SOLVED PROBLEM S7.5

T. SmunL Manufacturing Corp. has the process displayed below. The drilling operation occurs separately from and simultaneously with the sawing and sanding operations. The product only needs to go through one of the three assembly operations (the assembly operations are “parallel”).

a) Which operation is the bottleneck?

b) What is the throughput time for the overall system?

d) Suppose that a second drilling machine is added, and it takes the same time as the original drilling machine. What is the new bottleneck time of the system?

e) Suppose that a second drilling machine is added, and it takes the same time as the original drilling machine. What is the new throughput time?

SOLUTION

a) The time for assembly is 78 minutes/3 operators = 26 minutes per unit, so the station that takes the longest time, hence the bottleneck, is drilling, at 27 minutes.

b) System throughput time is the maximum of (15 + 15 + 25 + 78), (27 + 25 + 78) = maximum of (133, 130) = 133 minutes.

c) Monthly capacity = (60 minutes)(8 hours)(22 days)/27 minutes per unit = 10,560 minutes per month/27 minutes per unit = 391.11 units/month.

d) The bottleneck shifts to Assembly, with a time of 26 minutes per unit.

e) Redundancy does not affect throughput time. It is still 133 minutes.

Problems

**S7.1** Southeastern Oklahoma State University’s business program has the facilities and faculty to handle an enrollment of 2,000 new students per semester. However, in an effort to limit class sizes to a “reasonable” level (under 200, generally), Southeastern’s dean, Holly Luize, placed a ceiling on enrollment of 1,500 new students. Although there was ample demand for business courses last semester, conflicting schedules allowed only 1,450 new students to take business courses. What are the utilization and efficiency of this system?

- **S7.2** Amy Xia’s plant was designed to produce 7,000 hammers per day but is limited to making 6,000 hammers per day because of the time needed to change equipment between styles of hammers. What is the utilization?

- **S7.3** If a plant has an effective capacity of 6,500 and an efficiency of 88%, what is the actual (planned) output?

- **S7.4** A plant has an effective capacity of 900 units per day and produces 800 units per day with its product mix; what is its efficiency?

- **S7.5** Material delays have routinely limited production of household sinks to 400 units per day. If the plant efficiency is 80%, what is the effective capacity?

- **S7.6** For the past month, the plant in Problem S7.2, which has an effective capacity of 6,500, has made only 4,500 hammers per day because of material delay, employee absences, and other problems. What is its efficiency?

- **S7.7** The effective capacity and efficiency for the next quarter at MMU Mfg. in Waco, Texas, for each of three departments are shown:

<table>
<thead>
<tr>
<th>DEPARTMENT</th>
<th>EFFECTIVE CAPACITY</th>
<th>RECENT EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>95,600</td>
<td>.95</td>
</tr>
<tr>
<td>Fabrication</td>
<td>156,000</td>
<td>1.03</td>
</tr>
<tr>
<td>Finishing</td>
<td>62,400</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Compute the expected production for next quarter for each department.

- **S7.8** Under ideal conditions, a service bay at a Fast Lube can serve 6 cars per hour. The effective capacity and efficiency of a Fast Lube service bay are known to be 5.5 and 0.880,
respectively. What is the minimum number of service bays Fast Lube needs to achieve an anticipated servicing of 200 cars per 8-hour day?

**S7.9** A work cell at Chris Ellis Commercial Laundry has a workstation with two machines, and each unit produced at the station needs to be processed by both of the machines. (The same unit cannot be worked on by both machines simultaneously.) Each machine has a production capacity of 4 units per hour. What is the throughput time of the work cell?

**S7.10** A production line at V. J. Sugumaran’s machine shop has three stations. The first station can process a unit in 10 minutes. The second station has two identical machines, each of which can process a unit in 12 minutes. (Each unit only needs to be processed on one of the two machines.) The third station can process a unit in 8 minutes. Which station is the bottleneck station?

**S7.11** The three-station work cell illustrated in Figure S7.7 has a product that must go through one of the two machines at station 1 (they are parallel) before proceeding to station 2.

![Figure S7.7](image)

a) What is the bottleneck time of the system?
b) What is the bottleneck station of this work cell?c) What is the throughput time?
d) If the firm operates 10 hours per day, 5 days per week, what is the weekly capacity of this work cell?

**S7.12** The three-station work cell at Pullman Mfg., Inc. is illustrated in Figure S7.8. It has two machines at station 1 in parallel (i.e., the product needs to go through only one of the two machines before proceeding to station 2).

a) What is the throughput time of this work cell?
b) What is the bottleneck time of this work cell?
c) What is the bottleneck station?

**S7.13** Klassen Toy Company, Inc., assembles two parts (parts 1 and 2): Part 1 is first processed at workstation A for 15 minutes per unit and then processed at workstation B for 10 minutes per unit. Part 2 is simultaneously processed at workstation C for 20 minutes per unit. Work stations B and C feed the parts to an assembler at workstation D, where the two parts are assembled. The time at workstation D is 15 minutes.

a) What is the bottleneck of this process?
b) What is the hourly capacity of the process?

d) If the firm operates 8 hours per day, 6 days per week, what is the weekly capacity of this work cell?

**S7.14** The Pullman Mfg., Inc. three-station work cell illustrated in Figure S7.8 has two machines at station 1 in parallel. (The product needs to go through only one of the two machines before proceeding to station 2.) The manager, Ms. Hartley, has asked you to evaluate the system if she adds a parallel machine at station 2.

a) What is the throughput time of the new work cell?
b) What is the bottleneck time of the new work cell?
c) If the firm operates 8 hours per day, 6 days per week, what is the weekly capacity of this work cell?
d) How did the addition of the second machine at workstation 2 affect the performance of the work cell from Problem S7.12?

**S7.15** Smithson Cutting is opening a new line of scissors for supermarket distribution. It estimates its fixed cost to be $500.00 and its variable cost to be $0.50 per unit. Selling price is expected to average $0.75 per unit.

a) What is Smithson’s break-even point in units?
b) What is the break-even point in dollars?

**S7.16** A production process at Kenneth Day Manufacturing is shown in Figure S7.9. The drilling operation occurs separately from, and simultaneously with, the sawing and sanding operations. A product needs to go through only one of the three assembly operations (the operations are in parallel).
a) Which operation is the bottleneck?
b) What is the bottleneck time?
c) What is the throughput time of the overall system?
d) If the firm operates 8 hours per day, 20 days per month, what is the monthly capacity of the manufacturing process?

- **7.17** Markland Manufacturing intends to increase capacity by overcoming a bottleneck operation by adding new equipment. Two vendors have presented proposals. The fixed costs for proposal A are $50,000, and for proposal B, $70,000. The variable cost for A is $12.00, and for B, $10.80. The revenue generated by each unit is $20.00.
  a) What is the break-even point in dollars for proposal A?
  b) What is the break-even point in units for proposal B?
  c) What is the throughput time or the overall system?
  d) If the firm operates 8 hours per day, 20 days per month, what is the monthly capacity of the manufacturing process?

- **7.18** Given the data in Problem 7.17, at what volume (units) of output would the two alternatives yield the same profit?

- **7.19** Using the data in Problem 7.17:
  a) What is the break-even point in dollars for proposal A if you add $10,000 installation to the fixed cost?
  b) What is the break-even point in dollars for proposal B if you add $10,000 installation to the fixed cost?

- **7.20** Janelle Heinke, the owner of Ha'Peppas!, is considering a new oven in which to bake the firm's signature dish, vegetarian pizza. Oven type A can handle 20 pizzas an hour. The fixed costs associated with oven A are $20,000 and the variable costs are $2.00 per pizza. Oven B is larger and can handle 40 pizzas an hour. The fixed costs associated with oven B are $30,000 and the variable costs are $1.25 per pizza. The pizzas sell for $14 each.
  a) What is the break-even point for each oven?
  b) If the owner expects to sell 9,000 pizzas, which oven should she purchase?
  c) If the owner expects to sell 12,000 pizzas, which oven should she purchase?
  d) At what volume should Janelle switch ovens?

- **7.21** Given the following data, calculate:
  a) BEP;  
b) BEP;  
c) the profit at 100,000 units:

\[ P = \$8/\text{unit} \quad V = \$4/\text{unit} \quad F = \$50,000 \]

- **7.22** You are considering opening a copy service in the student union. You estimate your fixed cost at $15,000 and the variable cost of each copy sold at $0.01. You expect the selling price to average $0.50.
  a) What is the break-even point in dollars?
  b) What is the break-even point in units?

- **7.23** An electronics firm is currently manufacturing an item that has a variable cost of $5.00 per unit and a selling price of $1.00 per unit. Fixed costs are $14,000. Current volume is 30,000 units. The firm can substantially improve the product quality by adding a new piece of equipment at an additional fixed cost of $6,000. Variable cost would increase to $6.00, but volume should jump to 50,000 units due to a higher-quality product. Should the company buy the new equipment?

- **7.24** The electronics firm in Problem 7.23 is now considering the new equipment and increasing the selling price to $1.10 per unit. With the higher-quality product, the new volume is expected to be 45,000 units. Under these circumstances, should the company purchase the new equipment and increase the selling price?

- **7.25** Zan Azlett and Angela Zesiger have joined forces to start A&Z Lettuce Products, a processor of packaged shredded lettuce for institutional use. Zan has years of food processing experience, and Angela has extensive commercial food preparation experience. The process will consist of opening crates of lettuce and then sorting, washing, slicing, preserving, and finally packaging the prepared lettuce. Together, with help from vendors, they think they can adequately estimate demand, fixed costs, revenues, and variable cost per 5-pound bag of lettuce. They think a largely mechanized process will have monthly fixed costs of $37,500 and variable costs of $1.25 per bag. A more mechanized process will have fixed costs of $75,000 per month with variable costs of $1.25 per 5-pound bag. They expect to sell the shredded lettuce for $2.50 per 5-pound bag.
  a) What is the break-even quantity for the manual process?
  b) What is the revenue at the break-even quantity for the manual process?
  c) What is the break-even quantity for the mechanized process?
  d) What is the revenue at the break-even quantity for the mechanized process?
  e) What is the monthly profit or loss of the manual process if they expect to sell 60,000 bags of lettuce per month?
  f) What is the monthly profit or loss of the mechanized process if they expect to sell 60,000 bags of lettuce per month?
  g) At what quantity would Zan and Angela be indifferent to the process selected?
  h) Over what range of demand would the manual process be preferred over the mechanized process? Over what range of demand would the mechanized process be preferred over the manual process?

- **7.26** As a prospective owner of a club known as the Red Rose, you are interested in determining the volume of sales dollars necessary for the coming year to reach the break-even point. You have decided to break down the sales for the club into four categories, the first category being beer. You estimate of the beer sales is that 30,000 drinks will be sold. The selling price for each unit will average $1.50; the cost is $0.75. The second major category is meals, which you expect to be 10,000 units with an average price of $10.00 and a cost of $5.00. The third major category is desserts and wine, of which you also expect to sell 10,000 units, but with an average price of $2.50 per unit sold and a cost of $1.00 per unit. The final category is lunches and inexpensive sandwiches, which you expect to total 20,000 units at an average...
price of $6.25 with a food cost of $3.25. Your fixed cost (i.e., rent, utilities, and so on) is $1,800 per month plus $2,000 per month for entertainment.

a) What is your break-even point in dollars per month?

b) What is the expected number of meals each day if you are open 30 days a month?

\*\*7.27 As manager of the St. Cloud Theatre Company, you have decided that concession sales will support themselves. The following table provides the information you have been able to put together thus far:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SELLING PRICE</th>
<th>VARIABLE COST</th>
<th>% OF REVENUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft drink</td>
<td>$1.00</td>
<td>$0.65</td>
<td>25</td>
</tr>
<tr>
<td>Wine</td>
<td>$1.75</td>
<td>$0.95</td>
<td>25</td>
</tr>
<tr>
<td>Coffee</td>
<td>$1.00</td>
<td>$0.30</td>
<td>30</td>
</tr>
<tr>
<td>Candy</td>
<td>$1.00</td>
<td>$0.30</td>
<td>30</td>
</tr>
</tbody>
</table>

Last year’s manager, Jim Freeland, has advised you to be sure to add 10% of variable cost as a waste allowance for all categories.

You estimate labor cost to be $250.00 (5 booths with 2 people each). Even if nothing is sold, your labor cost will be $250.00, so you decide to consider this a fixed cost. Booth rental, which is a contractual cost at $50.00 for each booth per night, is also a fixed cost.

a) What is the break-even volume per evening performance?

b) How much wine would you expect to sell each evening at the break-even point?

\*\*7.28 James Lawson’s Bed and Breakfast, in a small historic Mississippi town, must decide how to subdivide (remodel) the large old home that will become its inn. There are three alternatives: Option A would modernize all baths and combine rooms, leaving the inn with four suites, each suitable for two to four adults. Option B would modernize only the second floor; the result would be six suites, four for two to four adults, two for two adults only. Option C (the status quo option) leaves all walls intact. In this case, there are eight rooms available, but only two are suitable for four adults, and four rooms will not have private baths. Below are the details of profit and demand patterns that will accompany each option:

<table>
<thead>
<tr>
<th>ALTERNATIVES</th>
<th>ANNUAL PROFIT UNDER VARIOUS DEMAND PATTERNS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIGH</td>
</tr>
<tr>
<td>A (modernize all)</td>
<td>$90,000</td>
</tr>
<tr>
<td>B (modernize 2nd)</td>
<td>$80,000</td>
</tr>
<tr>
<td>C (status quo)</td>
<td>$60,000</td>
</tr>
</tbody>
</table>

Which option has the highest expected monetary value?

\*\*7.29 What is the net present value of an investment that costs $75,000 and has a salvage value of $45,000? The annual profit from the investment is $15,000 each year for 5 years. The cost of capital at this risk level is 12%. Determine, via the present value method, which machine Tim should recommend.

\*\*7.30 What is the present value of $5,600 when the interest rate is 8% and the return of $5,600 will not be received for 15 years?

\*\*7.31 As operations manager of Holz Furniture, you must make a decision about adding a line of rustic furniture. In discussing the possibilities with your sales manager, Steve Gilbert, you decide that there will definitely be a market and that your firm should enter that market. However, because rustic furniture has a different finish than your standard offering, you decide you need another process line. There is no doubt in your mind about the decision, and you are sure that you should have a second process. But you do question how large to make it. A large process line is going to cost $400,000; a small process line will cost $300,000. The question, therefore, is the demand for rustic furniture. After extensive discussion with Mr. Gilbert and Tim Ireland of Ireland Market Research, Inc., you determine that the best estimate you can make is that there is a two-out-of-three chance of profit from sales as large as $600,000 and a one-out-of-three chance as low as $300,000.

With a large process line, you could handle the high figure of $600,000. However, with a small process line, you could not and would be forced to expand (at a cost of $150,000), after which time your profit from sales would be $500,000 rather than the $600,000 because of the lost time in expanding the process. If you do not expand the small process, your profit from sales would be held to $400,000. If you build a small process and the demand is low, you can handle all of the demand.

Should you open a large or small process line?

\*\*7.32 The initial cost of an investment is $65,000 and the cost of capital is 10%. The return is $16,000 per year for 8 years. What is the net present value?

\*\*7.33 Tim Smunt has been asked to evaluate two machines. After some investigation, he determines that they have the costs shown in the following table. He is told to assume that:

1. The life of each machine is 3 years.
2. The company thinks it knows how to make 12% on investments no more risky than this one.
3. Labor and maintenance are paid at the end of the year.

<table>
<thead>
<tr>
<th>MACHINE A</th>
<th>MACHINE B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original cost</td>
<td>$10,000</td>
</tr>
<tr>
<td>Labor per year</td>
<td>2,000</td>
</tr>
<tr>
<td>Maintenance per year</td>
<td>4,000</td>
</tr>
<tr>
<td>Salvage value</td>
<td>2,000</td>
</tr>
</tbody>
</table>

Determine, via the present value method, which machine Tim should recommend.

\*\*7.34 Bold’s Gym, a health club chain, is considering expanding into a new location: the initial investment would be $1 million in equipment, renovation, and a 6-year lease, and its annual upkeep and expenses would be $75,000 (paid at the beginning of the year). Its planning horizon is 6 years out, and at the end, it can sell the equipment for $30,000. Club capacity is 500 members who would pay an annual fee of $600. Bold’s expects to have no problems filling membership slots. Assume that the interest rate is 10%. (See Table 7.1)