Business Logistics/ Supply Chain Management

Planning, Organizing, and Controlling the Supply Chain

Fifth Edition

Instructor's Manual

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CONTENTS

Preface		iii
Chapter 1	Business Logistics/Supply Chain—A Vital Subject………	1
2	Logistics/Supply Chain Strategy and Planning……………	2
3	The Logistics/Supply Chain Product...……………………	4
4	Logistics/Supply Chain Customer Service…..……………	9
5	Order Processing and Information Systems……………….	13
6	Transport Fundamentals…………………………………..	14
7	Transport Decisions……………………………………….	17
	Fowler Distributing Company…………………………..	35
	Metrohealth Medical Center…………………………….	41
	Orion Foods, Inc……………………………...............	48
	R & T Wholesalers……………………………………...	52
8	Forecasting Supply Chain Requirements…………….……	65
	World Oil………………………………………………..	84
	Metro Hospital …………………………………………	88
9	Inventory Policy Decisions………………………………..	94
	Complete Hardware Supply, Inc….……………………..	121
	American Lighting Products…………………………….	124
	American Red Cross: Blood Services…………………..	131
10	Purchasing and Supply Scheduling Decisions…………….	134
	Industrial Distributors, Inc………………………………	144
11	The Storage and Handling System………………………...	147
12	Storage and Handling Decisions…………………………..	148
13	Facility Location Decisions……………………………….	162
	Superior Medical Equipment	186
	Company………………...	190
	Ohio Auto & Driver's License Bureau………………….	198
	Southern Brewery ………………………………………	
14	The Logistics Planning Process…………………………...	204
	Usemore Soap	208
	Company…………………….……………..	217
	Essen USA…………………….……………..	
15	Logistics/Supply Chain Organization…………………….	229
16	Logistics/Supply Chain Control……………..…………….	230

PREFACE

This instructor's guide provides answers to the more quantitatively oriented problems at the end of the textbook chapters. If the questions or problems are for discussion or they involve a substantial amount of individual judgment, they have not been included.

Solutions to the cases and exercises in the text are also included. These generally require computer assistance for solution.

With the text, you are provided with a collection of software programs, called LOGWARE, that assist in the solution of the problems, cases, and exercises in the text. The LOGWARE software along with a user's manual is available for downloading from the Prentice Hall website or this book. The user's manual is in Microsoft Word or Acrobat .pdf formats. This software, along with the user's manual, may be freely reproduced and distributed to your classes without requiring permission from the copyright holder. This permission is granted as long as the use of the software is for educational purposes. If you encounter difficulty with the software, direct questions to

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CHAPTER 1
BUSINESS LOGISTICS/SUPPLY CHAIN—A VITAL SUBJECT

12

(a) This problem introduces the student to the evaluation of alternate channels of production and distribution. To know whether domestic or foreign production is least expensive, the total of production and distribution costs must be computed from the source point to the marketplace. Two alternatives are suggested, and they can be compared as follows.

Production at Houston:

Total cost = Production cost at Houston + Transportation and storage costs

= \$8/shirt×100,000 shirts + \$5/cwt. ×1,000 cwt.

= \$805,000/year

Production at Taiwan:

Total cost = Production cost in Taiwan

+ Transportation and storage costs from Taiwan to Chicago

+ Import duty + Raw material transportation cost from Houston to Taiwan

= \$4/shirt×100,000 shirts + \$6/cwt. ×1,000 cwt. + \$0.5/shirt×100,000 shirts + \$2/cwt. ×1,000 cwt.

= \$458,000/year

Producing in Taiwan would appear to be the least expensive.

(b) Other factors to consider before a final decision is made might be:

(i) How reliable would international transportation be compared with domestic transportation?

(ii) What is the business climate in Taiwan such that costs might change in favor of Houston as a production point?

(iii) How likely is it that the needed transportation and storage will be available?

(iv) If the market were to expand, would there be adequate production capacity available to support the increased demand?

CHAPTER 2
LOGISTICS/SUPPLY CHAIN STRATEGY AND PLANNING

13

The purpose of this exercise is to allow the student, in an elementary way, to examine the tradeoffs between transportation and inventory-related costs when an incentive transportation rate is offered. Whether the incentive rate should be implemented depends on the shipment size corresponding to the minimum of the sum of transportation, inventory, and order processing costs. These costs are determined for various shipping quantities that might be selected to cover the range of shipment sizes implied in the problem. Table 2-1 gives a summary of the costs to Monarch for various shipment sizes.

From Monarch's point of view, the incentive rate would be beneficial. Shipment sizes should be approximately doubled so that the 40,000 lb. minimum is achieved. It is important to note that the individual cost elements are not necessarily at a minimum at low shipment sizes, whereas order-processing costs are low at high shipment sizes. They are in cost conflict with each other. Transportation costs are low at high shipment sizes, but exact costs depend on the minimum volume for which the rate is quoted.

In preparation for a broader planning perspective to be considered later in the text, the student might be asked what the place of the supplier is in this decision. How does he affect the decision, and how is he affected by it? This will focus the student's attention on the broader issues of the physical distribution channel.

TABLE 2-1 Evaluation of Alternative Shipment Sizes for the Monarch Electric Company

	Current			*Proposed*	
Type of cost	*57 motors or 10,000 lb.*	*114 motors or 20,000 lb.*	*171 motors or 30,000 lb.*	*228 motors or 40,000 lb.*	*285 motors or 50,000 lb.*
Transportation	9×8,750	5×8,750	5×8,750	3×8,750	3×8,750
R×D	= $78,750	= $43,750	= $43,750	= **$26,250**[a]	= $26,250
Inventory carrying[b]	0.25×200×57/2	0.25×200×114/2	0.25×200×171/2	0.25×200×228/2	0.25×200×285/2
I×C×Q/2	= **$1,425**[a]	= $2,850	= $4,275	= $5,700	= $7,125
Order processing[c]	5,000×15/57	5,000×15/114	5,000×15/171	5,000×15/228	5,000×15/285
D×S/Q	= $1,316	= $658	= $439	= $329	= **$263**[a]
Handling	0.30×8,750	0.30×8,750	0.30×8,750	0.30×8,750	0.30×8,750
H×D	= $2,625	= $2,625	= $2,625	= $2,625	= $2,625
Total	$84,116	$49,883	$51,089	**$34,904**[a]	$36,263

[a] Minimum values.
[b] Students should be informed that average inventory can be approximated by one half the shipment size.
[c] Demand *D* has been converted to units per year.

LEGEND

R = transportation rate, $/cwt.
D = annual demand, cwt.
I = inventory carrying cost, %/year.
C = cost of a motor, $/motor.
Q = shipment size in motors, where Q/2 represents the average number of motors maintained in inventory.
S = order processing costs, $/order.
H = handling costs, $/cwt.

CHAPTER 3

THE LOGISTICS/SUPPLY CHAIN PRODUCT

3

The 80-20 principle applies to sales and items where 80 percent of the dollar volume is generated from 20 percent of the product items. While this ratio rarely holds exactly in practice, the concept does. We can apply it to these data by ranking the products by sales, and the percentage that the cumulative sales represent of the total. The following table shows the calculations.

Product code	*Dollar sales*	*Cumulative sales*	*Cumulative sales as % of total*	*Cumulative items as % of total*
08776	**$71,000**	**$ 71,000**	**18.2**	**8.3**
12121	**63,000**	**134,000**	**34.3**	**16.7**
10732	56,000	190,000	48.6	25.0
11693	51,000	241,000	61.6	33.3
10614	46,000	287,000	73.4	41.7
12077	27,000	314,000	80.3	50.0
07071	22,000	336,000	85.9	58.3
10542	18,000	336,000	90.5	66.7
06692	14,000	354,000	94.1	75.0
09721	10,000	368,000	96.7	83.3
14217	9,000	378,000	98.9	91.7
11007	4,000	391,000	100.0	100.0
Total	$391,000			

The 80-20 rule cannot be applied exactly, since the cumulative percent of items does not break at precisely 20 percent. However, we might decide that only products 08776 and 12121 should be ordered directly from vendors. The important principle derived from the 80-20 rule is that not every item is of equal importance to the firm, and that different channels of distribution can be used to handle them. The 80-20 rule gives some rational basis for deciding which products should be shipped directly from vendors and which are more economically handled through a system of warehouses.

6

(a) Reading the ground transport rates for the appropriate zone as determined by zip code and the weight of 27 lb. (rounding upward of 26.5 lb.) gives the following total cost table for the four shipments.

To zip code	*Catalog price*	*UPS zone*	*Transport cost*[a]	*Total cost*
11107	$99.95	2	$ 7.37	$107.32
42117	99.95	5	10.46	110.41
74001	99.95	6	13.17	113.12
59615	99.95	8	18.29	118.24

[a] Use 27 lb.

(b) The transport rate structure is reasonably fair, since ground rates generally follow distance and size of shipment. These are the factors most directly affecting transport costs. They are not fair in the sense that customers within a zone are all charged the same rate, regardless of their distance from the shipment origin point. However, all customers may benefit from lower overall rates due to this simplified zone-rate structure.

10

(a) This is a delivered pricing scheme where the seller includes the transport charges in the product price. The seller makes the transport arrangements.

(b) The seller prices the product at the origin, but prepays any freight charges; however, the buyer owns the goods in transit.

(c) This is a delivered pricing scheme where the freight charges are included in the product price, however the freight charges are then deducted from the invoice, and the seller owns the goods in transit.

(d) The seller initially pays the freight charges, but they are then collected from the buyer by adding them to the invoice. The buyer owns the goods in transit, since the pricing is f.o.b. origin.

(e) The price is f.o.b. origin. The buyer pays the freight charges and owns the goods in transit.

Regardless of the price policy, the customer will ultimately pay all costs. If a firm does not consider outbound freight charges, the design of the distribution system will be different than if it does. Since pricing policy is an arbitrary decision, it can be argued that transport charges should be considered in decision making, whether the supplying firm directly incurs them or not.

11

This shows how Pareto's law (80-20 principle) is useful in estimating inventory levels when a portion of the product line is to be held in inventory. An empirical function that approximates the 80-20 curve is used to estimate the level of sales for each product to be held in inventory. According to Equation 3-2, the constant A is determined as follows.

$$A = \frac{X(1-Y)}{Y-X} = \frac{0.25(1-.75)}{0.75-0.25} = 0.125$$

The 80-20 type curve according to Equation 3-1 is:

$$Y = \frac{(1+A)}{A+X} = \frac{(1+0.125)X}{0.125+X}$$

This formula can be used to estimate the cumulative sales from the cumulative item proportion. For example, item 1 is 0.05 of the total number of items (20) so that:

$$Y = \frac{(1+0.125)(0.05)}{0.125+0.05} = 0.321$$

Of the $2,600,000 in total annual warehouse sales, item 1 should account for 0.321×2,600,000 = $835,714.

By applying this formula to all items, the following inventory investment table can be developed which shows sales by item. The average inventory investment by item is found by dividing the turnover ratio into the item sales. The sum of the average inventory value for each item gives a total projected inventory of $380,000.

Inventory Investment Table

Pro-duct		*Cumulative item pro-portion, X*	*Cumulative sales, Y*	*Projected item sales*	*Turnover ratio*	*Average inventory value*
1		0.05	$ 835,714	$ 835,714	8	$104,464
2	*A*	0.10	1,300,000	464,286	8	58,036
3		0.15	1,595,454	295,454	8	36,932
4		0.20	1,800,000	204,546	8	25,568
5		0.25	1,950,000	150,000	6	25,000
6		0.30	2,064,705	114,706	6	19,118
7	*B*	0.35	2,155,263	90,558	6	15,093
8		0.40	2,228,571	73,308	6	12,218
9		0.45	2,289,130	60,559	6	10,093
10		0.50	2,340,000	50,870	6	8,478
11		0.55	2,383,333	43,333	4	10,833
12		0.60	2,420,689	37,356	4	9,339
13		0.65	2,453,226	32,537	4	8,134
14		0.70	2,481,818	28,592	4	7,148
15	*C*	0.75	2,507,142	25,324	4	6,331
16		0.80	2,529,719	22,587	4	5,647
17		0.85	2,550,000	20,271	4	5,068
18		0.90	2,568,293	18,293	4	4,473
19		0.95	2,584,884	16,591	4	4,148
20		1.00	2,600,000	15,116	4	3,779
					Total	$380,000

12

This problem involves the application of Equations 3-1 and 3-2. We can develop an 80-20 curve based on 30 percent of the items accounting for 70 percent of sales. That is,

$$A = \frac{X(1-Y)}{Y-X} = \frac{0.30(1-0.70)}{0.70-0.30} = 0.225$$

Therefore, the sales estimating equation is:

$$Y = \frac{(1+0.225)X}{0.225+X}$$

By applying this estimating curve, we can find the sales of *A* and *B* items. For example, 20 percent of the items, or 0.2×20 = 4 items, will be *A* items with a cumulative proportion of sales of:

$$Y_A = \frac{(1+0.225)(0.20)}{0.225+0.20} = 0.5765$$

and 3,000,000×0.5765 = 1,729,412.

The *A*+*B* item proportion will be:

$$Y_{A+B} = \frac{(1+0.225)(0.50)}{0.225+0.50} = 0.8448$$

and 3,000,000×0.8448 = 2,534,400. The product group *B* sales will *A*+*B* sales less *A* sales, or 2,534,400 − 1,729,412 = $804,988.

The product group *C* will be the remaining sales, but these are not of particular interest in this problem.

The average inventories for *A* and *B* products are found by dividing the estimated sales by the turnover ratio. That is,

A:	1,729,412/9	= 192,157
B:	804,988/5	= 160,988
Total inventory		353,155 cases

The total cubic footage required for this inventory would be 353,155×1.5 = 529,732 cu. ft. The total square footage for products *A* and *B* is divided by the stacking height. That is, 529,731/16 = 33,108 sq. ft.

13

This problem is an application of Equations 3-1 and 3-2. We first determine the constant *A*. That is,

$$A = \frac{X(1-Y)}{Y-X} = \frac{0.20(1-0.65)}{0.65-0.20} = 0.156$$

and

$$0.75 = \frac{(1+0.156)X}{0.156+X}$$

Solving algebraically for *X*, we have:

$$X = \frac{AxY}{1+A-Y} = \frac{0.156x0.75}{1+0.156-0.75} = 0.288$$

That is, about 29% of the items (0.288×5,000 = 1,440 items) produce 75% of the sales.

14

The price would be the sum of all costs plus an increment for profit to place the automotive component in the hands of the customer. This would be 25+10+5+8+5+transportation cost, or 53+*T*. Based on the varying transportation cost, the following price schedule can be developed.

Quantity	*Price per unit*	*Discount*
1 to 1,000 units	53+5=$58	0
1,001 to 2,000 units	53+4.00=57	1.7%[a]
>2,000 units	53+3.00=56	3.5%

[a] [(58 - 57)/58][100]=1.7%

CHAPTER 4

LOGISTICS/SUPPLY CHAIN CUSTOMER SERVICE

6

(a) This company is fortunate to be able to estimate the sales level that can be achieved at various levels of distribution service. Because of this, the company should seek to maximize the difference between sales and costs. These differences are summarized as follows.

	Percent of orders delivered within 1 day						
Contribution to	50	60	70	80	90	95	100
profit	-1.8	2.0	3.5	4.0	3.4	2.8	-2.0

The company should strive to make deliveries within 1 day 80 percent of the time for a maximum contribution to profit.

(b) If a competing company sets its delivery time so that more than 80 percent of the orders are delivered in 1 day and all other factors that attract customers are the same, the company will lose customers to its competitor, as the sales curve will have shifted downward. Cleanco should adjust its service level once again to the point where the profit contribution is maximized. Of course, there is no guarantee that the previous level of profits can be achieved unless the costs of supplying the service can correspondingly be reduced.

7

(a) This problem solution requires some understanding of experimental design and statistical inference, which are not specifically discussed in the text. Alert the students to this.

The first task is to determine the increase in sales that can be attributed to the change in the service policy. To determine if there is a significant change in the control group, we set up the following hypothesis test.

$$z = \frac{\overline{X}_2 - \overline{X}_1}{\sqrt{\dfrac{s_2^2}{N_2} + \dfrac{s_1^2}{N_1}}} = \frac{224 - 185}{\sqrt{\dfrac{61^2}{102} + \dfrac{79^2}{102}}} = \frac{39}{\sqrt{36.48 + 61.18}} = 3.94$$

Now, referring to a normal distribution table in Appendix A of the text, there is a significant difference at the 0.01 level in the sales associated with the control group. That is, some factors other than the service policy alone are causing sales to increase.

Next, we analyze the test group in the same manner.

$$z = \frac{2,295 - 1,342}{\sqrt{\frac{576^2}{56} + \frac{335^2}{56}}} = \frac{953}{\sqrt{5,924 + 2,004}} = 10.7$$

This change is also significant at the 0.01 level.

The average increase in sales for the control group is 224/185 = 1.21, or 21%. The average sales increase in the test group is 2295/1342 = 1.71, or 71%. If we believe that 21% of the 71% increase in the test group is due to factors other than service policy, then 71 – 21 = 50% was the true service effect. Therefore, for each sales unit, an incremental increase in profit of (0.40×95)(0.50) = \$19 can be realized. Since the cost of the service improvement is \$2, the benefit exceeds the cost. The service improvement should be continued.

Note: If the students are not well versed in statistical methodology, you may wish to instruct them to consider the before and after differences in the mean values of both groups as significant. The solution will be the same.

(b) The use of the before-after-with-control-group experimental design is a methodology that has been used for some time, especially in marketing research studies. The outstanding feature of the design is that the use of the control group helps to isolate the effect of the single service variable. On the other hand, there are a number of potential problems with the methodology:

- The sales distributions may not be normal.
- The time that it takes for diffusing the information that a service change has taken place may distort the results.
- The products in the control group may not be mutually exclusive from those in the test group.
- The method only shows the effect of a single step change in service and does not develop a sales-service relationship.
- It may not always be practical to introduce service changes into on-going operations to test the effect.

8

(a) The optimum service level is set at that point where the change in gross profit equals the change in cost.

The change in gross profit:

ΔP = Trading margin × Sales response rate × Annual sales
= 1.00×0.0015×100,000
= \$150 per year per 1% change in the service level

The change in cost:

ΔC = Annual carrying cost × Standard product cost × Δz

$\times$ Demand standard deviation for order cycle

$= 0.30 \times 10.00 \times 400 \times \Delta z$

Now, set $\Delta P = \Delta C$ and solve for Δz.

$$150 = 1200 \times \Delta z$$
$$\Delta z = 0.125$$

From the tabulated changes in service level with those changes in *z*, the service level should be set between 96-97%.

(b) The weakest link in this analysis is estimating the effect that a change in service will have on revenue. This implies that a sales-service relationship is known.

9

The methodology is essentially the same as that in question 7, except that we are asked to find *X* instead of *Y*. That is,

$$\Delta P = 0.75 \times 0.0015 \times 80{,}000$$
$$= 90$$

and

$$\Delta C = 0.25 \times 1{,}000 \times 500 \times \Delta z$$
$$= 1250 \times \Delta z$$

Then,

$$\Delta P = \Delta C$$
$$90 = 1250 \times \Delta z$$
$$\Delta z = 0.072$$

From the normal distribution (see Appendix A), the *z* for an area under the curve of 93% is 1.48, and for 92%, *z* is 1.41. Since the difference of 1.48 – 1.41 = 0.07, we can conclude that the in-stock probability should be set at 92-93%. Of course, the change in *z* is found by taking the difference in *z* values for 1% differences in the area values under the normal distribution curve for a wide range of area percentages.

10

Apply Taguchi's concept of the loss function. First, estimate the loss per item if the target level of service is not met. We know the profit per item as follows.

Sales price	\$5.95
Cost of item	-4.25
Other costs	-0.30
Profit per item	\$1.40

Since one-half of the sales are lost, the opportunity loss per item would be

Profit per item *Sales lost*

$$\text{Opportunity loss} = \frac{\$1.40 \times (1/2)(880)}{880} = \$0.70/\text{item}$$

Current sales

Next, find k in the loss function.

$$L = k(y - m)^2$$

out-of-stock % at point where ½ sales are lost

$$0.70 = k(10 - 5)^2$$

Target %

$$0.70 = k(25)$$

$$k = 0.03$$

Finally, the point where the marginal supply cost equals the marginal sales loss is

$$(y - 5) = \frac{B}{2k} = \frac{0.10}{2(0.03)} = 1.67\%$$

$$y = 1.67 + 5 = 6.67\%$$

The retailer should not allow the out-of-stock percentage to deviate more than 1.67%, and should not allow the out-of-stock level to fall below 1.67 + 5 = 6.67%.

CHAPTER 5
ORDER PROCESSING AND INFORMATION SYSTEMS

All questions in this chapter require individual judgment and response. No answers are offered.

CHAPTER 6
TRANSPORT FUNDAMENTALS

14

The maximum that the power company can pay for coal at its power plant location in Missouri is dictated by competition. Therefore, the landed cost at the power plant of coal production costs plus transportation costs cannot exceed $20 per ton. Since western coal costs $17 per ton at the mine, the maximum worth of transportation is $20 − $17 = $3 per ton. However, if the grade of coal is equal to the coal from the western mines, eastern coal can be landed in Missouri for $18 per ton. In light of this competitive source, transportation from the western mines is worth only $18 − $17 = $1 per ton.

15

Prior to transport deregulation, it was illegal for a carrier to charge shippers less for the longer haul than for the shorter haul under similar conditions when the shorter haul was contained within the longer one. To be fair, the practice probably should be continued.

If competitive conditions do not permit an increase in the rate to *Z*, then all rates that exceed $1 per cwt. on a line between *X* and *Z* should not exceed $1 per cwt. Therefore, the rate to *Z* is blanketed back to *Y* so that the rate to *Y* is $1 per cwt. By blanketing the rate to *Z* on intervening points, no intervening point is discriminated against in terms of rates.

16

(a) From text Table 6-4, the item number for place mats is 4745-00. For 2,500 lb., the classification is 100 since 2,500 lb. is less than the minimum weight of 20,000 lb. for a truckload shipment. From text Table 6-5, the rate for a shipment ≥2,000 lb. is 8727¢/cwt. The shipping charges are $87.27 × 25 cwt. = $2,181.75.

(b) This is an LTL shipment with a classification of 100, item number 4980-00 in text Table 6-4. From Table 6-5, the minimum charge is 9351¢ and the rate for a <500 lb. shipment is 5401¢/cwt. Check the charges using the <500 lb. rate and compare it to the minimum charge. That is,

$54.01 × 1.5 cwt. = $81.02

Since this is less than the minimum charge of $93.51, pay the minimum charge.

(c) From Table 6-4, the item number is 2055-00 with a classification of 55 for LTL and 37.5 for TL at a minimum weight of 36,000 lb. There are three possibilities that need to be examined:

(1) Ship LTL at class 55 and 27,000 lb. shipment.
(2) Ship at class 55 and 30,000 lb. rate.
(3) Ship at class 37.5 and 36,000 lb. rate.

Try (1): Rate is \$5.65/cwt. $5.65 \times 270 = \$1,525.50$.

Try (2): Rate is \$3.87/cwt. $3.87 \times 300 =$ **\$1,161.00** ← Lowest cost

Try (3): Rate is \$3.70/cwt. $3.70 \times 360 = \$1,332.00$

(d) The shipment is a truckload classification (2070-00) of 65. The rate at 30,000 lb. is \$4.21/cwt. The charges are $4.21 \times 300 = \$1,263.00$.

(e) Classification of this product is 55 (4860-00) for a truckload of 24,000 lb. Check the break weight according to Equation 6-1.

$$\text{Break weight} = \frac{3.87 \times 30{,}000}{5.65} = 20{,}549 \text{ lb.}$$

Since current shipping weight of 24,000 lb. exceeds the break weight, ship as if 30,000 lb. Hence, $3.87 \times 300 = \$1,161.00$. Now, discount the charges by 40 percent. That is,

$\$1,161 \times (1 - 0.40) = \$696.60$

21

The question involves evaluating two alternatives. The first is to compute the transport charges as if there are three separate shipments. The next is to see if a stop-off privilege offers any cost reduction. The comparison is shown below.

Separate shipments

Loading/unloading	*Route*	*Rate, \$/cwt.*	*Stop-off charge*	*Charges*
22,000	A to D	\$3.20	---	\$704.00
3,000	A to C	2.50	---	75.00
15,000	B to C	1.50	---	225.00
			Total charges	\$1,004.00

With stop-off

Ship direct to *B* and split deliver thereafter.

Loading/unloading	*Route*	*Rate, \$/cwt.*	*Stop-off charge*	*Charges*	
25,000	A to B	\$1.20		\$ 300.00	Direct shipment
40,000	B to D	2.20		880.00	
Stop-off @ C		\$25.00		25.00	
Stop-off @ D		25.00		25.00	
			Total charges	\$1,230.00	