Fall 9-1-2001

MBA 650.01: Quantitative Analysis

Gary Cleveland
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MBA 650
QUANTITATIVE ANALYSIS
COURSE OUTLINE–FALL 2001

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Course Objectives and Approach
MBA 650 provides a balanced overview of the Management Science methods. Management Science (or quantitative analysis) provides structured support models for managerial decision making. It uses the scientific approach to decision making. This course addresses the assumptions and limitations underlying the scientific approach and emphasizes its importance in both profit and nonprofit organizations.

MBA students will be imbued with the competence to effectively use the most common quantitative models, i.e., linear programming, decision theory, decision trees, queuing theory, and simulation. They will learn that qualitative as well as quantitative factors influence the solutions to most problems. Thus, managers should use the quantitative models to help them make decisions, not to make their decisions for them. An understanding of all the factors that apply to the decision-making situation will enable students to comprehend and critically evaluate quantitative presentations and publications.

The course stresses teamwork. Students will be organized into teams and assigned to work in real-world environments. Using *QM for Windows* (or *Excel*), students will integrate theory with practice. Students will learn to define a problem, formulate an appropriate model, use the model to solve the problem, and then analyze the resulting solution. During preparation of the subsequent managerial reports, they will practice their interpersonal skills and present their findings to the class.

Required Material
Render & Stair, *Quantitative Analysis for Management*, Prentice Hall, 1999 (7th Ed.), with *QM for Windows* software.

Grading
Letter grades for the course will be based on performance in the following areas:

Three Group Case Study (16% each)	48%
Midterm Exam	26%
Final Exam	26%
	100%

Group Cases
There will be three group cases. Each case will require a managerial report complete with technical appendixes. Although it may be difficult to work in groups, the benefits outweigh the costs. This is so because group work is an excellent way for students to learn the course material, practice communicating and negotiating, and develop project management skills.

Each group will consist of approximately five students. The groups will be formed on the first day of class. They will remain together for the entire course. A student who is unable to participate in the preparation and/or presentation of a particular case must negotiate an equitable trade-off with the other members of his/her group.

Case Presentations
Oral communications skills are critical to success . . . but how are these skills developed? PRACTICE - - FEEDBACK - - PRACTICE! Each group will deliver one 15 - 20 minute presentation in front of the class. The instructor will assign a presentation to each group on the first day of class.

Exams
The midterm and final exams will cover the material presented in class and assigned as homework. They may contain problems, short essays, and/or multiple-choice questions.

Guidelines for Cases
The cases are *Red Brand Canners*, *Hollingsworth Paper Company*, and *Drink-At-Home, Inc.* The written reports must be typewritten with a maximum of four double-spaced pages. The page limitation is intentional; it's an exercise in discipline. Make your words count. Remember: good reports are short reports. Up to four additional pages may be added as technical appendixes, charts and graphs. The reports must be organized according to the attached "Format and Guidelines for Written Reports."

Red Brand Canners (attached):
This case is a good exercise in the use of relevant information, particularly sunk costs. It provides you with the opportunity to formulate and solve a linear program, interpret the resulting computer output, and use shadow prices to decide whether to purchase additional tomatoes.

The main issue is how to allocate 3-million pounds of tomatoes. Your objective is to maximize profits, i.e., total sales less production and selling costs. In setting up the constraints, you must satisfy grade, demand and quality requirements. Formulate the problem and solve it using QM for Windows. List the assumptions you made during the analysis.

Another issue: Should you buy an additional 80,000 pounds of grade A tomatoes? This would increase the amount of grade A tomatoes from 600,000 pounds to 680,000 pounds. To answer the question you could reformulate the problem by modifying the appropriate constraints and objective function coefficients, but there's a better way. Use sensitivity analysis and the shadow price to determine the value of purchasing the additional tomatoes at 8.5 cents per pound.

Hollingsworth Paper Company (attached):
Hollingsworth is contemplating a capacity expansion, either by building a new plant or expanding an existing one. The company is motivated by a desire to reduce the costs incurred by manufacturing and the distribution network. Formulate the problem as a transportation algorithm and solve it using QM for Windows. List the assumptions made during your analysis.

The transportation algorithm is widely used in the design of production-distribution systems. However, the algorithm is only a part of the overall analysis. When evaluating potential benefits, the algorithm will help you to determine what annual cost reductions actually exist within the present production-distribution system. Some costs are not immediately available, but can be inferred from the information given in the text. The expansion at St. Louis involves mixing old and new capacities at one location. Use the algorithm to mix these capacities in a reasonable way. Fixed costs occur in the cost structure; although they can't be incorporated explicitly in the algorithm, they should be recognized during the analysis.

The algorithm will help you make decisions, but should not make your decisions for you. Intangible factors must be considered as well. What are the implications of closing a plant? What are the risks involved in building a plant in an unfamiliar location? Remember: The algorithm is used mainly to estimate potential cost savings, not to specify actual shipment quantities.

Drink-At-Home, Inc. (attached)
The company is developing a new beverage. At what pace should it proceed? You must develop an introduction strategy by enumerating the various alternatives and their consequences. Sort out the elements of the decision-making situation. The problem contains explicit and implicit contingencies that make it quite suitable for decision tree analysis.

Perform a sensitivity analysis on the optimal decision. Some of the data in the text may sound speculative, but don't worry about its precision. Instead, determine whether the decision is sensitive to certain costs and probabilities. To some extent, you can identify the costs and probabilities to which the decision is most sensitive.

SYLLABUS, FALL 2001 (TENTATIVE) - - SECTION 01

Class	Discussion Topic	Reading Assignment	Discussion Questions and Problems
10-9	Introduction to Quantitative Analysis	Chapter 1	DQ8, 10, 11, 12
10-11	Linear Programming: Graphical Method	Chapter 7	P14, 15, 18, 19, 21, 34
10-16	LP: Simplex Method	Chapter 9	P15, 27
10-18	LP: Simplex Method	Chapter 9	P25, 29
10-23	LP: Complications	Chapter 7 Chapter 9	P27 P20, 21, 22
10-25	LP: Sensitivity Analysis	Chapter 9	P31
10-30	LP: Sensitivity Analysis LP: Computer Analysis Integer Programming	Chapter 9 Chapter 8 Chapter 11	P33, 34 P1, 4, 6, 9 P15, 23, 24
11-1	**Case No. 1 Due (11-1, Class)** **Case No. 1 Presentations**		
11-6	Transportation Problem	Chapter 10	P14, 16
11-8	**Midterm Exam**		
11-13	Transportation Problem	Chapter 10	P12, 13
11-15	Transportation Problem Assignment Problem	Chapter 10 Chapter 10	P17, 18, 25, 26 P27, 28, 31
11-20	Decision Theory	Chapter 3	P11, 12, 19, 29, 30
11-27	**Case No. 2 Due (11-27, Class)** **Case No. 2 Presentations**		
11-29	Decision Trees	Chapter 4	P12, 13, 14, 15, 16
12-4	Waiting Lines and Queuing Theory	Chapter 14	P10, 14, 17, 19, 20
12-6	Waiting Lines and Queuing Theory	Chapter 14	P21, 22, 24, 26, 27
12-11	Simulation Modeling	Chapter 15	P15
12-13	**Case No. 3 Due (12-13, Class)** **Case Presentations**		

Final Exam: Monday, 17 December, 10:10 a.m.–12:10 p.m.

SYLLABUS, FALL 2001 (TENTATIVE) - - SECTION 60

Class (Location)	Discussion Topic	Reading Assignment	Discussion Questions and Problems
10-9	Introduction to Quantitative Analysis	Chapter 1	DQ8, 10, 11, 12
(Missoula)	Linear Programming: Graphical Method	Chapter 7	P14, 15, 18, 19, 21, 34
10-16 (Billings)	LP: Simplex Method	Chapter 9	P15, 25, 27, 29
10-23	LP: Complications	Chapter 7	P27
(Kalispell)	LP: More Complications	Chapter 9	P20, 21, 22
	LP: Sensitivity Analysis	Chapter 9	P31
10-30	LP: Sensitivity Analysis	Chapter 9	P33, 34
(Missoula)	LP: Computer Analysis	Chapter 8	P1, 4, 6, 9
	Integer Programming	Chapter 11	P15, 23, 24
	Case No.1 Due (10-30, Noon, GBB309)		
	Case No. 1 Presentations		
11-6	Transportation Problem	Chapter 10	P14, 16
(Missoula)			
11-13	**Midterm Exam**		
(Butte)	Transportation Problem	Chapter 10	P12, 13, 17, 18, 25, 26
	Assignment Problem	Chapter 10	P27, 28, 31
11-20	**Case No. 2 Due (11-20, Noon, GBB309)**		
(Missoula)	**Case No. 2 Presentations**		
	Decision Theory	Chapter 3	P11, 12, 19, 29, 30
11-27	Decision Trees	Chapter 4	P12, 13, 14, 15, 16
(Missoula)	Waiting Lines and Queuing Theory	Chapter 14	P10, 14, 17, 19, 20
12-4	Waiting Lines and Queuing Theory	Chapter 14	P21, 22, 24, 26, 27
(Missoula)	Simulation Modeling	Chapter 15	P15
12-11	**Case No.3 Due (12-11, Noon, GBB309)**		
(Missoula)	**Case No.3 Presentations**		

Final Exam: Tuesday, 18 December, 6:10 p.m.-8:10p.m.

FORMAT AND GUIDELINES FOR WRITTEN REPORTS

The Assignment

Prepare an action-oriented advisory report, which presents concisely your analysis and recommendations. Restrict the main body of the report to no more than four-type written pages (exclusive of the executive summary and appropriate appendices).

The Report Format

A. Executive Summary (1/2 page, single-spaced)
Report--*main body* (4 pages, double-spaced)

B. Label each of the four parts of your report with the subheading indicated below:
   I. Statement of the Problem
   II. Recommendations
   III. Discussion and Analysis of Recommendations
   IV. Limitations and General Comments

C. Appendices, tables and exhibits as appropriate (4 pages maximum, single- or double-spaced, 1" margins)

Instructions for Writing the Report

A. ***Executive Summary*** – Write the *executive summary* in memo form. It is from you to the manager to whom you report. It provides an overview of the report to follow. The memo should consist of four paragraphs, each of which concisely summarizes the corresponding section in your report. Memo form is as follows:

TO:
FROM:
DATE:
SUBJECT:

Do NOT sign the memo.

B. ***Main Body of the Report***

I. *Statement of the Problem* – Concisely specify the questions to be resolved in your report. Include the sub-parts of the problem and all its requirements, which have been established for a satisfactory solution. Indicate also any critical restrictions, which have been placed on an acceptable solution, such as limitations on monetary expenditures, time, disruptions to an activity, personnel, etc. State the problem in terms of the possible action to be taken, e.g., "how to improve ... so as to achieve ... without an undue expenditure of ... "

Be sure you have the problem, not symptoms of it. Unless your diagnosis of the problem is correct, all subsequent decision-making will be futile, no matter how efficient it is.

In the second paragraph, indicate the significance or importance of the problem by referring to its magnitude, urgency, difficulty of solution, and/or possible consequences of delay.

II. *Recommendations* – Spell out your recommended action, i.e., the solution that you recommend (or seek authority) to implement. Your recommendation should come from an imaginative and thorough identification of all the alternatives that might reasonably overcome the obstacles involved in the problem. Base your choice upon a critical evaluation of the "crucial differences" among these alternatives, but give only your preferred alternative here. Leave the conclusions reached as a result of your analysis (and thus the substantiation for your choice) for Part III. Do not include them here.

Be specific. Take a stand for action. Do not merely suggest "more study" or "call a consultant." Instead, your recommendations should eliminate the underlying causes, not just minimize or eliminate the apparent, surface symptoms. In other words, solve the problem stated in Part I.

Be sure to include necessary follow through. (Remember that the ultimate success of your major recommendation will often be dependent upon secondary steps.) Make clear the sequence in which the various steps are to be taken. Strive to provide and coordinate steps for accomplishing a thorough solution to the problem. (What, by whom, and when should action be taken?) Because of the limited length imposed on your report, treat your recommendation as summary in nature, including only the more important, less detailed actions.

III. *Discussion and Analysis of Recommendations* – Specify your conclusions regarding the problem so as to defend your position. Include mention of the most significant and relevant facts, assumptions, or principles, which led you to decide upon your recommended course of action. Do not attempt to justify each step; concentrate on supporting the total program. (Acceptance of your supplemental steps will occur automatically when you succeed in selling your recommendation.)

Support your recommendation by indicating the results (benefits and relief from difficulties), which you expect will be forthcoming. Anticipate these results on the basis of known factors; do not engage in "blue sky" thinking.

An extensive, long statement of facts is not desirable. It can confuse and even weaken your case. It is much more preferable to present only those major points that specifically support your decision.

IV. *Limitations and General Comments* – State here the disadvantages that might negatively influence the viability of your recommendation. Every recommendation -- no matter how thorough -- generally has limitations about what management can do or desires to do. Identification of these limitations increases the credibility of your report.

Next list the alternative courses of action, which you seriously considered but rejected. Their inclusion here reassures your reader that you were thorough in your analysis. They are not suggested for possible implementation in place of your recommendation, either now or later. They should be considered only as "second choices," which were rejected for good and sufficient reasons. (The reasoning for all of this should be found in Part III, however, not here.)

C. ***Appendixes*** – Make appropriate and extensive use of tables and figures in the main body of the report. Attach data or detailed quantitative work in the appendices. Remember, it is not only what you say, but how you say it that will influence your grade. Therefore, write a succinct, direct, and convincing report.

RED BRAND CANNERS

On Monday, September 13, 1965, Mr. Mitchell Gordon, Vice-President of Operations, asked the Controller, the Sales Manager, and the Production Manager to meet with him to discuss the amount of tomato products to pack that season. The tomato crop, which had been purchased at planting, was beginning to arrive at the cannery, and packing operations would have to be started by the following Monday. Red Brand Canners was a medium-size company that canned and distributed a variety of fruit and vegetable products under private brands in the western states.

Mr. William Cooper, the Controller, and Mr. Charles Myers, the Sales Manager, were the first to arrive in Mr. Gordon's office. Dan Tucker, the Production Manager, came in a few minutes later and said that he had picked

TABLE 1 *Demand forecasts*

Product	*Selling price per case ($)*	*Demand forecast (cases)*
24–2½ whole tomatoes	4.00	800,000
24–2½ choice peach halves	5.40	10,000
24–2½ peach nectar	4.60	5,000
24–2½ tomato juice	4.50	50,000
24–2½ cooking apples	4.90	15,000
24–2½ tomato paste	3.80	80,000

up Produce Inspection's latest estimate of the quality of the incoming tomatoes. According to their report, about 20 percent of the crop was Grade "A" quality and the remaining portion of the 3,000,000-pound crop was Grade "B."

Gordon asked Myers about the demand for tomato products for the coming year. Myers replied that they could sell all of the whole canned tomatoes they could produce. The expected demand for tomato juice and tomato paste, on the other hand, was limited. The Sales Manager then passed around the latest demand forecast, which is shown in Table 1. He reminded the group that the selling prices had been set in light of the long-term marketing strategy of the company, and potential sales had been forecasted at these prices.

Bill Cooper, after looking at Myers's estimates of demand, said that it looked like the company "should do quite well (on the tomato crop) this year." With the new accounting system that had been set up, he had been able to compute the contribution for each product, and according to his analysis the incremental profit on the whole tomatoes was greater than for any other tomato product. In May, after Red Brand had signed contracts agreeing to purchase the grower's production at an average delivered price of 6 cents per pound, Cooper had computed the tomato products' contributions (see Table 2).

Dan Tucker brought to Cooper's attention that, although there was ample production capacity, it was impossible to produce all whole tomatoes as too small a portion of the tomato crop was "A" quality. Red Brand used a numerical scale to record the quality of both raw produce and prepared products. This scale ran from zero to ten, the higher number representing better quality. Rating tomatoes according to this scale, "A" tomatoes averaged nine points per pound and "B" tomatoes averaged five points per pound. Tucker noted that the minimum average input quality for canned whole tomatoes was eight, and for juice it was six points per pound. Paste could be made entirely from "B" grade tomatoes. This meant that whole tomato production was limited to 800,000 pounds.

TABLE 2 *Product item profitability*

Costs ($)	Product					
	24–2½ Whole tomatoes	*24–2½ Choice peach halves*	*24–2½ Peach nectar*	*24–2½ Tomato juice*	*24–2½ Cooking apples*	*24–2½ Tomato paste*
Selling price	4.00	5.40	4.60	4.50	4.90	3.80
Variable costs						
Direct labor	1.18	1.40	1.27	1.32	.70	.54
Variable overhead	.24	.32	.23	.36	.22	.26
Variable selling	.40	.30	.40	.85	.28	.38
Packaging material	.70	.56	.60	.65	.70	.77
Fruit*	1.08	1.80	1.70	1.20	.90	1.50
Total variable costs	3.60	4.38	4.20	4.38	2.80	3.45
Contribution	.40	1.02	.40	.12	1.10	.35
Less allocated overhead	.28	.70	.52	.21	.75	.23
Net profit	.12	.32	(.12)	(.09)	.35	.12

* Product usage is as given below

Product	*Pounds per case*
Whole tomatoes	18
Peach halves	18
Peach nectar	17
Tomato juice	20
Cooking apples	27
Tomato paste	25

Gordon stated that this was not a real limitation. He had been recently solicited to purchase 80,000 pounds of Grade "A" tomatoes at 8½ cents per pound and at that time had turned down the offer. He felt, however, that the tomatoes were still available.

Myers, who had been doing some calculations, said that although he agreed that the Company "should do quite well this year," it would not be by canning whole tomatoes. It seemed to him that the tomato cost should be allocated on the basis of quality and quantity rather than by quantity only, as Cooper had done. Therefore, he had recomputed the marginal profit on this basis (see Table 3), and from his results, Red Brand should use 2 million pounds of the "B" tomatoes for paste, and the remaining 400,000 pounds of "B" tomatoes and all of the "A" tomatoes for juice. If the demand expectations were realized, a contribution of $48,000 would be made on this year's tomato crop.

TABLE 3 *Marginal analysis of tomato products*

Costs ($)	*Product*		
	Canned whole tomatoes	*Tomato juice*	*Tomato paste*
Selling price	$4.00	$4.50	$3.80
Variable cost (excluding tomato costs)	2.52	3.18	1.95
	1.48	1.32	1.85
Tomato cost	1.49	1.24	1.30
Marginal profit	($ .01)	$ .08	$ .55

Z = cost per pound of "A" tomatoes in cents
Y = cost per pound of "B" tomatoes in cents
(1) (600,000 lbs. × Z) + (2,400,000 lbs. × Y) = (3,000,000 lbs. × 6)
(2) $\frac{Z}{9} = \frac{Y}{5}$
Z = 9.32 cents per pound
Y = 5.18 cents per pound

Case Questions

1. Before any systematic analysis can be performed on the Red Brand Cannery problem, the issue of relevant data must be resolved. With which cost-and-profit data do you agree—Table 2 or Table 3? Does the fact that Red Brand has already purchased the 3-million-pound crop at planting affect your answer?
2. Do you think that the allocated overhead should be subtracted from the profit contribution per case as shown in Table 2?
3. Propose a systematic procedure for developing a good solution for the production of tomato products. Model the problem to obtain an optimal product mix. Solve the problem using an LP computer package. Be sure to include a sensitivity analysis of whether Red Brand should purchase the additional 80,000 pounds of grade A tomatoes.
4. Reformulate the model to explicitly consider the additional purchase of the 80,000 pounds of grade A tomatoes. How many pounds should be purchased? Does the answer agree with your answer in part 3?
5. If the marketing manager wanted to increase the demand for juice by 20,000 cases, how much should Red Brand be willing to pay for an advertising campaign?
6. Suppose that the price of juice increased 8 cents per case. Does your computer output tell you whether the optimal production plan will change?

HOLLINGSWORTH PAPER COMPANY

The Hollingsworth Paper Company is an integrated manufacturer of paper products for markets throughout the United States. Its Container Division produces corrugated cardboard boxes at four plants and sells through six regional distribution centers (DC's). Last year's sales of nearly 60,000 tons accounted for revenues of almost $30 million. A regional breakdown of sales is given in Exhibit 1.

EXHIBIT 1 Last Year's Sales by Geographic Region

Northeast sales (Boston DC)	2,600 T	4%
Northeast sales (Philadelphia DC)	9,700 T	17%
Southeast sales (Atlanta DC)	15,500 T	26%
Midwest sales (Chicago DC)	10,100 T	17%
Southwest sales (Houston DC)	13,400 T	23%
Far West sales (San Francisco DC)	7,500 T	13%
	58,800 T	100%

Cardboard containers are designed to meet a variety of customer needs. This variety reflects such features as size, shape, thickness, and type of closure. However, the technology is fairly simple, and competitors have the capability to manufacture the same products. To maintain its 10% share of the market, Hollingsworth emphasizes its quick and reliable delivery service. The firm has established its DC's to stock most of its standard items close to the major demand locations, but even specialty orders are processed through the DC's just to simplify paperwork.

Because there are several firms in the industry, and because few proprietary advantages exist, the market for cardboard boxes is quite competitive. The prices offered the customer are virtually the same no matter where the product is made or what its delivery route. This means that the manufacturer absorbs its own freight costs. With price competition as strong as it is, Hollingsworth's freight costs are a critical part of the profit picture.

PRODUCTION AND DISTRIBUTION FACILITIES

At present Hollingsworth has four plants with one-shift capacities in the range of 12,000 to 16,000 tons per year. At two of the four plants last year's production fell below one-shift capacity, while in the other two plants a substantial amount of second-shift output was necessary. This pattern reflected the concentration of sales in the Midwest and South. Details are given in Exhibit 2.

The plant located in Nashua, New Hampshire, is Hollingsworth's oldest facility. Its layout and equipment are somewhat outmoded; consequently, its productivity is relatively low. The Portland, Oregon, plant is the company's newest site, with a work force roughly one-half the size of Nashua's. Labor rates are cheapest at Asheville, North Carolina, and most expensive at St. Louis, Missouri. Variations in the process and wage rates, together with different utilizations, result in somewhat different costs at each location. An accounting summary of last year's operations revealed that costs per ton varied from a low of $397.70 at Portland to a high of $447.30 at Nashua. Exhibits 3 to 5 provide some additional details on these figures.

EXHIBIT 2 Plant Capacities and Production

Plant	*One-Shift Capacity*	*Production*	*Percent Utilization of One-Shift Capacity*
Nashua, NH	14,000 T	12,300 T	88%
Asheville, NC	12,000 T	15,500 T	129%
St. Louis, MO	16,000 T	23,500 T	147%
Portland, OR	12,000 T	7,500 T	63%
Total	54,000 T	58,800 T	109%

EXHIBIT 3 Total Costs (per ton)

	Variable Costs	*Allocated Fixed Costs*	*Total Costs*
Nashua	$439.80	$ 8.50	$448.30
Asheville	406.60	10.30	416.90
St. Louis	400.40	8.10	408.50
Portland	379.70	18.00	397.70

EXHIBIT 4 Plant Variable Costs (per ton)

	Materials	*Labor*	*Supervision*	*Other Overhead*	*Fringe* Benefits*	*Total*
Nashua						
1st Shift	$299.20	$104.00	$19.60	$3.40	$13.60	$439.80
2nd Shift	299.20	110.80	20.80	3.40	14.48	448.68
Asheville						
1st Shift	305.20	76.00	13.00	1.20	9.80	405.20
2nd Shift	305.20	81.00	13.60	1.20	10.40	411.40
St. Louis						
1st Shift	301.20	74.60	12.40	.90	9.60	398.70
2nd Shift	301.20	78.80	13.10	.90	10.10	404.10
Portland						
1st Shift	299.20	61.40	10.10	1.10	7.86	379.60
2nd Shift	299.20	65.00	10.70	1.10	8.32	384.32

* 11% of labor and supervision.

EXHIBIT 5 Plant and Fixed Costs

	Supervision	*Fringe* Benefits*	*Other Overhead*	*Depreciation*	*Total*
Nashua					
1st Shift	$60,000	$6,600	$8,000	$30,000	$104,600
2nd Shift	30,000	3,300	2,000	—	35,300
Asheville					
1st Shift	60,000	6,600	8,000	50,000	124,600
2nd Shift	30,000	3,300	2,000	—	35,300
St. Louis					
1st Shift	60,000	6,600	8,000	80,000	154,600
2nd Shift	30,000	3,300	2,000	—	35,300
Portland					
1st Shift	60,000	6,600	8,000	60,000	134,600
2nd Shift	30,000	3,300	2,000	—	35,300

* 11% of labor and supervision.

PATTERNS OF DISTRIBUTION

Facing the competitive market with tight margins, Hollingsworth has paid particular attention to its freight costs. For a number of years, its policy has been to supply each DC from the nearest plant, thus minimizing the freight component of cost. Last year's freight rates are reproduced in Exhibit 6. Under this company policy, the Nashua plant supplies the Boston and Philadelphia DC's, Asheville supplies the Atlanta DC, St. Louis supplies the Chicago and Houston DC's, and Portland supplies the San Francisco DC. This pattern results in very different profits in the various regions, ranging from around $40 per ton in Chicago to a slight loss in Philadelphia. The DC managers, whose annual bonus partly reflects the profits made in their region, have complained about this system for years. Exhibit 7 summarizes last year's records.

EXPANSION PROPOSALS

Over the years Hollingsworth has made investments to improve its productive capacity in several places. As sales in the Midwest grew, the St. Louis plant was expanded. New equipment was installed in Asheville to keep pace with sales growth in the South. Based on these experiences, the engineering staff was eventually able to design the new Portland plant, which reduced the cost of meeting demand in the West. Few improvements, however, have been implemented at Nashua. The two-story layout hampers innovation, and the engineers have expressed some concern about whether the old building is strong enough to support some of the heavier pieces of machinery now used elsewhere.

As a continuation of these investment initiatives, the Facilities Planning Committee at Hollingsworth has produced two large-scale expansion plans to help meet predicted sales growth over the next eight to ten years. One proposal involves a large addition to the St. Louis plant, while the second proposal involves construction of a new plant in Houston.

The St. Louis proposal calls for an expansion of the existing plant sufficient to raise its annual one-shift capacity to 28,000 tons. The cost for the building for this

EXHIBIT 6 Last Year's Transportation Rates per Ton

	To:					
	Boston	***Philadelphia***	***Atlanta***	***Chicago***	***Houston***	***San Francisco***
From:						
Nashua	$ 16.00	$ 20.00	$ 64.00	$56.00	$72.00	$104.00
Asheville	52.00	48.00	20.00	56.00	56.00	88.00
St. Louis	56.00	52.00	56.00	20.00	32.00	72.00
Portland	112.00	112.00	104.00	64.00	68.00	36.00
Houston	64.00	60.00	48.00	30.00	0.00	76.00

EXHIBIT 7 Last Year's Profits per Ton

	Selling Price	*Cost of Goods Sold*	*Warehousing, Selling and Administrative Expenses*	*Freight Absorbed*	*Net Profit Before Taxes*
Boston	$500.00	$448.30	$32.00	$16.00	$ 3.70
Philadelphia	500.00	448.30	32.00	20.00	(0.30)
Atlanta	500.00	416.90	29.00	20.00	34.10
Chicago	500.00	408.50	31.00	20.00	40.50
Houston	500.00	408.50	30.00	32.00	29.50
San Francisco	500.00	397.70	32.00	36.00	34.30

* Includes a 4% sales commission.

expansion has been estimated at $1.6 million, and there is adequate land at the St. Louis site. The equipment investment is estimated to be $1.5 million. The plant expansion would afford Hollingsworth an opportunity to use the latest machinery available.

The Houston proposal calls for building a new plant with annual one-shift capacity of 12,000 tons. Although Hollingsworth already has a DC located in Houston, there would be a need to purchase land for the new plant. The cost of land is estimated at $500,000. The plant itself would cost about $2 million, while the investment in equipment is estimated at $1.5 million, since the technology would be much the same as in the St. Louis expansion. Additional estimates for the two proposals are shown in Exhibit 8.

As mentioned earlier, the Facilities Planning Committee anticipates that some kind of expansion will be needed to meet the needs of the market during the next 8–10 years. Over that period, the costs of labor, materials, and freight are likely to increase at slightly different rates, but the company controller has commented that the firm's cost structure is not likely to change drastically.

EXHIBIT 8 Anticipated Costs for New Facilities

	Houston	*St. Louis*
Variable costs per ton:		
Direct materials	$302.40	$301.20
Direct labor	57.00	60.40
Supervision	9.00	10.00
Other overhead*	1.00	1.00
Fixed operating costs per year:		
Supervision	$60,000	$40,000
Other overhead*	8,000	8,000

* Includes supplies, heat, light, power, insurance.

Case Questions:

1. What is the major decision facing HPC?
2. How good was last year's cost performance in distribution?
3. How do we extend the model to accommodate expansion possibilities?
4. What additional information do we want to include in our analysis?

CASE

13

DRINK-AT-HOME, INC.

Drink-At-Home, Inc. (DAH, Inc.), develops, processes, and markets mixes to be used in nonalcoholic cocktails and mixed drinks for home consumption. Mrs. Lee, who is in charge of research and development at DAH, Inc., this morning notified Mr. Dick Jones, the president, that exciting developments in the research and development section indicate that a new beverage, an instant piña colada, should be possible because of a new way to process and preserve coconut. Mrs. Lee is recommending a major program to develop the piña colada. She estimates that expenditure on the development may be as much as $100,000 and that as much as a year's work may be required. In the discussion with Mr. Jones, she indicated that she thought the possibility of her outstanding people successfully developing such a drink now that she'd done all the really important work was in the neighborhood of 90 percent. She also felt that the likelihood of a competing company developing a similar product in 12 months is 80 percent.

Mr. Jones is strictly a bottom line guy and is concerned about the sales volume of such a beverage. Consequently, Mr. Jones talked to Mr. Besnette, his market research manager, whose speciality is new product evaluation, and was advised that a market existed for an instant piña colada, but was somewhat dependent on acceptance by both grocery stores and retail liquor stores. Mr. Besnette also indicated that the sales reports indicate that other firms are considering a line of tropical drinks. If other firms should develop a competing beverage the market would, of course, be split among them. Mr. Jones pressed Mr. Besnette to make future sales estimates for various possibilities and to indicate the present (discounted value of

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future profits) value. Mr. Besnette provided Table C13.1.

Mr. Besnette's figures did not include (1) cost of research and development, (2) cost of new production equipment, or (3) cost of introducing the piña colada. The cost of the new production equipment is expected to be $100,000 because of the special way the coconut needs to be handled, and the cost of introducing the new product is expected to be about $150,000 because of the point-of-purchase displays that would be necessary to introduce the new product.

Mrs. Lee has indicated that she does have alternative development proposals, which are:

1. A reduced research program to see if someone else comes out with the product first and if not, then proceed with a crash program. The reduced program for the first eight months would cost $10,000 per month. One advantage of this is that if the effort was unsuccessful then development costs would be held to the eight-month figure (8 months × $10,000 = $80,000). The likelihood of success under this approach is the same as the more orderly development. (The likelihood of a competing company developing a product in 8 months is 60 percent.) The crash development program would take place in months 9 through 12 and would cost an additional $60,000. It would proceed only if the eight-month study guaranteed a success.

2. Use a reduced research program and maintain an awareness of industry developments to see if someone else develops a product. If someone else has developed a product at the end of six months, it would cost only an additional $30,000 to analyze their product and duplicate it. The reduced development program would cost $10,000 per month.

TABLE C13.1 Sales and profit potentials

Consumer Acceptance (Sales Potential)	*Probability*	*Present Values (Discounted Value of Future Profits)*
Substantial	0.10	$800,000
Moderate	0.60	$600,000
Low	0.30	$500,000

Mr. Besnette, being the great marketer that he is, is of course reluctant to be second on the market with a new product. He says that the first product on the market will usually obtain a greater share of the market, and it will be difficult to win those customers back. Consequently, he indicates that only about 50 percent of the sales that he indicated in Table C13.1 could be expected if Drink-at-Home waited until competing brands were already on the market. Moreover he suspects that there is only a 50/50 chance that the competitor will be out with a product within the next six months.

There are four options: (1) orderly development of the piña colada, (2) modest development effort followed by the crash program, (3) a modest development effort for the first six months to see if a competitive product comes on the market, and (4) do nothing.

DISCUSSION QUESTION

What do you recommend?