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BUILDING AIRPLANES

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ABSTRACT

This exercise has worked well in microeconomics courses to illustrate many of the basic concepts involved in the study of marginal supply curves for firms and industries. It also helps students understand the demand for labor and the effects of technological advances. With minor changes in the exercise itself, it could easily be used to examine issues in introductory management, organizational theory, strategy and policy, etc. Consequently, this paper discusses some of these potential uses as well as my actual use of the exercise in my microeconomics courses.

INTRODUCTION

In this exercise students make paper airplanes for educational benefit rather than for teacher harassment. The company involved begins with a single owner-builder and grows to a full-scale assembly line. As the exercise progresses, new technologies are introduced, affecting production methods, optimal numbers of workers, etc.

Objectives

Since microeconomics courses and texts vary significantly in the sequence of topics, what you stress with this exercise will depend on your particular situation. I have listed the basic objectives for my use of it below:

1. To identify some economies of scale which contribute to an initially decreasing marginal cost curve for the firm.
2. To illustrate the law of diminishing returns as more workers are added.
3. To demonstrate the effects of new technologies on worker productivity, optimal numbers of workers, etc.
4. To relate marginal physical product (MPP) and marginal revenue product (MRP) to worker wages and the number of workers hired, and to show how productivity gains permit noninflationary wage increases.

Possible approaches for other business courses are discussed later in the section entitled, "Some Possible Variations."

Time Requirements

The exercise can be completed successfully in as little as fifty minutes, including a fairly thorough debrief.

Group Size

Each assembly line should have at least ten people available for the labor pool. Also, each line needs several observers to study the changes that occur as new workers and technologies are added. In a large class, you can operate several assembly lines or use one assembly line and have the rest of the class observe.

Materials Required for Each Assembly Line

1. About 70 sheets of paper at least 8½ x 11 (I used discarded computer paper because it was cheap!).
2. Colored felt markers (two or three colors are plenty).
3. One pair of scissors.
4. Two rulers.
5. Tape dispenser with tape.
6. Tape on roll and NOT in dispenser. A refill roll for a tape dispenser works fine and is marvelously hard to use (an asset in this exercise).
7. One piece of fairly sturdy cardboard (10"x12"), posterboard, or mat board.
8. Watch, preferably with stop watch function.

CONDUCTING THE EXERCISE

1. Select one student to be the owner-builder in the new airplane business.
2. Give (orally or in writing) the student the specification for the airplanes to be built. Here are the ones I have used with computer paper (11" x 14"). Note that the students must cut the paper on two sides to meet the specifications.
 - a. Airplane to be folded from a piece of paper 10" x 12" with tolerance of ±0.25 inches in both dimensions (see Figure 1 for folding layout).
 - b. Finished dimensions in inches:
Width at tail: 5.75 - 6.25
Length: 11.75 - 12.25
Height: 1.75 - 2.25
 - c. Fasteners: Taped at nose, under fuselage, and at rear of airplane (see Figure 2).
 - d. Decals: Anything and anywhere you wish. You can really increase the construction time with complex decals and lettering if you desire.
 - e. Flying ability: Not required.
3. Show the student how to fold the airplane. If have trouble, ask a kid in fifth or sixth grade to help you!
4. Give the student the scissors, two rulers, markers, tape NOT on a dispenser, and the paper; let the student build two airplanes for practice to reduce learning curve effects later.

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5. Tell the student all finished airplanes can be sold for \$1000 and that partially completed airplanes are prorated.
 6. Have the student build as many airplanes as possible in five minutes, and instruct the observers to watch what procedures the student follows in building the airplanes. Record the number of completed airplanes (fractions of airplanes are permissible).
 7. Add three workers, and give the owner and employees a few minutes to decide the best way to do the work. Let them test their work layout and train the new employees by building two practice airplanes. Then have them build as many airplanes as possible in five minutes; record production totals. NOTE: The purpose of adding three workers at once is to reduce the time required to reach the point of diminishing returns. You could, of course, add any number you wish.
 8. Explain to the class two new technological advances which have occurred: 1) a tape dispenser, which greatly simplifies the fastening operation; and 2) a pattern (10" x 12" piece of cardboard) to reduce layout time. Give them to the student-owner, and have the students build as many airplanes as possible in five minutes. Record production totals.
 9. Add three workers and repeat Step 7, omitting the practice time. Again record the number of airplanes built.
 10. Repeat Step 9.
 11. By now the students should have already reached the point of diminishing returns (my groups often reach it before this point). Unless you have a budding industrial engineer in the group, you should have people tripping over each other. Marginal revenue product should be falling. Stop the exercise and discuss what happened.
3. The eventual decreases in MPP and MRP which occur as the point of diminishing returns is reached (usually seven to nine workers). In this exercise, the shortage of capital (scissors, ruler, etc.) is usually the limiting factor, but sometimes unmotivated workers and a lack of managerial supervision produce this effect first. Point out that in real life the company could usually purchase more capital goods.
 4. The price the company would be willing to pay for the new technology. Here the time value of money becomes important; if you are not covering this topic in your course, you may want to explain it intuitively.
 5. The wage the company is willing to pay its workers based on the MRP, and the effects of increasing worker productivity on this wage.
 6. The point where the company stops hiring workers. This point is NOT synonymous with the point of diminishing returns, but for some reason students often think it is.

SOME POSSIBLE VARIATIONS

Depending on your orientation, you might want to include some of the following ideas in a basic economics course. Even more importantly, I believe you could use them to adapt the basic exercise to many other business courses as well.

1. Operate several companies at once, and give each student-owner considerable autonomy. For example, allow the students to choose their workers and decide whether to buy the new technologies and purchase more capital equipment (scissors, tape dispenser, markers, etc.). Also look for differences in leadership style and note the effects on the companies. Finally, discuss the organization of each company (division of labor, structure of jobs, presence or absence of supervisors, communication patterns, etc.) and the resulting production each group achieved.
2. At some point in the exercise, change the technology or the capital equipment so that some workers are no longer needed. Observe the effects on these workers. You might want to give the student-owner the right to lay off such workers. Explore the feelings of any idled workers.
3. Discuss the feelings of all workers as the company grows from a one-person shop to an assembly line. How much satisfaction is there in doing one small part of the whole job as compared to building the whole airplane? What can be done to make the work both fun and efficient?
4. Discuss the changing need for managerial controls as the company grows. What are some of the costs of implementing these controls? For example, if the owner decides to spend his time managing, he cannot produce parts of the airplanes as he did previously. A similar situation exists if he designates one person to serve as a quality controller.

CONCLUSION

In describing this exercise, I have tried to include the most important points of the procedure and the debrief. However, because of all the things which could happen whenever you try something new, the real credit for successfully using this or any other

DEBRIEFING THE EXERCISE

These debriefing suggestions are based on the assumption that, for the most part, things went according to plan (e.g., the students were able to produce more with the new technologies than without them!). If the numbers didn't work the way you hoped, improvise! Here are some basic points I encourage students to explore and discuss, but I am sure you can find many other points to make as well.

1. The increases in MPP and MRP which accompany the adoption of mass production techniques (division of labor, etc.) as the company grows.
2. The dramatic increases made possible by technological advances and the changes in optimal work layout and numbers of workers needed to benefit fully from the new technologies. For example, with the 10" x 12" pattern, a student can mark and cut out more 10" x 12" sheets than one person can fold; thus, two people folding airplanes can usually work more efficiently than one person. Also, one person can usually fasten (tape) the output of at least two folders with the new high-technology tape dispenser, whereas with just a roll of tape (no dispenser) the work is much slower. As workers are added and production increases, it often is beneficial to have several workers applying the "decals," each one using a separate color so tool changeover is minimized.

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exercise belongs to you. Your creativity in adapting it to the needs of your classes, your insight in discovering important applications I missed, and your ability to improvise, to think on your feet, and to change direction as the classroom situation dictates will make it work for you.

FIGURE 1
FOLDING DIAGRAM

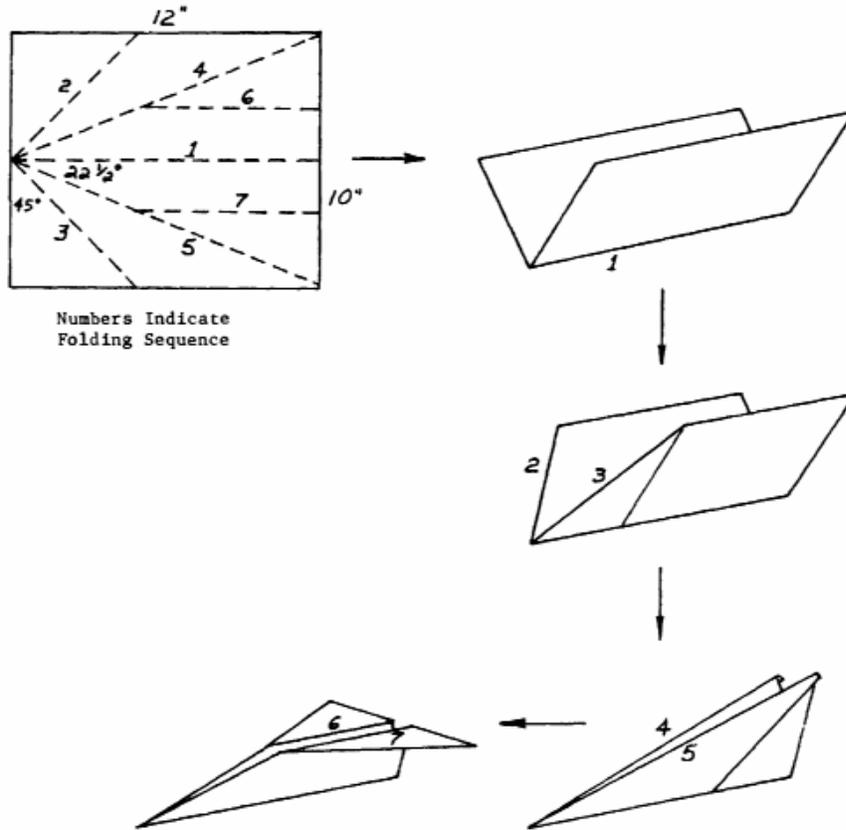


FIGURE 2
TAPING DIAGRAM

