a. Construct the economic breakeven chart.
b. Compare annual profit when the plant is operating at 90% of capacity with the plant operation at 100% capacity. Assume that the first 90% of capacity output is sold at \$90 per unit, and the remaining 10% of production is sold at \$70 per unit. (2.3)

2-19. The fixed cost for a steam line per meter of pipe is \$350X + \$50 per year. The cost for loss of heat from the pipe per meter is \$4.8/$X^{1/2}$ per year. Here X represents the thickness of insulation in meters, and X is a continuous design variable. (2.4)

a. What is the optimum thickness of the insulation?
b. How do you know that your answer in (a) minimizes total cost per year?
c. What is the basic tradeoff being made in this problem?

2-20. A farmer estimates that if he harvests his soybean crop now, he will obtain 1,000 bushels, which he can sell at \$3.00 per bushel. However, he estimates that this crop will increase by additional 1,200 bushels of soybeans for each week he delays harvesting, but the price will drop at a rate of 50 cents per bushel per week. In addition, it is likely that he will experience spoilage of approximately 200 bushels per week for each week he delays harvesting. When should he harvest his crop to obtain the largest net cash return, and how much will be received for his crop at that time? (2.4)

2-21. A recent engineering graduate was given the job of determining the best production rate for a new type of casting in a foundry. After experimenting with many combinations of hourly production rates and total production cost per hour, he summarized his findings in Table I below. The engineer then talked to the firm's marketing specialist, who provided these estimates of selling price per casting as a function of production output (see Table II below). There are 8,760 hours in a year. (2.4)

a. What production rate would you recommend to maximize total profits per year?
b. How sensitive is the rate in (a) to changes in total production cost per hour?

2-22. The cost of operating a large ship (C_o) varies as the square of its velocity (v); specifically, $C_o = knv^2$, where n is the trip length in miles and k is a constant of proportionality. It is known that at 12 miles/hour the *average* cost of operation is \$100 per mile. The owner of the ship wants to minimize the cost of operation, but it must be balanced against the cost of the perishable cargo (C_c), which the customer has set at \$1,500 per hour. At what velocity should the trip be planned to minimize the total cost (C_T), which is the sum of the cost of operating the ship and the cost of perishable cargo? (2.4)

2-23. Refer to Example 2-10. If the cost of electricity is \$0.04 per kWh (instead of \$0.074 per kWh), which thickness of insulation should be recommended? Recall that the life of the insulation was assumed to be 25 years. Comment on the basic tradeoff that is being made in this problem (relative to Example 2-10). (2.4)

2-24.

a. Compare the probable part cost from Machine A and Machine B, assuming each will make the part to the same specification. Which

	Machine A	Machine B
Initial capital investment	\$35,000	\$150,000
Life	10 years	8 years
Salvage value	3,500	515,000
Parts required per year	10,000	10,000
Labor cost per hour	\$16	\$20
Time to make one part	20 minutes	10 minutes
Maintenance cost per year	\$1,000	\$3,000

(Pr. 2-21)

Table I	Total cost hour	\$ 1	\$2,600	\$3,200	\$3,900	\$4,700
	Castings produced/hour	100	200	300	400	500
Table II	Selling price casting	\$20.00	\$17.00	\$16.00	\$15.00	\$14.50
	Castings produced hour	100	200	300	400	500

(Pr 2-26)

	Carbon Steel	Tool Steel
Output at optimum speed	100 pieces/hour	130 pieces/hour
Time between tool grinds	3 hours	6 hours
Time required to change tools	1 huur	I hour
Cost of unsharpened tools	$400.00	$1200.00
Number of times tools can be ground	10	5

machine yields the lowest part cost? Assume the interest rate is negligible.

b. If the cost of labor can be cut in half by using part-time employees, which machine should be recommended?

2-25. The "We Win Them All" *Formula-Car* manufacturing company needs spindles for their rolling chassis. They can buy them from an outside manufacturer for $200 per spindle plus shipping costs. Each spindle weighs 18 lbs and shipping costs are $1.50 per pound. The outside manufacturer will give a discount for bulk orders (does not include shipping costs). The first 50 spindles are at full price, the next 50 have a 10% discount per spindle, and the next 50 have a 15% discount per spindle. Or they can make the spindles themselves. It costs $0.75/lb ior aluminum, takes 72 minutes per unit to machine, and the cost of the machine operator is $14.00/hour. Assume there is no scrap. Should the company produce or buy the spindles if 175 are needed? Support your answer. (2.5)

2-26. Either tool steel or carbon steel can be used for the set of tools on a certain lathe. It is necessary to sharpen the tools periodically. Relevant information for each is shown above.

The cost of the lathe operator is 514.00 per hour, including the tool-changing time during which he is idle. The tool changer costs $20.00 per hour fur just the time he is changing tools. Variable overhead costs for the lathe are $28.00 per hour, including tool-changing time. Which type of steel should be used to minimize overall cost per piece? (2.5)

2-27. An automatic machine can be operated at three speeds, with the following results

Speed	Output (pieces per hour)	Time between Toot Grinds (hours)
A	400	15
B	480	12
C	540	10

A set of unsharpened tools costs $150 and can be ground 20 times. The cost of each grinding is $25. The time required to change and reset the tools is 1.5 hours, and such changes are made by a tool-setter who is paid $8.00 per hour. Variable overhead on the machine is charged at the rate of $3.75 per hour, including tool-changing time. At which speed should the machine be operated to minimize total cost per piece? The basic tradeoff in this problem is between the rate of output and tool usage. (2.5)

2-28. A company is analyzing a make-versus-purchase situation for a component used in several products, and the engineering department has developed these data:

Option A. Purchase 10,000 items per year at a fixed price of $8.50 per item. The cost of placing the order is negligible according to the present cost accounting procedure.

Option B: Manufacture 10,000 items per year using available capacity in the factory. Cost estimates are direct materials = $5.00 per item and direct labor = $1.50 per item. Manufacturing overhead is allocated at 200% of direct labor (= $3.00 per item).

a. Based on these data, should the item be purchased or manufactured? (2.5)

b. If manufacturing overhead can be traced directly to this item—thus avoiding the 200% overhead rate—and it amounts to $2.15 per item, what choice should be recommended? (Traceable overhead is possible with an activity-based cost accounting procedure; is incremental to the manufacture of tlic part; and consists of such cost elements as employee training, material handling, quality control, supervision, and utilities.) Traceable overhead associated with purchasing this item (vendor certification, benchmarking, etc.) is $0.50 per item.

2-29. In the design of an automobile radiator, an engineer has a choice of using either a brassment associated with each operation is identical. Each completed part increases in value by $0.40 per part.

Operation 1 produces 2,000 parts per hour. After each hour, the tooling must be adjusted by the machine operator. This adjustment takes 20 minutes. The machine operator for Operation 1 is paid $20 per hour. (This includes fringe benefits.)

Operation 2 produces 1,750 parts per hour, but the tooling needs to be adjusted by the operator only once every two hours. This adjustment takes 30 minutes. The machine operator for Operation 2 is paid $11 per hour. (This includes fringe benefits.)

Assume an 8-hour work day. Further assume that all parts produced can be sold. (2.5)

a. Should Operation 1 or Operation 2 be recommended? Show all work.

b. What is the basic trade-off in this problem?

2-31. Rework Example 2-12 for the case where the capacity of each machine is further reduced by 25% because of machine failures, materials shortages, and operator errors. In this situation, 30,000 units of good (nondefective) product must be manufactured during the next three months. Assume one shift per day and five work days per week. (2.5)

a. Can the order be delivered on time?

b. If only one machine (*A* or *B*) can be used in part (a), which one should it be?

2-32. Two alternative designs are under consideration for a tapered fastening pin. The fastening pins are sold for $0.70 each. Either design will serve equally well and will involve the same material and manufacturing cost except for the lathe and drill operations.

Design *A* will require 16 hours of lathe time and 4.5 hours of drill time per 1,000 units. Design *B* will require 7 hours of lathe time and 12 hours of drill time per 1,000 units. The variable operating cost of the lathe, including labor, is $18.60 per hour. The variable operating cost of the drill, including labor, is $16.90 per hour. Finally, there is a sunk cost of $5,000 for Design *A* and $9,000 for Design B due to obsolete tooling. (2.5)

a. Which design should be adopted if 125,000 units are sold each year?

b. What is the annual saving over the other design?

2-33. In some countries, motorists are required to drive with their headlights on at all times. General Motors is beginning to equip their cars with daytime running lights. Most people would agree that driving with the headlights on at night is cost-effective with respect to extra fuel consumption and safety considerations. Given the following data and any additional assumptions you feel are necessary, analyze the cost-effectiveness of driving with your headlights on during the day by answering the following questions [cost-effective means that benefits outweigh (exceed) the costs]: (2.5)

75% of driving takes place during the daytime.

2% of fuel consumption is due to accessories (radio, headlights, etc.).

Cost of fuel = $1.15 per gallon.

Average distance traveled per year = 15,000 miles.

Average cost of an accident = $2,500.

Purchase price of headlights = $25.00 per set (2 headlights).

Average time car is in operation per year = 350 hours.

Average life of a headlight = 200 operating hours.

Average fuel consumption = 1 gallon per 30 miles.

a. What are the extra costs associated with driving with your headlights on during the day?

b. What are the benefits associated with driving with your headlights on during the day?

c. What additional assumptions (if any) do you need to complete your analysis?

d. It is cost-effective to drive with your headlights on during the day? Be sure to support your recommendation with the necessary calculations.

2-34. Suppose you are a mechanical engineer faced with the problem of designing a rigid coupling that will be used to join two odd-sized instrument shafts for a special customer order. Only 40 couplings will be produced, and there is no reason to suspect that there will be a repeat order in the near future. The coupling is fairly simple and can be turned from round steel rod stock. The manufacturing engineering department indicates that two machining methods are available. The following table summarizes the data for the metal lathe production and the automatic-screw production alternatives for the rigid coupling.

Comparative Costs of Two Production Processes

	Lathe	Automatic Screw Machine
Production rate	4 pieces/hr	18 pieces/hr
Machine charge	\$5/hr	\$25/hr
Setup charge (labor)	—	\$15
Operating charge (labor)	\$15/hr	\$12/hr
Material cost	Same	Same
Inspection cost	Same	Same

Since an automatic screw machine is a more complex and versatile device than a turret lathe, it is not surprising that its hourly cost is higher. A skilled machine operator is needed to operate the lathe, whereas a less-skilled machine operator tends the automatic-screw machine. The setup charge for the screw machine is to pay for the services of a highly skilled setup man who initially adjusts its operation. The operator then keeps it supplied with raw material. Raw material and inspection costs would be independent of the method of production. The actual cutting tools for an automatic-screw machine would probably be more expensive than those for a lathe, because the screw machine operates at a higher cutting speed. For this short run (40 units), however, tool wear will be negligible, and this cost can be ignored. (2.5)

a. Compute the cost of producing the coupling by each method.

b. How does cost per part vary with number of items produced? Draw a graph to illustrate your answer.

2-35. One method for developing a mine containing an estimated 100,000 tons of ore will result in the recovery of 62% of the available ore deposit and will cost \$23 per ton of material removed. A second method of development will recover only 50% of the ore deposit, but it will cost only \$15 per ton of material removed. Subsequent processing of the removed ore recovers 300 pounds of metal from each ton of processed ore and costs \$40 per ton of ore processed. The recovered metal can be sold for \$0.80 per pound. Which method for developing the mine should be used if your objective is to maximize total profit from the mine? (2.5)

2-36. Ocean water contains 0.9 ounce of gold per ton. Method *A* costs \$220 per ton of water processed and will recover 85% of the metal. Method *B* costs \$160 per ton of water processed and will recover 65% of the metal. The two methods require the same investment and are capable of producing the same amount of gold each day. If the extracted gold can be sold for \$350 per ounce, which method of extraction should be used? Assume that the supply of ocean water is unlimited. Work this problem *on the basis of profit per ounce of gold extracted*. (2.5)

2-37. Which of the following statements are true and which are false? (all sections)

a. Working capital is a variable cost.

b. The greatest potential for cost savings occurs in the operation phase of the life cycle.

c. If the capacity of an operation is significantly changed (e.g., a manufacturing plant), the fixed costs will also change.

d. The initial investment cost for a project is a nonrecurring cost.

e. Variable costs per output unit are a recurring cost.

f. A noncash cost is a cash flow.

g. Goods and services have utility because they have the power to satisfy human wants and needs.

h. The demand for necessities is more inelastic than the demand for luxuries.

i. Indirect costs can normally be allocated to a specific output or work activity.

j. Present economy studies are often done when the time value of money is not a significant factor in the situation.

k. Overhead costs normally include all costs that are not direct costs.

l. Optimal volume (demand) occurs when total costs equal total revenues.

m. Standard costs per unit of output are established in advance of actual production or service delivery.

n. A related sunk cost will normally affect the prospective cash flows associated with a situation.

o. The life cycle needs to be defined within the context of the specific situation.

p. The greatest commitment of costs occurs in the acquisition phase of the life cycle.

2-38. One component of a system's life-cycle cost is the cost of system failure. Failure costs can be