

American Office Systems, Inc., was established by the late R. J. Miller, Sr., in 1939. It started as an office supply store in Mountain View, California, and expanded slowly over the years into the manufacture of small office equipment, overhead projectors, and bookkeeping machines. In the 1950s, computers started eroding its market for bookkeeping machines, so the company diversified into the copy machine market. However, it never captured a large market share because bigger firms such as Xerox, Canon, Sharp, and A. B. Dick were so firmly entrenched.

A few years ago, American Office Systems' engineering staff developed an adapter that links a standard copy machine to personal computers, allowing a copy machine to be used as a laser printer, scanner, and fax. The adapters show great promise for both home and office use. However, the company is not well known by either the financial community or the copy machine market, principally due to its small size and rather lackluster record, so it could secure only \$15 million in initial financial backing for the adapters. The \$15 million was used to finance the construction of a small production facility and of administrative offices in 1994, and in 1995 production and sales began. Two versions of the adapter exist, one for IBM-compatible computers and one for Macintosh computers. The former sells for \$175 and the latter for \$200.

At the beginning of December 1995, Dr. R. J. Miller, II, President, convened a meeting about the coming year's plans for the adapters. Rob Olsen, Vice President of Production, argued that production facilities should be expanded: "Until we have sufficient capacity to produce the adapters," he said, "there is no use advertising." Sue Williams, Director of Marketing, replied, "On the contrary, without any demand for the adapters, there is no reason to produce them. We need to focus on advertising first." J. T. Howell, the Comptroller, pointed out that Olsen and Williams were talking about the situation as if it only involved a decision between production and marketing: "Yes, funds need to be allocated between production and advertising. However, more important than both is the cash flow difficulty that the company has been

experiencing. As you know, it was only yesterday that, finally, I was able to secure a \$750,000 line of credit for the coming year from Citibank. I might add that it is at a very favorable interest rate of 16%. This will partially solve our cash flow problems and it will have a big effect on both production and advertising decisions. In addition, there are financial and accounting factors that must be allowed for in any decision about the adapters." Olsen interjected, "Wow, this is more complicated than I anticipated originally. Before we make a decision, I think we ought to use some modern management science techniques to be sure that all the relevant factors are considered. Last week I hired Carlos Garcia from Stanford. He has a Master's Degree in Operations Research. I think this would be a good project for him." However, Williams said that she thinks that an executive, judgmental decision would be much better. "Let's not get carried away with any of the quantitative mumbo-jumbo that Rob is always suggesting. Besides, his studies always take too much time and are so technical that no one can understand them. We need a decision by the end of next week." After listening to the discussion, Miller decided to appoint an executive action team to study the problem and make a recommendation at next week's meeting. "Rob and Sue, I want both of you to document your arguments in more detail. J. T., be more precise with your comments about the cash flow, accounting, and financial problems. And, by the way Rob, have Carlos look into a model to see if it might produce some insights."

Most of the \$15 million initial financing was used to build a five-story building in Mountain View, south of San Francisco. Although currently only about 90% complete, it is being used. The first floor contains the production and shipping facilities plus a small storage area. A larger warehouse, already owned by the company, is located across the street. The other four floors of the building are for the engineering department (second floor), a research lab (third floor), and administration (top two floors). The production facility operates two shifts per day and has a production capacity of 30 IBM adapters and 10 Macintosh adapters per hour. Olsen uses 20 production days per month in his planning. Usually there are a few more, but these are reserved for maintenance and repairs. The last stage of the initial construction will

¹¹ This case was written by William D. Whisler, California State University, Hayward.

be finished by the beginning of the fourth quarter, making the building 100% finished. This will increase the production capacity rates by 10%.

Howell normally does the company's financial planning monthly, and he assumes that cash flows associated with all current operating expenses, sales revenues (taking collections into account), advertising costs, loans from the line of credit, investments of excess cash in short-term government securities, and so forth, occur at the end of the corresponding month. Because he needs information for the meeting next week, however, he decides to do a rough plan on a quarterly basis. This means that all the just mentioned cash flows, and so on, will be assumed to occur at the end of the quarter. After the meeting, when more time is available, the plan will be expanded to a monthly basis. To get started, one of his senior financial analysts prepares the list of quarterly fixed operating expenses shown in Table 4.16. In addition, the accounting department calculates that the variable costs of the adapters are \$100 each for the IBM version and \$110 each for the Macintosh version.

Table 4.16 Quarterly Fixed Operating Expenses

Expense	Cost
Administrative expense	\$1,500,000
Fixed manufacturing costs	750,000
Sales agents' salaries	750,000
Depreciation	100,000

At present, American Office Systems is experiencing a cash flow squeeze due to the large cash requirements of the startup of the adapter production, advertising, and sales costs. If excess cash is available in any quarter, however, Howell says that the company policy is to invest it in short-term government securities, such as treasury bills. He estimates that during the coming year these investments will yield a return of 6%.

Olsen asks Garcia to look into the production and inventory aspects of the situation first, because this area was his specialty at Stanford. Then he says that he wants him to think about a programming model that might integrate all components of the

problem—production, sales, advertising, inventory, accounting, and finance. A mixed-integer programming model appears to be the most appropriate; however, he asks Garcia to use linear programming as an approximation due to the time limitations and Williams's concern about his ideas always being too technical. "There will be more time after next week's meeting to refine the model," he says.

After discussions with Olsen and Williams, Garcia feels that something needs to be done to help the company handle the uncertainty surrounding future sales of the adapters. He points out that it is impossible to guarantee that the company will never be out of stock. However, it is possible to decrease shortages so that any difficulties associated with them would be small and they would not cause major disruptions or additional management problems, such as excess time and cost spent expediting orders, and so forth. Thus, Garcia formulates an inventory model. To be able to solve the model, he has to check the inventory levels of the adapters currently on hand in the warehouse. From these quantities, he calculates that there will be 10,000 IBM and 5,000 Macintosh adapters on hand at the beginning of 1996. Based on the results of the model, he recommends that a simple rule of thumb be used: production plus the end-of-period inventory for the adapters should be at least 10% larger than the estimated sales for the next period. This would be a safety cushion to help prevent shortages of the adapters. In addition, to provide a smooth transition to 1997, the inventory level plus production at the end of the fourth quarter of 1996 should be at least twice the maximum expected sales for that quarter. Garcia says that using these rules of thumb will minimize annual inventory costs. When explaining the inventory model to Olsen, Garcia emphasizes the importance of including inventory carrying costs as part of any analysis, even though such costs frequently are not out-of-pocket. He says that his analysis of data provided by the accounting department yielded a 1% per month inventory carry cost, and this is what he used in his model.

Sales during the first year (1995) for the adapters are shown in Table 4.17. Next year's sales are

uncertain. One reason for the uncertainty is that they depend on the advertising. To begin the analysis, Williams asks her marketing research analyst, Debra Lu, to estimate the maximum sales levels for the coming four quarters if no advertising is done. Since last year's sales of both models showed a steady increase throughout the year, Lu projects a continuation of the trend. She forecasts that the company will be able to sell any number of adapters up to the maximum expected sales amounts shown in Table 4.17.

Table 4.17 1995 Adapter Sales and Maximum Expected 1996 Sales

Quarter	1995 Sales		1996 Maximum Expected Sales	
	IBM Adapters	Macintosh Adapters	IBM Adapters	Macintosh Adapters
1	5,000	1,000	9,000	1,800
2	6,000	1,200	10,000	2,000
3	7,000	1,400	11,000	2,200
4	8,000	1,600	12,000	2,400

Miller suggests that advertising in magazines such as *PC World* and *Home Office* will increase consumer awareness of both the company and adapters. The next day, Williams has a meeting with several staff members of a San Francisco advertising agency. They show her recommendations for two types of ads (one for the IBM adapters and one for the Macintosh adapters), give her cost information, and the estimated effectiveness of an advertising campaign. Armed with this information and some data from Lu, Williams prepares a brief report for Miller setting out her reasons for thinking that each \$10 spent on advertising will sell an additional IBM adapter; the same relationship holds true for the Macintosh adapter.

Based on an analysis of 1995 sales and accounts receivable, the accounting department determines that collection experience is as shown in Table 4.18. For example, 75% of the IBM adapters sold in a quarter are paid for during the quarter; 20% are paid for during the following quarter; and 3% are paid for during

the third quarter. The remaining 2% are written off and sold to a collection agency for \$0.50 on the dollar.

Table 4.18 Collections

Quarter	IBM Adapters	Macintosh Adapters
1	0.75	0.80
2	0.20	0.11
3	0.03	0.05

Questions

- Suppose that you are Garcia. Develop an LP spreadsheet model of the situation to help the executive action team make a decision about how to allocate funds between production and advertising so that all the cash flow, financial, accounting, marketing, inventory, and production considerations are taken into account and American Office Systems' profits are maximized. Use the data collected and the estimates made by the members of the executive action team.
- Solve the LP model formulated in Question 1.

The executive action team has assembled to reconsider the plans for the adapters for the coming year. Garcia, who developed the LP model, concludes his presentation by saying, "As everyone can see, the model gives the optimal solution that maximizes profits. Since I have incorporated the estimates and assumptions that all of you made, clearly it is the best solution. No other alternative can give a higher profit." Even Williams, who initially was skeptical of using quantitative models for making executive-level decisions, is impressed and indicates that she will go along with the results.

Miller says, "Good work, Carlos! This is a complex problem but your presentation made it all seem so simple. However, remember that those figures you used were based on estimates made by all of us. Some were little better than guesses. What happens if they are wrong? In other words, your presentation has helped me get a handle on the problem we are facing, and I know that models are useful where hard, accurate, data exist. However, with all the uncertainty in our situation and the many rough estimates made, it seems to me that I will still have to make a

judgment call when it comes down to making a final decision. Also, there has been a new development. J.T. tells me that we might be able to get another \$1 million line of credit from a Bahamian bank. It will take a while to work out the details and maybe it will cost us a little. I am wondering if it is worth it. What would we do with the \$1 million if we got it?" T.J. responds, "We really need the \$1 million. But it is a drop in the bucket. My analysis shows that we really need another \$8 million line of credit."

Analyze, as Garcia is going to do, the effect of uncertainty and errors on the results of Questions 1 and 2 by answering the following questions. They should be attempted only after Questions 1 and 2 have been answered correctly.

3. One area where assumptions were made is adapter price.
 - a. What happens if the prices for the adapters are a little weak and they decrease to \$173 for the IBM version and \$198 for the Macintosh version? Does this make any difference?
 - b. What about decreases to \$172 and \$197, respectively, for the IBM and Macintosh versions? Explain the answers in terms that Miller will understand.
 - c. Suppose that American Office Systems can increase the price of the adapters to \$180 and \$205. How would this affect the original solution?
4. Another potential variable is adapter production cost.
 - a. Suppose that an error was made in determining the costs of the adapters and that they really should have been \$102 for the IBM version and \$112 for the Macintosh version. What is the effect of this error?
 - b. What about costs of \$105 and \$115? Explain the answers in terms that Miller will understand.
5. Howell notes that one of the contributing factors to American Office Systems' cash squeeze is the slow collection of accounts receivable. He is considering adopting a new collection procedure recommended by a consulting company. It will

cost \$100,000 and will change the collection rates to those given in Table 4.19.

- a. Analyze the effect of this new collection policy and make a recommendation to Howell about whether to implement the new procedure. As before, any accounts receivable not collected by the end of the third quarter will be sold to a collection agency for \$0.50 on the dollar.
- b. Howell wonders whether switching to selling adapters for all cash is worth the effort. This would ameliorate the cash squeeze because it would eliminate not only the slow collections but also the use of the collection agency for accounts that remain unpaid after 9 months. It would cost about \$90,000 more than at present to implement the all-cash policy because the accounting system would need to be modified and personnel would have to be retrained. Analyze this possibility and make a recommendation to Howell.

Table 4.19 New Collections

Quarter	IBM Adapters	Macintosh Adapters
1	0.90	0.92
2	0.07	0.03
3	0.01	0.01

6. Yet another variable is advertising effectiveness.
 - a. Suppose that Williams overestimated the effectiveness of advertising. It now appears that \$100 is needed to increase sales by one adapter. How will this affect the original solution? Explain the answer in terms that Miller will understand.
 - b. What happens if the required advertising outlay is \$12.50 per additional adapter sold?
7. Suppose that the line of credit from Citibank that Howell thought he had arranged did not work out because of the poor financial situation of the company. The company can obtain one for the same amount from a small local bank; however, the interest rate is much higher, 24%. Analyze how this change affects American Office Systems.

8. The safety cushion for inventory is subject to revision.
 - a. Suppose that Garcia finds a bug in his original inventory model. Correcting it results in a safety cushion of 15% instead of the 10% he suggested previously. Determine whether this is important.
 - b. What if the error is 20%? Explain the answers in terms that Miller will understand.
9. Production capacity is scheduled to increase by 10% in the fourth quarter.
 - a. Suppose that Miller is advised by the construction company that the work will not be finished until the following year. How will this delay affect the company's plans?
 - b. In addition to the delay in part a, suppose that an accident in the production facility damages some of the equipment so that the capacity is decreased by 10% in the fourth quarter. Analyze how this will affect the original solution.
10. Williams is worried about the accuracy of Lu's 1996 maximum expected sales forecasts. If errors in these forecasts have a big effect on the company profits, she is thinking about hiring a San Francisco marketing research firm to do a more detailed analysis. They would charge \$50,000 for a study. Help Williams by analyzing what would happen if Lu's forecasts are in error by 1,000 for IBM adapters and 200 for Macintosh adapters each quarter. Should she hire the marketing research firm?
 11. a. To determine whether the extra \$1 million line of credit is needed, analyze its effect on the original solution given in Question 2.
 - b. To fully understand the ramifications of the extra \$1,000,000 line of credit, redo (1) Question 3b, (2) Question 4b, (3) Question 6a, and (4) Question 8b. Summarize your results.
 - c. What about Howell's claim that an extra \$8,000,000 line of credit is necessary? Use that adjustment and redo Question 6a. ■