AGSM 5200
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due: 4:00 pm, March 26, 2004

Team Assignment

Make whatever assumptions you feel necessary, but state them explicitly.
This work is to be done in the teams you have been allocated to, with the few reallocations for Core Economics, already emailed.

All members of the team will receive the same grade for the team's report. The only exception would be if *all* members of the team signed a hard-copy letter asking for a different allocation of grades within the team for the report.

Choose one of the two Cases on the following pages:

I. Demand for Airline Travel and the Pricing of Tickets, ***or***

II. How the Japanese Revolutionized Manufacturing Techniques

Answer the questions listed at the back of your chosen Case.

Use only the information given in the Case: do not seek additional information or data. (The Course notes and text apart, of course.)

The reports will be marked as a whole, not question-by-question.

Limit: a *maximum* of 6000 words per team report.

Case Study I: Demand for Airline Travel and the Pricing of Tickets

Air travel is big business, and it has grown bigger recently with the advent of what has been termed "yield management:" the system by which airlines efficiently fill the maximum number of seats on any particular flight. More specifically, the system allows airlines to determine more accurately the number of seats it needs to allocate to different types of travellers (leisure, business, or first-class) on any particular flight. It estimates the number of seats that should be held off the market for last-minute business travellers who will pay top dollar (because they suddenly have to get from point A to point B by a specific time). These seats are not available to groups travelling together or simple vacation travellers, but these travellers typically pay discounted fares.[1]

It may seem like this is a simple problem, but it is severely compounded by the fact that most travellers of any sort must make connections at hub air-ports around the world. United Airlines knows, for example, that 60 percent of the seats on any given flight leaving O'Hare Airport in Chicago will be filled by passengers connecting from other locations. Yield-management systems need to be sensitive to surges or shortfalls in those connecting flights if they are to allow for the proper management of departing flights, and computer programs designed by IBM have fitted the bill. Systems also have to be sensitive to the needs of individual travellers. United would, for example, want to make sure that a high-priced business passenger from Frankfurt could make connections in Chicago to get to Sacramento, California, even if that meant delaying or losing a domestic passenger from Charlotte, North Carolina. United expected in 1997 that full implementation of a system that could track its 350,000 passengers a day over 3,000 separate flights would generate an extra US$50 million to US$100 million in revenue each year. And most of that extra revenue would add to 1997 earnings of slightly more than US$500 million against US$16.4 billion in gross revenue.

The stakes are high, but the reason behind their magnitude lies in the simple economics of distinguishing between different types of passengers. We can explore those economics by contemplating air travel markets for flights between North America and Europe. About 12 percent of all international air passengers travel between these two continents. It is a market that is defined in economic terms by at least two noteworthy characteristics. First, the bulk of the travellers are nonbusiness travellers. About 46 percent of all passengers on those routes are vacation travellers, 34 percent are visiting relatives and friends, and the rest are business travellers. Second, there is considerable seasonal variation in the demand for air travel in this market; summer is the peak season with more than one-third of traffic occurring between July and September.

Many major international airlines fly between North America and Europe. Many others have code-sharing arrangements with existing carriers that allow passengers to buy a ticket on a foreign flight from an otherwise domestic airline. All of these airlines, as well as a host of industry and government analysts, are vitally interested in the demand

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1. The *Philadelphia Inquirer* published a story on yield management on December 11, 1997. Follow-up articles have subsequently appeared, most notably in the *Wall Street Journal*. It is still a current topic, since business travellers continue to feel like they are being exploited by the testing differential fare schedules.

for air travel in this market. And if they are to exploit the opportunities offered by yield management, they must pay particular attention to the price elasticities and income elasticities of demand for such air travel by different types of flyers. J. M. Cigliano of the Lockheed-California Company published the results of a study in which he estimated these elasticities.[2] His findings have been used an a variety of contexts, as we shall see below. The estimates have been up-dated, to be sure, but his work was such a straightforward application of first principles that it suits our needs.

Table 1 shows estimated price and income elasticities, of demand for air travel between the United States and Europe, as well as between Canada and Europe. For the U.S-Europe route, the price elasticity of demand is about 1.2, which means that a 1 percent reduction in price would increase the quantity of air tickets demanded by about 1.2 percent. The income elasticity of demand is about 1.9, which means that a 1 percent increase in consumer incomes would increase the quantity demanded by about 1.9 percent.

Table 1

Price and Income Elasticities of Demand For Air Travel in the North Atlantic Market

Route	Price Elasticity	Income Elasticity
United States to (or from) Europe	1.2	1.9
Canada to (or from) Europe	0.8	1.8

Source: Cigliano, “Price and Income Elasticities”.

For the Canada-Europe route, the income elasticity (1.8) is much the same as between the United States and Europe, but the price elasticity (0.8) is much lower. This difference reflects, in large measure, a different mix of air travellers. Compared to the U.S.-Europe route, where only 20 percent of demand comes from business travellers whose travel plans are relatively insensitive to the price of air travel, perhaps as much as 60 percent of travel between Canada and Europe is business-related.

Table 2 shows the estimated price elasticities of demand for business and non-business travel between North America and Europe based on these proportions. As would be expected, the price elasticity of demand is much lower for business travel than for nonbusiness travel. If an airline believes that the business-related demand for its tickets is much less price elastic than the demand from leisure travellers, then it should be able to increase its revenues and profits by selling tickets to business travellers at a much higher price

While a rigorous proof of this statement must be postponed, it seems obvious that the airline should consider setting a higher price for the business traveller (who is less sensitive to price) than for the non-business traveller (who is more price-sensitive). What is less obvious is that a knowledge of the price elasticities of demand may enable us to estimate how big the difference between the prices should be, if profits are to be maximized. The evidence is in. Airlines increased business fares more than 20 percent in

2. J.M. Cigliano, “Price and Income Elasticities for Airline Travel: The North Atlantic Market,” *Business Economics*, September 1980

Table 2

Estimated Price Elasticities of Demand for Air Travel between North America and Europe

Traveler type	Price Elasticity
Business	0.4
Leisure	1.4

Source: Cigliano, “Price and Income Elasticities”.

1998—a period of time in which American Express Travel Services reported that leisure ticket prices actually fell slightly.

Note once again that the income elasticities of demand for air travel in the North Atlantic market are about 1.8 or 1.9. From the point of view of forecasting the demand for air travel in this market, this means that recessions (periods when consumer incomes drop) can hit air travel pretty hard. A 1 percent reduction in income would result in a 1.8 or 1.9 percent cut in air travel.

It is important to recognize that the demand curve for transatlantic transportation by a particular airline is quite different from the demand curve for the entire airline industry: a firm’s demand curve is likely to be more price elastic than that of the industry as a whole. The airlines compete among themselves in a variety of ways, such as in the quality of food and service, as well as safety.[3] Table 3 shows the cost of meals per passenger on transatlantic flights by various U.S. airlines in 1991. Virgin Atlantic Airways puts particular emphasis on high-quality service—good food, considerable legroom, excellent audio and video programming, and free limousine service to and from the airport.

Table 3

Cost per Passenger of Meals and Beverages on a Trans-Atlantic Flight 1991

Airline	Cost per passenger	Airline	Cost per passenger
American	US$31.25	TWA	US$16.40
Continental	12.11	United	18.81
Delta	28.67	US Air	26.99
Northwest	20.41	Average	21.29

Note: Some airlines include in cost the free liquor on international routes.

Source: *New York Times*, January 12, 1992

3. S.S. Borenstein and M. Zimmerman, “Market Incentives for Safe Commercial Airline Operation,” *American Economic Review*, December 1988; and N. Rose, “Fear of Flying? Economic Analysis of Airline Safety,” *Journal of Economic Perspectives*, Spring 1992.

Questions:

1. Why can we be sure that increases in air fares would reduce the total amount of money spent on air travel between the United Stares and Europe, but increase the amount spent on travel between Canada and Europe?
2. Between North America and Europe, is marginal revenue positive or negative for the business traveller? For the leisure traveller? Would a 20 percent increase in business fares increase revenue? Would a reduction in leisure fares reduce revenue?
3. Do you think that the amount of air travel from the United States to Europe is influenced by the prices of hotel rooms and meals in Europe? If so, what sort of effects would these prices have on the amount of air travel? Are hotel rooms and meals in Europe complements to air travel? Why or why not?
4. Would you expect the cross-price elasticity of demand between air travel from Europe to the United States and ground transportation in the United States to be positive or negative? Why?
5. Would airlines with a large proportion of business travellers tend to have high meal costs per passenger? Why or why not?
6. According to a study by S. Borenstein and M. Zimmerman, the occurrence of an accident on a particular airline between 1978 and 1985 resulted in a reduction in demand for tickets on this airline. Do you think that this effect exists for only a few months, or do you think it is longer term? Why?
7. Think about the yield-management problem in the context of the cost of errors that might be made. An airline that reserves too many seats for business passengers runs the risk of having them vacant as the flight leaves the airport. These are the seats that you can buy for almost nothing if you are willing to make travel plans to go where the airline has room at the last minute (or in the last 24 hours—a little revenue is better than none at that point). An airline that reserves too few seats for business travellers runs the risk of selling them to low-paying leisure travellers when they could have sold them for more. Discuss this tradeoff, and think about strategies like overbooking that airlines might employ to minimize their risk.
8. Do you think that the long-run price elasticity for business travel is much higher than in the short run? Would it be as sensitive to the time period as the price elasticity for leisure travel?

From: Mansfield & Yohe, *Microeconomics*.

Case Study II: How the Japanese Revolutionized Manufacturing Techniques

Everyone has heard of Henry Ford, the American manufacturing genius who was responsible for mass production methods in the automobile industry, but few have heard of Taiichi Ohno, the Japanese manufacturing genius responsible for his country's hugely successful repudiation of many of Ford's teachings. In the 1950s, Ohno concluded that mass production methods were not the optimal techniques for his employer, Toyota, a major automobile producer. Instead, he devised a production system often called "lean production" because, in the words of engineers at the Massachusetts Institute of Technology, "it uses less of everything than a comparable mass-production operation: half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product."[1]

In Ford's mass production system, each worker performed only a single task at a station beside a moving assembly line. To complement these narrowly focused production workers on the assembly floor, there was a small army of indirect workers who repaired tools, inspected for quality defects, and fixed up the defects that were identified. The emphasis was on keeping the assembly line moving, since stopping the line would result in delays and lost production which would necessitate expensive overtime work. Moreover, it was felt that little was lost by allowing defective items to go down the line since they could be fixed up later.

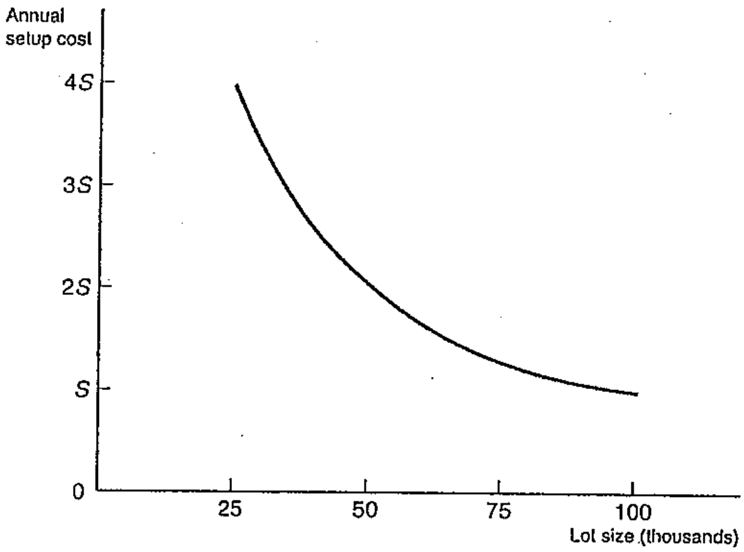
Ohno felt that this system was riddled with waste. In his view, the hordes of engineering and production specialists were not necessary; their work could be transferred to the assembly workers, if the latter were properly trained. Ohno organized the workers into teams and instructed them to decide for themselves how to do the necessary work. Each team was given a leader who participated in the assembly operations. Gradually the teams were given added responsibility, such as minor tool repair and quality checking, and they were asked to suggest ways to improve the manufacturing process. Moreover, in contrast to Ford's mass production system, each worker could stop the assembly line if problems developed that could not be resolved quickly. But the workers were expected to root out the causes of the problems. Eventually the number of errors fell, until now Toyota's assembly plants devote almost no labour hours to fixing mistakes (in contrast to mass production plants where 25 percent of total labour hours may be devoted to such activity). And ironically, although each worker can stop the assembly line, this very seldom occurs.

Turning from auto production to manufacturing generally, one of the hall-marks of Japanese manufacturers is that products are made in small batches or lots, whereas in the United States they have been made in relatively large batches or lots. There are many advantages in small lot sizes. Less inventories must be held. Also, there may be less scrap and better quality of workmanship. If a worker makes a single part and passes it to the next worker immediately (rather than making a large batch of the parts and then passing them on all at once), the first worker will be informed very soon if the next worker finds it defective. Thus the causes of defects tend to be nipped in the bud, and the production of large lots containing many defective items is avoided. Why have American firms

1. J. Womack, D. Jones, and D. Roos, *New York Times,* September 23, 1990.

produced relatively large lot sizes? To answer this question, we must discuss the factors determining the most economical lot size. Suppose that a firm needs to produce 100,000 identical parts of a particular type per year. For example, a manufacturer of outboard motors may have

FIGURE 1. Relationship between the Size of Lot and the Annual Setup Costs. *The larger the lot size, the lower the annual setup costs.*

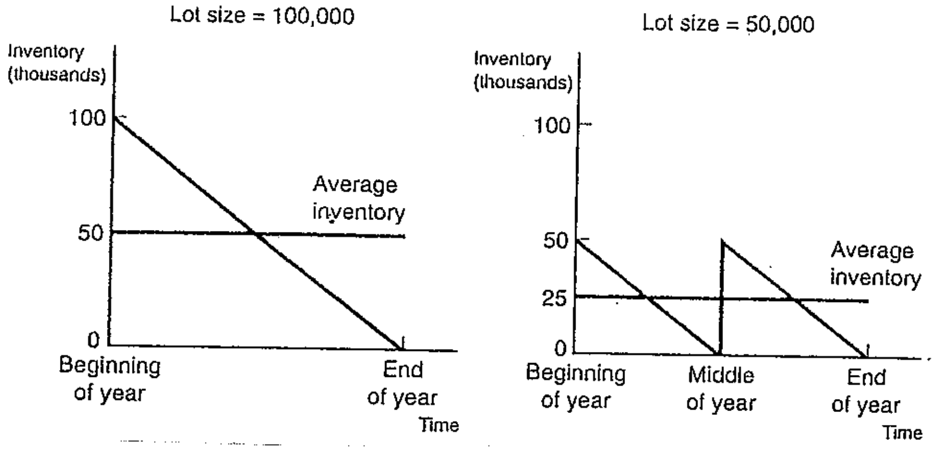


to produce 100,000 parts of a particular type, since each of its outboard motors requires such a part. Each time that the firm begins to produce this type of part, it incurs a setup cost of S dollars. For example, the outboard motor manufacturer may have to devote considerable labour time to setting up the equipment that produces this part. The advantage of producing large lots is that this cuts the total setup costs incurred during the year. If the firm were to produce its annual requirement of 100,000 parts in one huge lot, it would have to set up the equipment once, the result being that its total setup costs for the year would be S dollars. If it produced its annual requirement of 100,000 parts in two lots (each of 50,000), it would have to set up the equipment twice, the result being that the total setup costs for the year would be $2S$ dollars. The relationship between the size of a lot and the annual total setup costs is shown in Figure 1.

The disadvantage of producing large lots is that they result in large inventories that are expensive to maintain and finance. If, for example, the firm produces all 100,000 of the parts in one huge lot at the beginning of the year, its inventory equals 100,000 parts at the beginning of the year and zero parts at the end of the year. It's average inventory is 50,000 parts, as shown in the left-hand panel of Figure 2. On the other hand, if the firm produces the annual requirement of 100,000 parts in two lots (each of 50,000 units), its inventory equals 50,000 parts at the beginning of the year and zero parts at the end of six months; then after the second lot is produced, its inventory jumps back up to 50,000 parts, after which it declines once again to zero parts at the end of the year. Thus its average inventory is 25,000 parts, as shown in the right-hand panel of Figure 2.

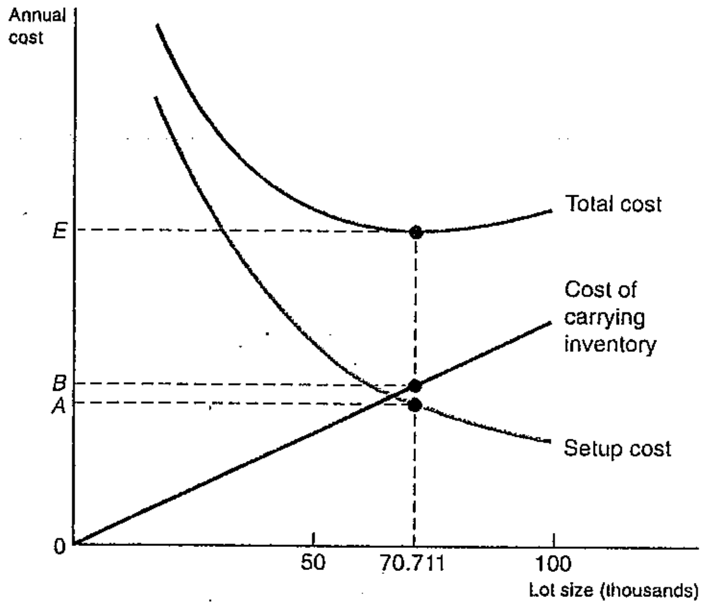
Assuming that the annual cost of holding inventory is proportional to the average

FIGURE 2. Size of Inventory During the Year, Given that Lot Size Equals 100,000 and 50,000. *Average inventory is 50,000 parts if the lot size equals 100,000, and 25,000 parts if the lot size equals 50,000.*



inventory, the relationship between the size of a lot and the annual cost of holding inventory is shown in Figure 3. Adding the annual setup costs for each lot size (taken from Figure 1 and reproduced in Figure 3) to

FIGURE 3. Relationship between Size of Lot and Total Annual Costs. Total cost is the sum of the cost of carrying inventory and the setup cost. Thus the "Total cost" curve is the vertical sum of the "Cost of carrying inventory" curve and the "Setup cost" curve. For example, if the Lot size is 70,711, annual setup cost equals OA, annual inventory cost equals OB, and annual total cost equals $OA + OB = OE$.



the inventory costs, we obtain the total annual cost for each tot size. Under the conditions shown in Figure 3, the optimal lot size is 70,711, where the total annual costs are a minimum.[2]

The value of the optimal lot size depends on the cost of setting up the equipment each time. If this cost is high, the optimal lot size tends to be large; if it is low, the optimal lot size tends to be small. This fact is shown in Figure 4. In the upper panel, the cost of each setup is large, which means that the curve showing the annual setup costs is higher than in the lower panel where the cost of each setup is small. Consequently, the optimal lot size, *OL*, is bigger in the case shown in the upper panel than in the case shown in the lower panel.

At this point, it is easy to understand why American firms have produced larger lot sizes than Japanese firms. The Japanese, using ingenuity and determination, have succeeded in lowering the cost of each setup. In other words, the Japanese have managed to get themselves into the situation shown in the lower panel of Figure 4, whereas American firms have tended to be in the situation shown in the top panel. The importance of this factor has been pointed out in the following way by Robert Hall:

> When the Japanese explain in detail how they achieved their big increases in productivity, the biggest "war stories" from the plant floor involve hard-fought battles to reduce setup times on a piece of equipment which at first was regarded as an insurmountable obstacle. Accounts of these battles detail changing the design of bolts, and the fit of pieces together on the machine. They describe the building of special tools to speed changeover, and practice sessions to learn how to perform changeovers quickly.[3]

To illustrate more specifically how the Japanese have gone about this, let's return to Toyota. In 1971, it took Toyota's workers about an hour to set up the 800-ton presses used in forming auto hoods and fenders. After five years of intensive effort, the setup time was reduced to 12 minutes (as contrasted with about 6 hours in the United States), and the aim was to reduce it to under 10 minutes. To accomplish this, "The press was modified to allow the old dies to quickly slide out of the press onto a waiting table while new dies are pushed in from the other side. The workers performing the changeover 'dry run' the procedure so that it worked like kicking the extra point after a touchdown in football."[4]

Recognizing the importance of this factor, American firms have been devoting

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2. In general, total annual setup costs equal SQ/L, where S is the cost per setup, Q is the total annual requirement of the relevant part, and L is the number of identical parts of this sort produced in a lot. Since $L/2$ is the average inventory, the annual cost of holding inventory equals $bL/2$, where b is the annual cost of holding each identical part of this sort in inventory for a year. Adding the annual setup costs and the annual costs of holding inventory, we obtain the following expression for the total annual costs:

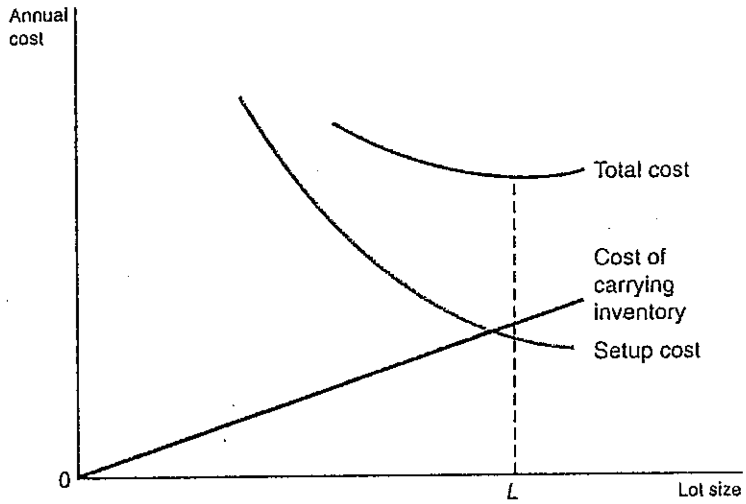
$$C = bL/2 + SQ/L.$$

To minimize total annual costs, we set $\frac{dC}{dL} = \frac{b}{2} - SQ/L^2 = 0$. Solving for L, we find that, to minimize total annual costs, L should equal $\frac{\sqrt{2SQ}}{b}$

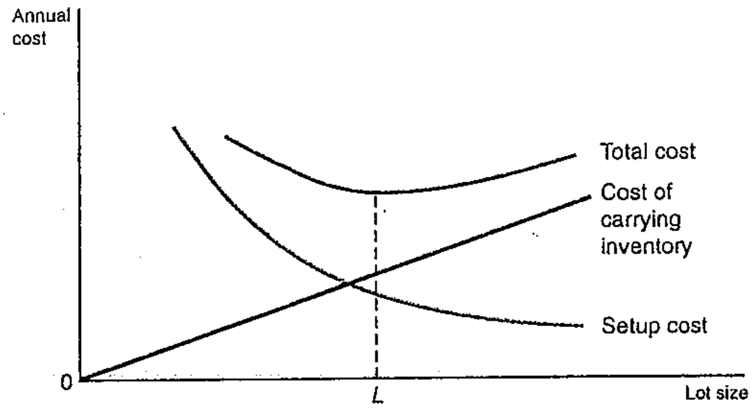
In the particular case in Figure 3, Q equals 100,000 and b equals $S/25{,}000$. Thus, to minimize total annual costs, L should equal $\sqrt{2S(100,000)\ /\ (S/25,000)} = \sqrt{5\,\text{billion}} = 70{,}711$. In other words the optimal lot size is 70,711, which means that 70,711 identical parts of this sort should be produced in each lot. (Of course, there is no reason for the number of setups per year to be an integer number. For example, one could have 5 setups during each two-year period, or 2½ setups per year.)

3. R. Schonberger, *Japanese Manufacturing Techniques*, New York: Free Press, 1982, p.20

FIGURE 4. Effect of Cost per Setup on Optimal Lot Size. *If the cost per setup is relatively high (as in panel A), the optimal lot size tends to be relatively large.*



A. High setup cost



B. Low setup cost

considerable effort to making similar reductions in setup costs. Because the Japanese industrial climate differs in many respects from that in the United States, it would be simplistic to think that what works in Japan will necessarily work in the United States. But there can be no doubt about the American interest in Japanese manufacturing techniques, as illustrated by the fact that 20,000 manufacturing executives and production engineers traveled to Toyota's Georgetown, Kentucky plant in 1991 alone to learn more about its operation.[5]

4. Ibid.,p.21.

Questions:

1. When Toyota reduced the time required to set up its presses, did it change its production function? If so, how?
2. If the manufacturer of outboard motors incurs a setup cost of $100,000 each time that it begins to produce a particular type of part, how much are its total setup costs per year if it produces 50,000 parts of this type each year and if the lot size is 10,000?
3. Under the conditions described in the previous question, what is the average level of inventory for this part? Why is it likely that the cost to the firm of carrying this inventory will increase as the inventory gets bigger?
4. Under the conditions described in Question 2, if the annual cost to the firm of holding each identical part of this sort in the inventory is $2, what is the total annual cost of holding inventory? What is the sum of the annual setup cost and the annual cost of holding inventory?
5. Under the conditions described in Questions 2 and 4, is the firm producing the optimal lot size? If not, what is the optimal lot size?
6. The firm's managers ask you to estimate how sensitive the firm's total cost (of setup and holding inventory) is to variations in the lot size from its optimal level. Why is this question important, and how would you answer it?
7. A government official asks you whether American firms should invest whatever resources are required to reduce their setup costs to the Japanese level. How would you answer this question?

From: Mansfield, *Microeconomics*.

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5. Ibid., and R.Hayes, "Why Japanese Factories Work," in A. Kantrow (ed), *Survival Strategies for American Industry* (New York: Wiley, 1983).