting from assigning demand to warehouses. Storage costs are computed by taking the storage rate and multiplying it by an estimate of the average inventory in the warehouse. Mathematically, this can be expressed as

$$SC_i = SR_i(26)(11.3D_i^{0.58})$$

where

SC_i = annual cost of stock storage at warehouse i ($)
SR_i = storage rate from warehouse i from Table 4
D_i = annual demand throughput at warehouse i (cwt.)

Figure 2 The Inventory-to-Warehouse Throughput Relationship for the Usemore Soap Company



Warehouse to Customer Distance	Percent of Demand	Cumulative Percent of Demand	Total Demand (cwt.)
0–100 mi.	56.4%	56.4%	833,043
101–200	21.3	77.7	314,607
201–300	15.7	93.4	231,893
301–400	2.1	95.5	31,018
401–500	1.5	97.0	22,155
501–600	0.5	97.5	7,385
601–700	2.0	99.5	29,541
701–800	0.5	100.0	7,384
801–900	0.0	100.0	0
901–1000	0.0	100.0	0
> 1000	0.0	100.0	0
	100.0%		1,477,026

Table 4 Benchmark Customer Service Profile

Handling costs are strictly a function of the warehouse throughput. They are determined by the handling rate multiplied by the throughput, or

$$HC_i = (HR_i)D_i$$

where

HC_i = annual handling cost at warehouse i ($)

HR_i = handling rate at warehouse i from Table 4

ORDER-PROCESSING COSTS

Order-processing costs refer to the charges incurred in handling the paperwork associated with stock replenishment and customer orders. Both types of costs are computed for each warehouse in essentially the same way. That is, the order-processing rate is multiplied by the annual demand on the warehouse and the result divided by the order size.

TOTAL COSTS

The total costs for various production distribution configurations can be determined by summing all the relevant costs. For the Usemore Soap Company, these are production costs; warehouse operating costs (storage, handling, stock order processing, and customer order processing); transportation costs (warehouse inbound, outbound, and local delivery); and inventory-carrying costs. Changing the number and location of plants and warehouses will cause a change in the balance of these cost factors. For example, adding warehouses will typically reduce transportation costs but increase inventory costs, as well as affect customer service. Assessing the trade-offs between costs and customer service is at the heart of this problem type.

The cost and customer service summaries for the current network design are shown in Tables 4 and 5. At present, Usemore Soap is able to place 93 percent of its demand within 300 miles of warehouses for a total annual cost of $42,112,463.

A COMPUTER-ASSISTED ANALYSIS

Although enough data have been provided to carry out an analysis manually, a computer program (WARELOCA, a module in LOGWARE) accompanies this case study. Given a particular combination of plants, plant capacities,

Table 5
Cost Profile for the Current Distribution Network

Cost Category	Cost
Production	$30,761,520
Warehouse operations	1,578,379
Order processing	369,027
Inventory carrying	457,290
Transportation:	
Inbound to warehouse	2,050,367
Outbound from warehouse	6,895,880
Total cost	$42,112,463

customer service constraints, and warehouses, the program optimally assigns demand centers to warehouses and warehouses to plants by means of linear programming. From the selected list of warehouses, the least expensive will be chosen if more than one choice is available within the prescribed service distance from a demand center. If a warehouse cannot be found within the service distance, the warehouse closest to the demand center will be selected.

Only linear variable costs are used in the allocation of demand centers to warehouses. Storage and capital costs, which are nonlinear, are not used in the allocation process. They are included in the system costs for a particular configuration. Fixed costs are neither included in the allocation, nor are they shown in the total system costs. They must be externally added to system costs.

WARELOCA is a program in which you provide the plant locations and capacities, warehouse locations, customer service distance, and demand and cost levels. Each run of the program represents an evaluation of a particular network configuration. The results of a sample WARELOCA run in which the current network is *approximated*[3] (not the true benchmark) where the existing 4 plants and 22 warehouses are evaluated are given in Figure 3. ■

Figure 3 WARELOCA Results for an Approximated Benchmark Run

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                    WARELOCA RESULTS

     SUMMARY OF ANALYSIS FOR
  22 POTENTIAL WAREHOUSE LOCATIONS

          -SYSTEM COSTS-
Production costs               $30,761,518
Warehouse operations             1,515,395
Order processing                   357,343
Inventory carrying                 447,282
Transportation costs
  Inbound to whse                2,354,017
  Outbound from whse             6,657,464
                               -----------
       Total costs             $42,093,020
```

[3]Plant capacities are set at current production levels, customer service set at 300 miles, and the current 22 warehouses are selected for evaluation.

Figure 3 (*cont.*)

CUSTOMER SERVICE PROFILE FOR A DESIRED
SERVICE DISTANCE OF 300 MILES

Distance from whse to customer (miles)			Percent of demand	Distance from whse to customer (miles)			Percent of demand
0	to	100	55.9	800	to	900	.0
100	to	200	18.2	900	to	1,000	.0
200	to	300	19.5	1,000	to	1,500	.0
300	to	400	1.8	1,500	to	2,000	.0
400	to	500	2.0	2,000	to	2,500	.0
500	to	600	.3	2,500	to	3,000	.0
600	to	700	2.0		>	3,000	.0
700	to	800	.4				
						Total	100.0

-PLANT THRUPUT AND COSTS-

Location	Thruput (cwt)	Production costs
COVINGTON KY	595,102	12,497,142
NEW YORK NY	390,876	7,778,432
ARLINGTON TX	249,662	5,392,699
LONG BEACH CA	241,386	5,093,244
MEMPHIS TN	0	0
CHICAGO IL	0	0
Totals	1,477,026	30,761,518

-WAREHOUSE THRUPUT AND COSTS-

Whse no.	Location	Thruput (cwt)	Whse Total, $	Storage	Handling	Capital
1	COVINGTON KY P	236,640	180,853	25,845	108,854	46,153
2	NEW YORK NY P	228,067	189,677	21,345	123,156	45,176
3	ARLINGTON TX P	104,081	86,246	18,033	39,550	28,662
4	LONG BEACH CA P	106,047	109,288	17,747	62,567	28,974
5	ATLANTA GA	46,949	55,775	14,239	23,474	18,062
6	BOSTON MA	49,350	83,524	27,919	37,012	18,592
7	BUFFALO NY	28,342	45,076	10,625	20,973	13,478
8	CHICAGO IL	87,860	170,997	44,858	100,160	25,979
9	CLEVELAND OH	0	0	0	0	0
10	DAVENPORT IA	13,068	33,837	10,337	14,897	8,602
11	DETROIT MI	82,999	131,269	19,815	86,318	25,135
12	GRD RAPIDS MI	17,330	45,238	16,736	18,369	10,132
13	GREENSBORO NC	31,832	57,362	9,203	33,741	14,417
14	KANSAS CITY KS	73,416	137,595	24,618	89,567	23,409
15	BALTIMORE MD	38,128	62,294	15,021	31,264	16,008
16	MEMPHIS TN	67,480	83,888	18,409	43,187	22,292
17	MILWAUKEE WI	28,121	51,015	17,632	19,965	13,417
18	ORLANDO FL	44,523	71,765	19,076	35,173	17,515
19	PITTSBURGH PA	21,553	50,534	14,249	24,785	11,499
20	PORTLAND OR	74,280	127,242	44,250	59,424	23,568
21	W SACRAMENTO CA	65,744	137,256	23,915	91,384	21,957
22	W CHESTER PA	31,216	51,936	11,772	25,909	14,255
	Totals	1,477,026	1,962,667	425,655	1,089,739	447,282

Whse no	Location	Order processing	Transport costs Inbound	Outbound
1	COVINGTON KY P	57,453	0	1,166,502
2	NEW YORK NY P	46,603	210,610	1,135,465
3	ARLINGTON TX P	29,020	96,128	511,022
4	LONG BEACH CA P	21,101	97,942	528,650
5	ATLANTA GA	6,293	112,810	212,015
6	BOSTON MA	19,794	82,324	261,289
7	BUFFALO NY	5,424	59,064	72,647
8	CHICAGO IL	15,850	168,091	276,774
9	CLEVELAND OH	0	0	0
10	DAVENPORT IA	4,898	30,896	74,424
11	DETROIT MI	35,631	154,332	173,983
12	GRD RAPIDS MI	4,434	34,705	46,545
13	GREENSBORO NC	5,222	71,933	129,723
14	KANSAS CITY KS	12,896	196,711	381,234
15	BALTIMORE MD	6,504	60,638	152,684
16	MEMPHIS TN	16,611	174,640	344,308
17	MILWAUKEE WI	19,857	62,954	42,548
18	ORLANDO FL	7,302	174,726	236,580
19	PITTSBURGH PA	5,746	45,302	47,416
20	PORTLAND OR	13,906	325,989	343,276
21	W SACRAMENTO CA	13,811	153,326	379,100
22	W CHESTER PA	8,977	40,887	141,269
	Totals	357,343	2,354,017	6,657,465

S Essen USA

Essen is a German candy company that produces and distributes chocolate and other types of candies throughout Europe and the United States. For the U.S. market, the candies are manufactured in Essen, Germany, and shipped through the port at Amsterdam in the Netherlands. The product enters the United States through a port in New Jersey and is stored in a warehouse in Edison, New Jersey. From this central warehouse, the product is redistributed to the warehouses (there are many of these) of the purchasing companies that in turn ship it to their retail outlets (there are many of these). These buyers typically are large retailers such as Wal-Mart, Walgreens, and Giant Eagle, as well as many small retailers that purchase through distributors. Essen's supply channel is shown in Figure 1. Essen's distribution cost and customer service are affected by the product flow throughout the entire supply chain. Although Essen directly controls only a portion of the supply chain, good planning of the entire supply chain may benefit Essen, its buyers, and, ultimately, the customers. Essen may be able to influence its customers through price-quantity discounts and other incentives, if it can estimate the effect that these might have on its downstream channel members.

SALES

Essen had annual sales to its customers (level 2) of about $80 million in the United States on 36 million pounds of candies. Sales at retail (level 1)