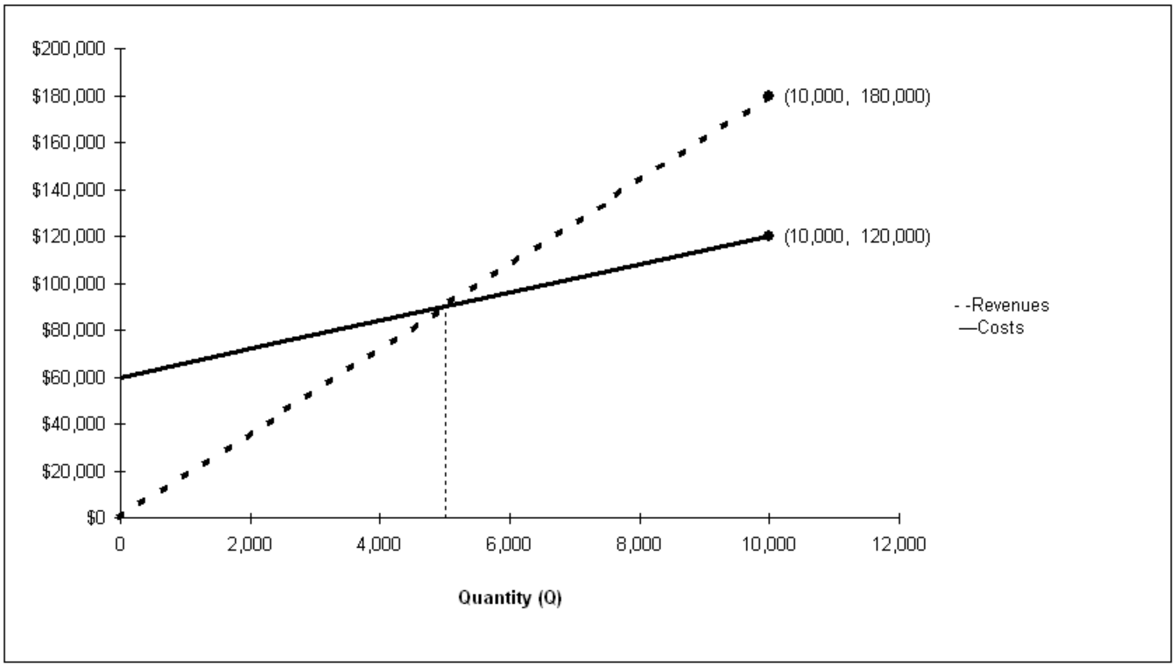
Supplement

A Decision Making

PROBLEMS

Break-Even Analysis

1. Williams Products
   a. Break-even quantity
   $(Q) = \text{Fixed costs}/(\text{Unit price} - \text{Unit variable costs})$
   $= \$60{,}000/(\$18 - \$6)$
   $= 5{,}000$ units
   The graphic approach is shown on the following illustration, using *Break-Even Analysis* Solver of OM Explorer.



   Two lines must be drawn:
   Total Revenue = 18Q
   Total Cost = 60,000+6Q

   b. Profit = Total Revenue – Total Cost
   $= pQ - (F + cQ) = (\$14.00)10{,}000 - [\$60{,}000 + (\$6)10{,}000]$
   $= \$140{,}000 - \$120{,}000 = \$20{,}000$

   c. Profit = Total Revenue – Total Cost

$$= pQ - (F + cQ) = (\$12.50)15,000 - [\$60,000 + (\$6)15,000]$$
$$= \$187,500 - \$150,000 = \$37,500$$

Therefore, the strategy of using a price of \$12.50 will result in a greater contribution to profits.

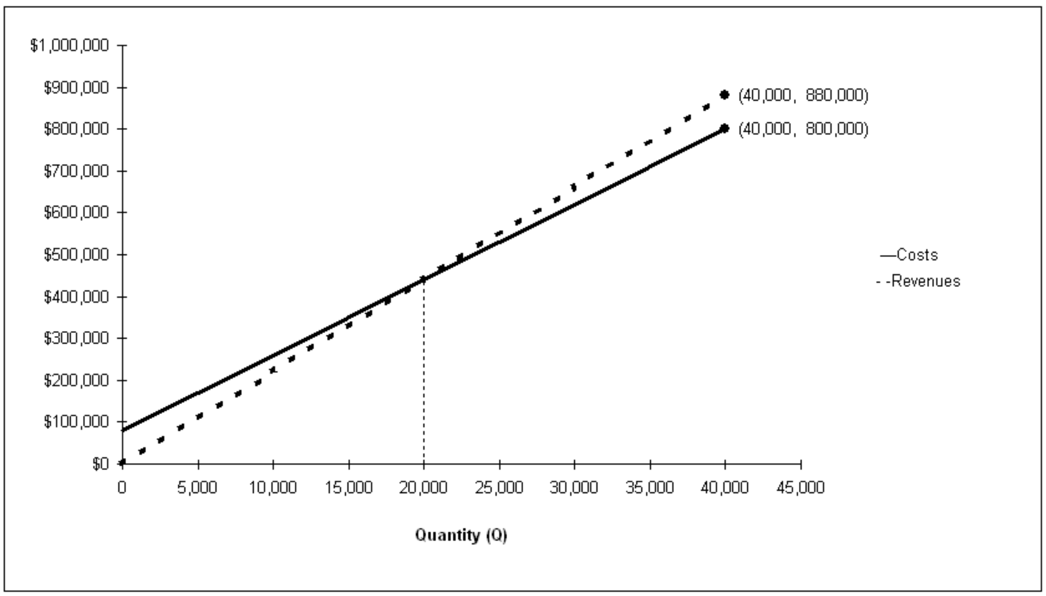
d. Williams must also consider how this product fits within her existing product line from the perspective of required technologies and distribution channels. Other marketing, operations, and financial criteria must also be considered.

2. Jennings Company

a. Break-even quantity

$$(Q) = \text{Fixed costs}/(\text{Unit price} - \text{Unit variable costs})$$
$$= \$80,000/(\$22 - \$18)$$
$$= 20,000 \text{ units}$$

The graphic approach is shown on the following graph created by the *Break-Even Analysis* Solver.



Two lines are:

$$\text{Total Revenues:} = \$22Q$$
$$\text{Total costs:} = \$80,000 + 18Q$$

b. To calculate the new unit variable cost required to breakeven, use the breakeven equation from part a, but solve for unit variable cost (c).

$$\frac{80,000}{22-c}=17,500$$
$$80,000=(22-c)17,500$$
$$80,000=385,000-17,500c$$
$$c=17.43$$

Thus, the variable cost would have to reduce from \$18 per unit to \$17.43 per unit.

c. With a \$1 price decrease, the breakeven quantity would be:

$$\frac{80,000}{(22-1)-18}=26,667$$

This quantity exceeds a 50% increase in sales (17,500 x 1.5) = 26,250

Thus, sales would have to increase by 52% (26,667/17,500=1.52) for Jennings to breakeven with a \$1 reduction in price.

d. Alternative 1: Sales increase by 30 percent, to 22,750 units (or 17,500 x 1.3).

Profit $= pQ-(F+cQ)$

$$= (\$22)22{,}750 - \ \$80{,}000 + (\$18)22{,}750$$
$$= \$11{,}000$$

Alternative 2: Cost reduction to 85 percent results in \$15.30 (or \$18 x 0.85) unit cost.

Profit $= pQ-(F+cQ)$

$$= (\$22)17{,}500 - \ \$80{,}000 + (\$15.30)17{,}500$$
$$= \$37{,}250$$

Therefore, the cost reduction leads to much higher profits in this example.

e. Initial unit profit is $(\$22-\$18)=\$4.00$

Alternative 1: $(\$22-\$18)=\$4.00$

The percentage change in profit margin is zero.

Alternative 2: $(\$22-\$15.30)=\$6.70$

The percentage change is [(\$6.70–\$4)/4]100 =67.5% increase.

3. Interactive television service

$$F=(p-c)Q$$
$$=(\$15-\$10)15{,}000$$
$$=\$75{,}000$$

4. Brook Trout

$$Q = F/(p-c)$$
$$p = (F/Q) + c$$
$$= \$10,600/800 + \$6.70$$
$$= \$19.95$$

5. Spartan Castings

a. Total cost = Fixed cost + Variable cost

$$TC = F + cQ$$
$$TC(\textit{first process}) = \$350{,}000 + \$50Q$$
$$TC(\text{sec}\textit{ond process}) = \$150{,}000 + \$90Q$$

At the break-even quantity,

$$\$350{,}000 + \$50Q = \$150{,}000 + 90Q$$
$$\$200{,}000 = \$40Q$$
$$Q = 5000\,\textit{units}$$

Beyond 5000 units the first process becomes more attractive.

b. At Q=10,000 units

$$TC(\textit{first process}) = \$350{,}000 + \$50(10{,}000) = \$850{,}000$$
$$TC(\text{sec}\textit{ond process}) = \$150{,}000 + \$90(10{,}000) = \$1{,}050{,}000$$

The difference in total cost = $1,050,000 - $850,000 = $200,000

6. News clipping service

a. $$Q = \frac{F_m - F_a}{c_a - c_m} = \frac{\$400{,}000 - \$1{,}300{,}000}{\$2.25 - \$6.20} = 227{,}848 \text{ clippings}$$

b. Profit = Total Revenue − Total Cost

Current (manual) situation:

$$= (225{,}000 \times \$8.00) - \ \$400{,}000 + (225{,}000 \times \$6.20)$$

Profit = $5,000

Modernization:

$$= (900{,}000 \times \$4.00) - \ \$1{,}300{,}000 + (900{,}000 \times \$2.25)$$

Profit = $275,000

The clipping service should be modernized.

c. $$Q = \frac{F}{p-c} = \frac{\$1,300,000}{\$4.00 - \$2.25} = 742,857 \text{ clippings}$$

7. Hahn Manufacturing

a. Total cost of buying 750 units from the supplier:

$$TC_b = (\$1{,}500/\text{unit})(750 \text{ units}) = \$1{,}125{,}000$$

Total cost of making 750 units in-house:

$$TC_m = (\$1{,}100/\text{unit} + \$300/\text{unit})(750 \text{ units}) + \$40{,}000 = \$1{,}090{,}000$$

Therefore, Hahn should make the components in-house, saving $35,000 per year.

b. At the break-even quantity, the total cost of the two alternatives will be equal:

$$\$1{,}500Q = \$40{,}000 + \$1{,}400Q$$

$$100Q = \$40{,}000$$

$$Q = 400 \text{ units}$$

c. If the decision is to "buy," Hahn may get a quantity discount from the supplier (we would be ordering 750 per year instead of the current 150 per year). Just a $50 per unit quantity discount would make the "buy" alternative more attractive than the "make" alternative. Because the component is a key item, Hahn should check the reliability of the supplier and of their own processes. Reliability may argue for the "make" decision.

8. Techno Corporation

$$\text{Current Profit} = (\text{Price} - \text{Variable cost})(\text{Annual Volume}) - \text{Annual Fixed Costs}.$$

$$= (\$10.00 - \$5.00)(30{,}000) - (\$140{,}000)$$

$$= \$10{,}000$$

a. Profit with new equipment $= (\$10.00 - \$6.00)(50{,}000) - (\$200{,}000) = \$0$

Because the profit decreases, Techno **should not buy** the new equipment.

b. Profit with new equipment $= (\$11.00 - \$6.00)(45{,}000) - (\$200{,}000) = \$25{,}000$

Because the profit increases, Techno **should buy** the new equipment if they also raise the selling price.

9. This problem is a thinly disguised portrayal of an actual situation faced by Tri-State G&T Association, Inc. of Thornton, Colorado, and which is common to many other REA Utilities. However, the costs, prices, and demands stated in the problem are fictional.

a. $Q = \dfrac{F}{p-c}$

$$p = \frac{F}{Q} + c = \frac{\$82{,}500{,}000}{1{,}000{,}000} + \$25 = \$107.5 \text{ per MWH}$$

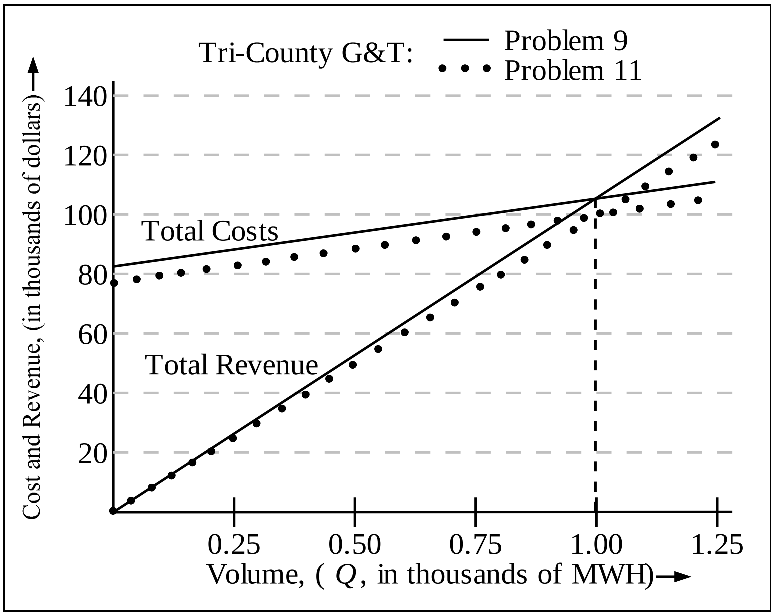
b. Profit (or loss) = Total Revenue – Total Cost

$$= (1{,}000{,}000 \times 95\%)(\$107.5) - \$82{,}500{,}000 + (1{,}000{,}000 \times 95\%)(\$25)$$

$$= \$102{,}125{,}000 - \$106{,}250{,}000$$

$$\text{Loss} = \$4{,}125{,}000$$

To break even, the price would have to be raised to $\left(\$107.5 + \dfrac{\$4{,}125{,}000}{950{,}000} = \$111.842\right)$, assuming even more conservation would not occur at this higher price.



10. Earthquake ... Build or Buy. This problem is related to problem 9.

Build: $F_1 + Qc_1 = \$10{,}000{,}000 + (150{,}000\text{MWH} \times \$35) = \$15{,}250{,}000$

Buy: $F_2 + Qc_2 = \$0 + (150{,}000\text{MWH} \times \$75) = \$11{,}250{,}000$

It would be less costly for Boulder to buy power from Tri-County. Note that Boulder enjoys a lower price ($75) than Tri-County charges its own REA customers ($107.50).

11. Tri-County G&T continued. This problem builds on problems 9 and 10 to show that Tri-County's REA customers also benefit from the bargain arrangement with Boulder.

$$\begin{aligned}\text{Contribution from sales to Boulder} &= Q(p-c)\\ &= 150{,}000(\$75-\$25)\\ &= \$7{,}500{,}000\end{aligned}$$

Remaining fixed costs to cover = $\$82{,}500{,}000 - \$7{,}500{,}000 = \$75{,}000{,}000$

$$Q = \frac{F}{p-c}$$

$$p = \frac{F}{Q} + c = \frac{\$75{,}000{,}000}{1{,}000{,}000} + \$25 = \$100 \text{ per MWH}$$

Note that selling power to Boulder at a reduced price also reduces the price to the REA customers. However, it may be difficult to persuade REAs that selling electricity to city slickers below "cost" also benefits rural customers.

Preference Matrix

12. Forsite Company

a. Say that each criterion (arbitrarily) receives 20 points:

Service	Calculation	Total Score
A	$20(0.6)+20(0.7)+20(0.4)+20(1.0)+20(0.2)$	= 58
B	$20(0.8)+20(0.3)+20(0.7)+20(0.4)+20(1.0)$	= 64
C	$20(0.3)+20(0.9)+20(0.5)+20(0.6)+20(0.5)$	= 56

The best alternative is service B and the worst is service C. This relationship holds as long as any arbitrary weight is equally applied to all performance criteria.

b. Let

$$x = \text{point allocation to criteria 1, 3, 4, and 5}$$

$$2x = \text{point allocation to criteria 2 (ROI)}$$

$$x+2x+x+x+x = 100 \text{ points}$$

$$6x = 100 \text{ points}$$

$$x = 16.7 \text{ points}$$

Product	Calculation	Total Score
A	$16.7(0.6)+33.3(0.7)+16.7(0.4)+16.7(1.0)+16.7(0.2)$	= 60.0
B	$16.7(0.8)+33.3(0.3)+16.7(0.7)+16.7(0.4)+16.7(1.0)$	= 58.4
C	$16.7(0.3)+33.3(0.9)+16.7(0.5)+16.7(0.6)+16.7(0.5)$	= 61.7

The rank order of the services has changed to C, A, B.

13. Five new suppliers

a. Let

$$x = \text{point allocation to criteria 2 and 3}$$

$$4x = \text{point allocation to criterion 1}$$

$$4x = \text{point allocation to criterion 4}$$

$$4x+x+x+4x = 100 \text{ points}$$

$$10x = 100 \text{ points}$$

$$x = 10 \text{ points}$$

Supplier	Calculation	Total Score
A	$40(8)+10(3)+10(9)+40(7)$	= 720
B	$40(7)+10(8)+10(5)+40(6)$	= 650
C	$40(3)+10(4)+10(7)+40(9)$	= 590
D	$40(6)+10(7)+10(6)+40(2)$	= 450
E	$40(9)+10(7)+10(5)+40(7)$	= 760

The threshold is $0.7\ 10(40+10+10+40) = 700$

Because Supplier A and Supplier E score greater than 700, they should be considered.

b. If the factors are equally weighted:

Supplier	Calculation	Total Score
A	25(8+3+9+7)	= 675
B	25(7+8+5+6)	= 650
C	25(3+4+7+9)	= 575
D	25(6+7+6+2)	= 525
E	25(9+7+5+7)	= 700

The threshold is $0.7\ 10(40+10+10+40)\ = 700$

Because no supplier's score is greater than 700, none should be considered. Stay with the current suppliers, which presumably have scores greater than 700.

14. Accel-Express Inc.
   a. The weighted score for Location A:
      $(10)(8)+(10)(7)+(10)(4)+(20)(7)+(20)(4)+(30)(7)=620$
      The weighted score for Location B:
      $(10)(5)+(10)(7)+(10)(7)+(20)(4)+(20)(8)+(30)(6)=610$
      Location A must be chosen.
   b. If equal weights are placed on the criteria, the two locations will be tied because the sum of the scores is 37 for both A and B.

15. Krebs Consulting
   a. As seen in the table below, Vendor C has the best rating of 710.

		Rating		
Performance Criterion	Factor Weight	Software A	Software B	Software C
Functionality	25	9	8	9
Vendor Reliability	10	7	5	9
Compatibility with current systems	20	6	8	6
Maintenance & Support	10	5	5	8
Total Cost	25	4	8	5
Speed of Implementation	10	8	4	7
	Total weighted score	645	700	710

   b. As seen in the following table, dropping Maintenance & Support and adding its factor weight to Total Cost changes the preferred Software to B.

		Rating		
Performance Criterion	Factor Weight	Software A	Software B	Software C
Functionality	25	9	8	9
Vendor Reliability	10	7	5	9
Compatibility with current systems	20	6	8	6

Maintenance & Support	0	5	5	8
Total Cost	35	4	8	5
Speed of Implementation	10	8	4	7
	Total weighted score	635	730	680

Decision Theory

16. Build-Rite Construction
   a. Maximin Criterion—Best Decision: Subcontract ... Payoff: $100,000
   b. Maximax Criterion—Best Decision: Hire ... Payoff: $625,000
   c. Laplace Criterion—Best Decision: Subcontract ... Weighted Payoff: $221,667

Alternative	**Weighted Payoff**
Hire	$-\$250{,}000+100{,}000+\$625{,}000\ /3=\$158{,}333$
Subcontract	$\$100{,}000+150{,}000+\$415{,}000\ /3=\$221{,}667$
Do nothing	$\$50{,}000+80{,}000+\$300{,}000\ /3=\$143{,}333$

   d. Minimax Regret Criterion—Subcontract ... Minimum Maximum Regret $210,000

Regrets ($000)
Demand for Home Improvements

Alternative	**Low**	**Moderate**	**High**	**Maximum**
Hire	$100-(-250)=350$	$150-100=50$	$625-625=0$	350
Subcontract	$100-100=0$	$150-150=0$	$625-415=210$	210
Hire	$100-50=50$	$150-80=70$	$625-300=325$	325

17. Robert Ragsdale

Note that this payoff table represents costs – so values closer to zero are preferred.
   a. Maximin Criterion—Best Decision: Buy the Insurance … Payoff: ($2,900.00)
   b. Maximax Criterion—Best Decision: Do not Buy the Insurance ... Payoff: ($2,500.00)
   c. Laplace Criterion—Best Decision: Buy the Insurance … Payoff: ($2,900.00)

Alternative	**Weighted Payoff**
Buy the Insurance	[$2,900+$2,900+$2,900]/3=($2,900)
Do not Buy the Insurance	[$5,000+$3,100+2,500]/3=($3,533.33)

   d. Minimax Regret Criterion—Buy ... Minimum Maximum Regret ($400)

Regrets ($000)
Demand for Home Improvements

Alternative	**Computer is Stolen**	**Computer Breaks**	**Computer neither is Stolen or Breaks**	**Maximum**
Buy	2,900-2,900 = 0	2,900-2,900= 0	2,500-2,900= -400	-400

Do not Buy	2,900-5,000= -2100	2,900-3,100= -200	2,500-2,500= 0	-2,100

18. Offshore Chemicals

The decision tree would have just one decision node with two branches (“build” and “do not build”). The “build” alternative is followed by an event node: “Facility works” (0.40) and “Facility fails” (0.60).

Decision Node 1

1. The “build” alternative has an expected payoff of **$2,000,000** [or 0.4 ($20,000,000) + 0.6 (–$10,000,000)]
2. The “do not build” has a payoff of **$0**.
3. Thus, the best choice, based on the expected value criterion, is to build. Prune the “Do not build” alternative.

Conclusion: Build the facility, with an expected payoff of **$2 million**. Of course, political or environmental considerations might also influence the final decision.

19. Small, medium, or large facility. First, develop a payoff table:

Decision	High Demand	Average Demand	Low Demand
Small Facility	$125,000	$75,000	$18,000
Medium Facility	$150,000	$140,000	($25,000)
Large Facility	$220,000	$125,000	($60,000)

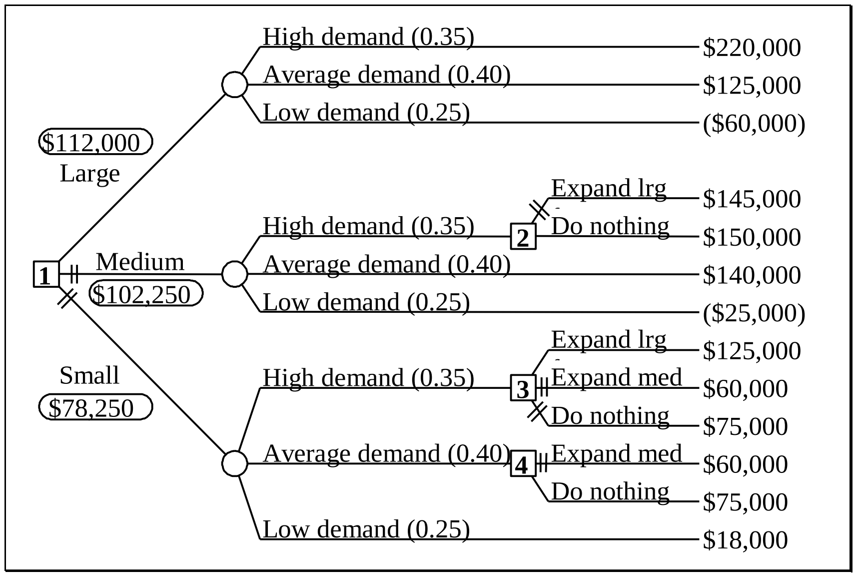
a. Maximin Criterion—Best Decision: Small Facility
b. Maximax Criterion—Best Decision: Large Facility
b. Minimax Regret Criterion—Best Decision: Medium Facility

		Regrets ($000)		
Alternative	**High**	**Average**	**Low**	**Maximum**
Small	220-125=95	140-75=65	18-18=0	95
Medium	220-150=70	140-140=0	18-(25)=43	**<u>70</u>**
Large	220-220=0	140-125=15	18-(60)=78	78

Decision Trees

20. Small, medium, or large facility (continuation of Problem 19).

Decision Tree



Working from right to left:

Decision Node 2

1. The best choice is to do nothing (**$150,000**), which becomes the expected payoff for Decision Node 2. Prune the “Expand to large” alternative.

Decision Node 3

2. The best choice is the “Expand to large” alternative (**$125,000**), which becomes the expected payoff for Decision Node 3. Prune the “Expand to medium” and “Do nothing” alternatives.

Decision Node 4

3. The best choice is to do nothing (**$75,000**), which becomes the expected payoff for Decision Node 4. Prune the “Expand to medium” alternative.

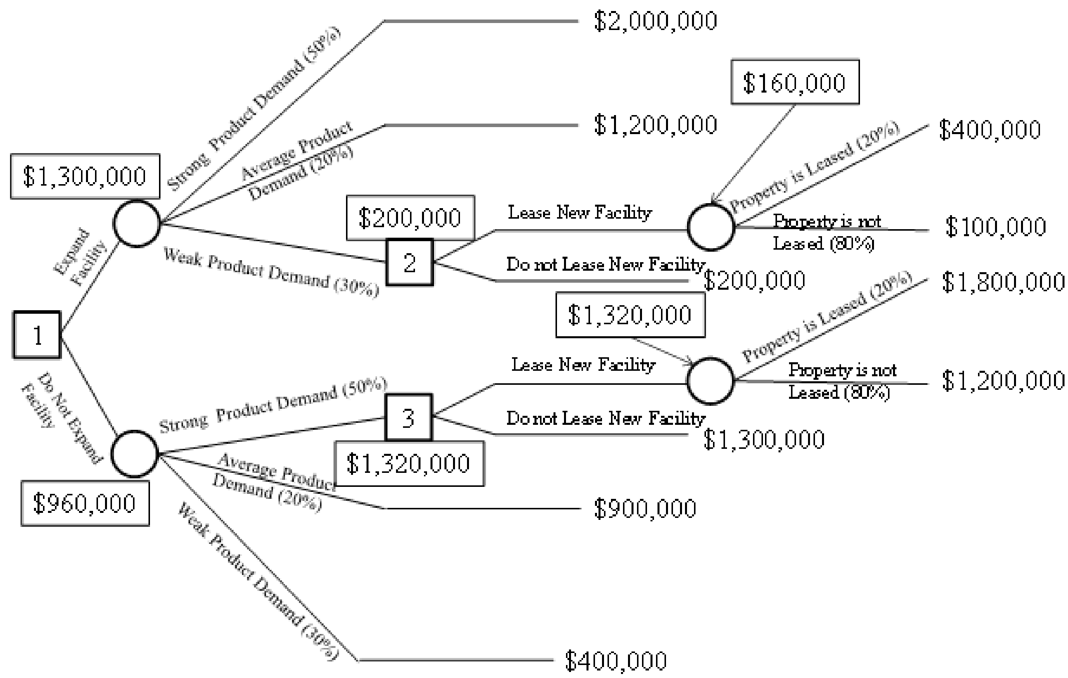
Decision Node 1

4. The alternative to build a large facility has an expected payoff of **$112,000** [or 0.35(220,000) + 0.40(125,000) + 0.25(–60,000)].
5. The alternative to build a medium-sized facility has an expected payoff of **$102,250** [or 0.35(150,000) + 0.40(140,000) + 0.25(–25,000)].
6. The alternative to build a small facility has an expected payoff of **$78,250** [or 0.35(125,000) + 0.40(75,000) + 0.25(18,000)].
7. Thus, the best choice is to build a large facility because it has a higher expected payoff (**$112,000**). Prune the medium and small alternatives.

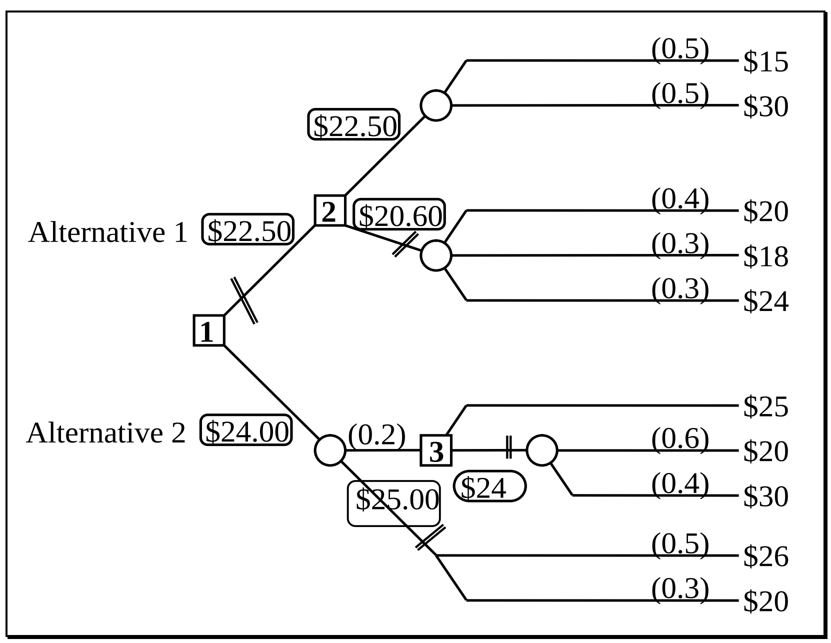
Conclusion: Build the large facility, with an expected payoff of **$112,000**.

21. Pearl Automotive Dealers

As seen in the decision tree below, the best decision is to “Expand Facility” and if “Weak Product Demand” occurs, do not attempt to lease the new expansion to an outside firm.



22. Decision Tree



Work from right to left. Here we begin with Decision Node 2, although Decision Node 3 would be an equally good starting point. The key concept is that we cannot begin analysis of Decision Node 1 until we know the expected payoffs for Decision Nodes 2 and 3.

Decision Node 2

1. Its first alternative (in the upper right portion of the tree) leads to an event node with an expected payoff of $22.50 [or 0.5(15) + 0.5(30)].
2. Its second alternative leading downward reaches an event node with an expected payoff of $20.60 [or 0.4(20) + 0.3(18)+ 0.3(24)].
3. Thus, the expected payoff for decision node 2 is **$22.50**, because the first alternative has the better expected payoff. Prune the second alternative.

Decision Node 3

4. Its second alternative leads to an event node has an expected payoff of $24 [or 0.6(20) + 0.4(30)].
5. Thus, the payoff for decision node 3 is **$25**, because the first alternative ($25) is better than the expected payoff for the second alternative ($24). Prune the second alternative.

Decision Node 1

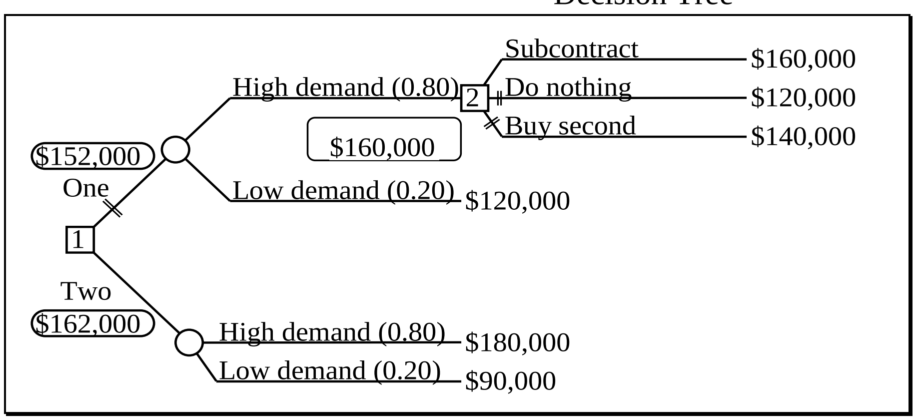
6. The second alternative leads to an event node has an expected payoff of $24 [or 0.2(25) + 0.5(26)+ 0.3(20)].
7. Thus, the expected payoff for decision node 1 is **$24**, because the second alternative ($24) is better than the expected payoff for the second alternative ($22.50). Prune the first alternative.

Thus, the best initial choice (Decision 1) is to select the lower branch, Alternative 2. If the top branch of the subsequent event occurs (a 20% probability), then Decision 3 must be made. Select its first alternative.

Conclusion: Select the lower branch, with an expected payoff of **$24**.

23. One machine or two.

a. Decision Tree



b. Working from right to left:

Decision Node 2

1. The best choice is to subcontact (**$160,000**), which becomes the expected payoff for Decision Node 2. Prune the “Do nothing” and Buy second” alternatives.

Decision Node 1

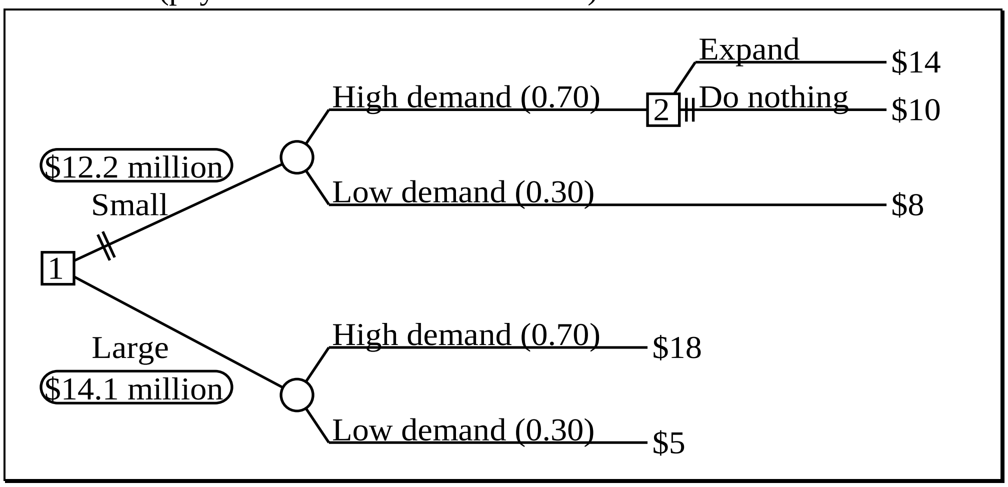
2. The alternative to buy one machine has an expected value of **$152,000** [or 0.8(160,000) + 0.2(120,000)].
3. The alternative to buy two machines has an expected value of **$162,000** [or 0.8(180,000) + 0.2(90,000)].

4. Thus, the best choice is to buy two machines because it has a higher expected payoff ($162,000 versus $152,000). Prune the one machine alternative.

Conclusion: Buy two machines, with an expected payoff of **$162,000**.

24. Small or large plant.

a. Decision Tree (payoffs are in millions of dollars)



b. Working from right to left:

Decision Node 2

1. The best choice is the "Expand" alternative (**$14**), which becomes the expected payoff for Decision Node 2. Prune the "Do nothing" alternative.

Decision Node 1

2. The alternative to build a small plant has an expected payoff of **$12.2 million** [or 0.70(14) + 0.30(8)].
3. The alternative to build a large plant has an expected payoff of **$14.1 million** [or 0.70(18) + 0.30(5)].
4. Thus, the best choice is to build a large plant because it has a higher expected payoff (**$14.1 million)**. Prune the small plant alternative.

Conclusion: Build the large facility, with an expected payoff of **$14.1 million**.