Solutions to Chapter 2 Problems

A Note To Instructors: Because of volatile energy prices in today's world, the instructor is encouraged to vary energy prices in affected problems (e.g. the price of a gallon of gasoline) plus and minus 50 percent and ask students to determine whether this range of prices changes the recommendation in the problem. This should make for stimulating in-class discussion of the results.

2-1 The total mileage driven would have to be specified (assumed) in addition to the variable cost of fuel per unit (e.g. $ per gallon). Also, the fixed cost of both engine blocks would need to be assumed. The efficiency of the traditional engine and the composite engine would also need to be specified

2-2

- **(a)** 4 – sunk
- **(b)** 5 – opportunity
- **(c)** 3 – fixed
- **(d)** 2 – variable
- **(e)** 6 – incremental
- **(f)** 1 – recurring
- **(g)** 7 – direct
- **(h)** 8 – nonrecurring

2-3 **(a)** $$\# \text{ cows} = \frac{1{,}000{,}000 \text{ miles/year}}{(365 \text{ days/year})(15 \text{ miles/day})} = 182.6 \text{ or } 183 \text{ cows}$$

Annual cost = (1,000,000 miles/year)($10 / 60 miles) = $166,667 per year

(b) Annual cost of gasoline = $\frac{1{,}000{,}000 \text{ miles/year}}{30 \text{ miles/gallon}} \times \$4\text{/gallon} = \$133{,}333$ per year

It would cost $33,334 more per year to fuel the fleet of cars with gasoline.

2-4

Cost	Site A	Site B
Rent Hauling	= \$5,000 (4)(200,000)(\$1.50) = \$1,200,000	= \$100,000 (3)(200,000)(\$1.50) = \$900,000
Total	\$1,205,000	\$1,000,000

Note that the revenue of \$8.00/yd^3 is independent of the site selected. Thus, we can maximize profit by minimizing total cost. The solid waste site should be located in Site B.

2-5 Present cost to company = \$1,000,000 + 40 repairs × 24 hrs/repair × \$2,500/hr = \$3,400,000

With Ajax, the cost to your company = \$2,000,000 + 40 repairs × R hrs/repair × \$2,500/hr

Ajax is preferred if

$$2{,}000{,}000 + 100{,}000R \leq \$3{,}400{,}000$$

or

$$R \leq 14 \text{ hours/breakdown.}$$

2-6 The $97 you spent on a passport is a sunk cost because you cannot get your money back. If you decide to take a trip out of the U.S. at a later date, the passport's cost becomes part of the fixed cost of making the trip (just as the cost of new luggage would be).

2-7 If the value of the re-machining option ($60,000) is reasonably certain, this option should be chosen. Even if the re-machined parts can be sold for only $45,001, this option is attractive. If management is highly risk adverse (they can tolerate little or no risk), the second-hand market is the way to proceed to guarantee $15,000 on the transaction.

2-8 The certainty of making \$200,000 - \$120,000 = \$80,000 net income is not particularly good. If your friend keeps her present job, she is turning away from a risky \$80,000 gain. This "opportunity cost" of \$80,000 balanced in favor of a sure \$60,000 would indicate your friend is risk averse and does not want to work hard as an independent consultant to make an extra \$20,000 next year.

2-9 **(a)** If you purchase a new car, you are turning away from a risky 20% per year return. If you are a risk taker, your opportunity cost is 20%, otherwise; it is 6% per year.

(b) When you invest in the high tech company's common stock, the next best return you've given up is 6% per year. This is your opportunity cost in situation (b).

2-10 Let X equal dollars per item delivered, and set total revenue equal to total cost:

$$\$X\ (15\ \text{items/hr}) = \$42.00/\text{hr} + (\$0.50/\text{item})(15\ \text{items/hr})$$

$$X = (\$49.50/\text{hr}) / (15\ \text{items/hr})$$

$$X = \$3.30\ \text{per item}$$

At least $3.30 per item delivered on Sunday will be needed to break even.

2-11 **(a)** Students can use Equation (2-10) to determine D^*.

$$D^* = \frac{75-30}{0.2} = 225 \text{ units/month}$$

Then

$p = 75 - 0.1(225) = \$52.50$ per unit

TR = 225 units × \$52.50/unit = \$11,812.50

C_T = \$1,000 + \$30/unit × 225 units = \$7,750

and

Maximum profit = TR – C_T = \$11,812.50 − \$7,750 = \$4,062.50 per month

(b) Using the quadratic equation to solve for the breakeven points:

$$D' = \frac{45 \pm \sqrt{(-45)^2 - 4(0.1)(1{,}000)}}{0.2}$$

$$D' = \frac{45 \pm 40.3}{0.2}$$

$D_1' = 24$ (rounded up from 23.5)

$D_2' = 426$ (rounded down from 426.5)

Thus, the profitable range of demand is from 24 to 426 units per month.

2-12 Re-write the price-demand equation as follows: $p = 2{,}000 - 0.1D$. Then,

$$\text{TR} = p \cdot D = 2{,}000D - 0.1D^2.$$

The first derivative of TR with respect to D is

$$d(\text{TR}) / dD = 2{,}000 - 0.2D$$

This, set equal to zero, yields the $\acute{D}$ that maximizes TR. Thus,

$$2{,}000 - 0.2\acute{D} = 0$$

$$\acute{D} = 10{,}000 \text{ units per month}$$

What is needed to determine maximum monthly profit is the fixed cost per month and the variable cost per lash adjuster.

2-13 $p = 150 - 0.01D$ $\quad C_F = \$50{,}000$ $\quad c_v = \$40/\text{unit}$

$\text{Profit} = 150D - 0.01D^2 - 50{,}000 - 40D = 110D - 0.01D^2 - 50{,}000$

$d(\text{Profit})/dD = 110 - 0.02D = 0$

$D' = 5{,}500$ units per year, which is less than maximum anticipated demand

At $D = 5{,}500$ units per year, Profit = \$252,500 and $p = \$150 - 0.01(5{,}500) = \$95/\text{unit}$.

2-14 **(a)** $D^* = (a - C_v) / 2b = (700 - 131.50) / 0.10 = 568.5 / 0.10 = 5{,}685\ 10^3$ board-feet

Price = \$700 – (0.05)(5,685) = \$415.75 per 10^3 board feet

Profit (per month) = $pD - C_F - C_vD$

$= \$415.75(5{,}685) - \$1{,}000{,}000 - \$131.50(5{,}685)$

$= 2{,}363{,}539 - 1{,}000{,}000 - 747{,}578$

= \$615,961/ month

(b) $-bD^2 + (a - C_v)D - C_F = 0$

$b = 0.05$

$(a - C_v) = 568.5$

$C_F = 1{,}000{,}000$

$-0.05D^2 + 568.5D - 1{,}000{,}000 = 0$

$$D'_{1,2} = \frac{-568.5 \pm [(568.5)^2 - 4(-0.05)(-1{,}000{,}000)]^{1/2}}{2(-0.05)}$$

$$= \frac{-568.5 \pm [323{,}192.25 - 200{,}000]^{1/2}}{-0.10}$$

$D_1 = (-568.5 + 351) / (-0.10) = 2{,}175$

$D_2 = (-568.5 - 351) / (-0.10) = 9{,}195$

2-15 **(a)** $$\text{Profit} = \left[38 + \frac{2700}{D} - \frac{5000}{D^2}\right]D - 1000 - 40D$$

$$= 38D + 2700 - \frac{5000}{D} - 1000 - 40D$$

$$\text{Profit} = -2D - \frac{5000}{D} + 1700$$

$$\frac{d(\text{Profit})}{dD} = -2 + \frac{5000}{D^2} = 0$$

or, $D^2 = \frac{5000}{2} = 2500$ and $D^* =$ <u>50 units per month</u>

(b) $$\frac{d^2(\text{Profit})}{dD^2} = \frac{-10{,}000}{D^3} < 0 \text{ for } D > 1$$

Therefore, <u>$D^* = 50$ is a point of maximum profit</u>.

2-16 Profit = Total revenue - Total cost

$= (15X - 0.2X^2) - (12 + 0.3X + 0.27X^2)$

$= 14.7X - 0.47X^2 - 12$

$$\frac{d\text{Profit}}{dX} = 0 = 14.7 - 0.94X$$

X = <u>15.64 megawatts</u>

Note: $\frac{d^2\text{Profit}}{dX^2} = -0.94$ thus, X = 15.64 megawatts maximizes profit

2-17 **(a)** Using Equation (2-10),

$$D^* = \frac{180 - 40}{2(5)} = 14 \text{ units per week}$$

(b) Total profit = $-5(14^2) + (180 - 40)(14)$

$= -980 + 140(14)$

$= \$980/\text{wk}$

2-18 20,000 tons/yr. (2,000 pounds / ton) = 40,000,000 pounds per year of zinc are produced.

The variable cost per pound is \$20,000,000 / 40,000,000 pounds = \$0.50 per pound.

(a) Profit/yr = (40,000,000 pounds / year) (\$1.00 - \$0.50) - \$17,000,000
= \$20,000,000 - \$17,000,000
= \$3,000,000 per year

The mine is expected to be profitable.

(b) If only 17,000 tons (= 34,000,000 pounds) are produced, then

Profit/yr = (34,000,000 pounds/year)(\$1.00 - \$0.50) - \$17,000,000 = 0

Because Profit =0, 17,000 tons per year is the breakeven point production level for this mine. A loss would occur for production levels < 17,000 tons/year and a profit for levels > 17,000 tons per year.

2-19 **(a)** BE = \$1,500,000 / (\$39.95 − \$20.00) = 75,188 customers per month

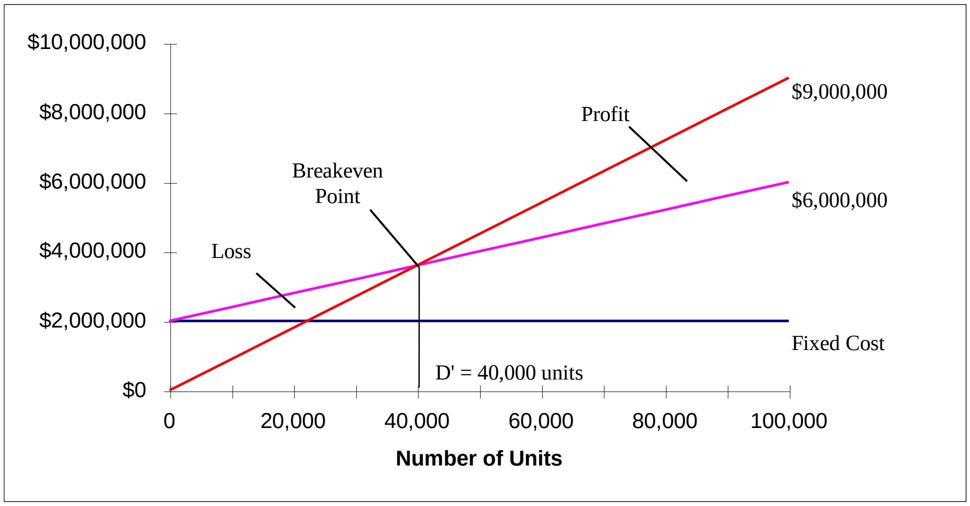
(b) New BE point = \$1,500,000 / (\$49.95 − \$25.00) = 60,120 per month

(c) For 63,000 subscribers per month, profit equals

63,000 (\$49.95 − \$25.00) − \$1,500,000 = \$71,850 per month

This improves on the monthly loss experienced in part (a).

2-20 **(a)** $D' = \frac{C_F}{p - c_v} = \frac{\$2,000,000}{(\$90 - \$40) / \text{unit}} = \underline{40,000 \text{ units per year}}$



(b) Profit (Loss) = Total Revenue - Total Cost

(90% Capacity) = 90,000 ($90) - [$2,000,000 + 90,000 ($40)]
= $<u>2,500,000</u> per year

(100% Capacity) = [90,000($90) + 10,000($70)] - [$2,000,000 + 100,000($40)]
= $<u>2,800,000</u> per year

2-21 Annual savings are at least equal to ($60/lb)(600 lb) = $36,000. So the company can spend no more than $36,000 (conservative) and still be economical. Other factors include ease of maintenance / cleaning, passenger comfort and aesthetic appeal of the improvements. Yes, this proposal appears to have merit so it should be supported.

2-22 Jerry’s logic is correct if the AC system does not degrade in the next ten years (very unlikely). Because the leak will probably get worse, two or more refrigerant re-charges per year may soon become necessary. Jerry’s strategy could be to continue re-charging his AC system until two re-charges are required in a single year. Then he should consider repairing the evaporator (and possibly other faulty parts of his system).

2-23 Over 81,000 miles, the gasoline-only car will consume 2,700 gallons of fuel. The flex-fueled car will use 3,000 gallons of E85. So we have

$$(3{,}000 \text{ gallons})(X) + \$1{,}000 = (2{,}700 \text{ gallons})(\$3.89/\text{gal})$$

and

$$X = \$3.17 \text{ per gallon}$$

This is 18.5% less expensive than gasoline. Can our farmers pull it off – maybe with government subsidies?

2-24 **(a)** $C_y = c_v X$ Eqn. (2-8)

$2,000,000 = $c_v(2000\ tons)$

c_v = $1,000/ton = $0.50/ lb.

Profit = $[s_p - c_v]$X - C_F

= [$0.80/lb - $0.50/ lb] 4,000,000 lb - $700,000

= $500,000

(b) X' = $C_F / (s_p - c_v)$ Eqn. (2-13)

= $700,000 / ($0.80/lb - $0.50/ lb)

= 2,333,333 lbs

$c_F = C_F$ / X' = $700,000 / 2,333,333 lbs = $0.30 / lb

OR

X'$(s_p - c_v) = c_F$ X' at breakeven point

$c_F = (s_p - c_v)$ = ($0.80/lb - $0.50/ lb) = $0.30/ lb

(c) $c_T = (Xc_v + C_F) / X$

= [4,000,000 lb ($0.50/lb) + $700,000] / 4,000,000 lb

= $0.675/ lb

2-25 **(a)** Ownership cost = \$120 + \$0.60X where X = horsepower rating.

Operating cost = $\frac{\$0.055}{\text{hp-hour}}\left(\frac{1}{X}\right) \times 9000$ hp-hour

Total annual cost = 120 + 0.60X + $\frac{0.055(9000)}{X}$ = 120 + 0.6X + $\frac{495}{X}$

$$\frac{dAC}{dX} = 0.6 - 495X^{-2} = 0$$

X = 28.72 horsepower

(b) For X to be a minimum of the function in part (a), show that $\frac{d^2AC}{dX^2} > 0$.

$\frac{d^2AC}{dX^2} = 990X^{-3}$ which is greater than 0 for all positive values of X.

2-26

$$C_T = C_o + C_c = knv^2 + \frac{\$1{,}500n}{v}$$

$$\frac{dC_T}{dv} = 0 = 2kv - \frac{1{,}500}{v^2} = kv^3 - 750$$

$$v = \sqrt[3]{\frac{750}{k}}$$

To find k, we know that

$$\frac{C_o}{n} = \$100\text{/mile at v} = 12 \text{ miles/hr}$$

$$\frac{C_o}{n} = kv^2 = k(12)^2 = 100$$

and

$$k = 100/144 = 0.6944$$

so, $$v = \sqrt[3]{\frac{750}{0.6944}} = 10.25 \text{ miles/hr}.$$

The ship should be operated at an average velocity of 10.25 mph to minimize the total cost of operation and perishable cargo.

Note: The second derivative of the cost model with respect to velocity is:

$$\frac{d^2C_T}{dv^2} = 1.388n + 3{,}000\frac{n}{v^3}$$

The value of the second derivative will be greater than 0 for n > 0 and v > 0. Thus we have found a minimum cost velocity.

2-27 <u>Solve for k:</u> $C_G / n = kv$ $\quad v$ in miles/hr

$1/18$ mils/gal = k (70 miles/hr) ; $k = 1$ hr – gal / 1,260 mi^2 = 0.000794 hr-gal/mi^2

C_G = (0.000794 hr-gal/mi^2)(3000)(v)($3.60/gal) = 8.5752 hr-gal/mi^2

C_{FSS} = ($15,000/hr)(1/$v$)

Find C_T

C_T = ($8.5752 hr/mi^2)($v$ mi/hr) + ($15,000/hr)($v^{-1}$hr/mi)($/mi)

$d\, C_T / dv = 8.5752 - 15{,}000/v^2 = 0$

$v^2 = 15{,}000/8.5752$

$v^* = 41.82$ mi/hr

Check $d^2\, C_T / dv^2 = 30{,}000 v^{-3}$ which is positive for $v > 0$, therefore we have minimized the total cost

2-28 (293 kWh/10^6 Btu)($0.15/kWh) = $43.95/$10^6$ Btu

	R11	R19	R30	R38
A. Investment cost	$2,400	$3,600	$5,200	$6,400
B. Annual Heating Load (10^6 Btu/yr)	74	69.8	67.2	66.2
C. Cost of heat loss/yr	$3,252	$3,068	$2,953	$2,909
D. Cost of heat loss over 25 years	$81,308	$76,693	$73,836	$72,737
E. Total Life Cycle Cost = A + D	$83,708	$80,293	$79,036	$79,137

Select R30 to minimize total life cycle cost.

2-29 **(a)** $\frac{dC}{d\lambda} = -\frac{C_I}{\lambda^2} + C_R t = 0$

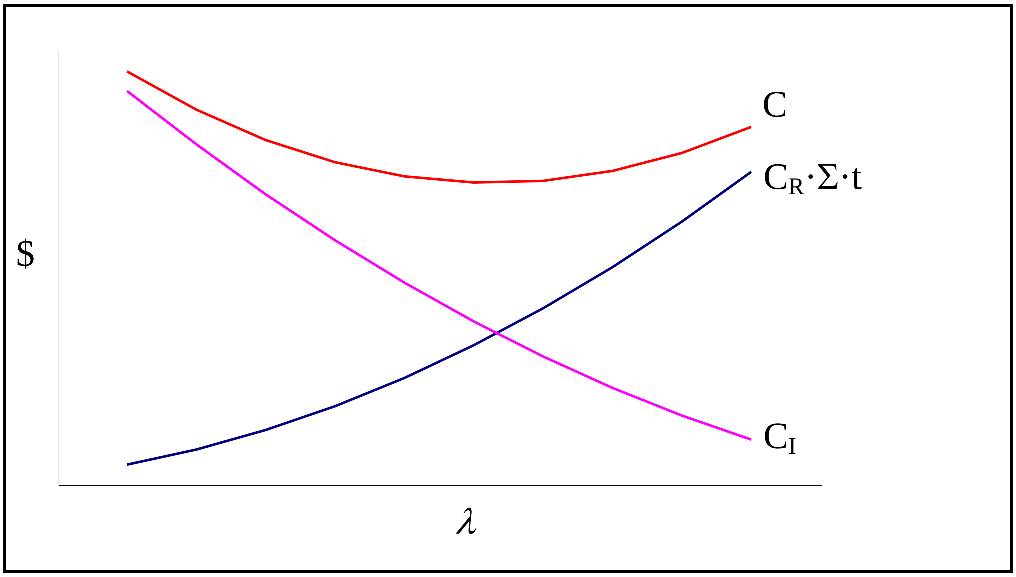
or, $\lambda^2 = C_I/C_R t$

and, $\lambda^* = (C_I/C_R t)^{1/2}$; we are only interested in the positive root.

(b) $\frac{d^2C}{d\lambda^2} = \frac{2C_I}{\lambda^3} > 0$ for $\lambda > 0$

Therefore, λ^* results in a minimum life-cycle cost value.

(c) Investment cost versus total repair cost



2-30 180 rpm

1 cycle = (12 jacks/refurb.)(1 +4 refurb.) / (7 jacks/hr) = 60/7 = 8.57 hrs

Cost per cycle = 1 brush ---- $90

4 refurb. --- 4($30)

Oper. Cost – 8.57 hr. ($70/hr)

= $810/cycle

Cost per jack = $810/60 = $13.50/jack

240 rpm

1 cycle = (8 x 3) / 10 = 2.4 hrs

Cost per cycle = $90 + 2($30) + 2.4hr ($70/hr) = $318/cycle

Cost per jack = $318/24 = $13.25/jack

300 rpm

1 cycle = (6 x 2) / 12 = 1hr

Cost per cycle = $90 + 1($30) + 1hr ($70/hr) = $190/cycle

Cost per jack = $190/12 = $15.83/jack

Select 240 rpm

2-31 **(a)** With Dynolube you will average (20 mpg)(1.01) = 20.2 miles per gallon (a 1% improvement). Over 50,000 miles of driving, you will save

$$\frac{50{,}000 \text{ miles}}{20 \text{ mpg}} - \frac{50{,}000 \text{ miles}}{20.2 \text{ mpg}} = 24.75 \text{ gallons of gasoline.}$$

This will save (24.75 gallons)($4.00 per gallon) = $99.

(b) Yes, the Dynolube is an economically sound choice.

2-32 The cost of tires containing compressed air is ($200 / 50,000 miles) = $0.004 per mile. Similarly, the cost of tires filled with 100% nitrogen is ($220 / 62,500 miles) = $0.00352 per mile. On the face of it, this appears to be a good deal if the claims are all true (a big assumption). But recall that air is 78% nitrogen, so this whole thing may be a gimmick to take advantage of a gullible public. At 200,000 miles of driving, one original set of tires and three replacements would be needed for compressed-air tires. One original set and two replacements (close enough) would be required for the 100% nitrogen-filled tires. What other assumptions are being made?

2-33 (a)

Speed	Drilling Rate (ft/min)	Bit life at this Speed (min)
A	2	10
B	3	6
C	4	3

Given: rock drill with 3 operating speeds

Cost= bit cost + operator cost (+ blasting penalty)

1 cycle = 96 ft. of drilling

Operator cost = $30/hr = $0.50/min

Bit cost = $10.00/each

Speed A – Cycle = 96ft / 2fpm = 48 min

Bit cost- 48 min/ 10 min/bit = 4.8 bits x $10 each = $48.00

Oper. Cost- 48 min x $0.50/min $24.00

$72.00/cycle

Cost/ft. = $72.00/cycle / 96 ft/cycle = $0.75/ft

Speed B – Cycle = 96ft / 3fpm = 32 min

Bit cost- 32 min/ 6 min/bit = 5.33 bits x $10 each = $53.33

Oper. Cost- 32 min x $0.50/min $16.00

$69.33/cycle

Cost/ft. = $69.33/cycle / 96 ft/cycle = $0.72/ft

Speed C – Cycle = 96ft / 4fpm = 24 min

Bit cost- 24 min/ 3 min/bit = 8 bits x $10 each = $80.00

Oper. Cost- 24 min x $0.50/min $12.00

$92.00/cycle

Cost/ft. = $92.00/cycle / 96 ft/cycle = $0.96/ft

Choose Speed B

2-33 **(b)** Penalty of $60.00/hour for cycle time greater than 30 minutes

$60/hr = $1.00/min

<u>Speed A</u>- Cycle Time = 48 min

Total cost/cycle = $72.00 + (48-30)$1.00 = $90.00
(includes penalty) ($0.9375/ft)

<u>Speed B</u>- Cycle Time = 32 min

Total cost/cycle = $69.33 + (32-30)$1.00 = $71.33
(includes penalty) ($0.743/ft)

<u>Speed C</u>- Cycle Time = 24 min (no penalty

Total cost/cycle = $92.00
($0.958/ft)

Speed B still has the lowest cost per cycle, now the cost per foot is $0.743/ft

2-34 **(a)** Manufacturing Option A

Labor = (40 x 5)($10) = $2000/wk.

Rental = $20,000

Σ = $22,000

Material = $15/unit

Purchase Option B = $20/unit

$22,000 + $15(x) = $20(x)

$22,000/5 = $\hat{x}$

$\hat{x}$ = 4,400 units/wk = Breakeven amount

(b) $22,000 + $15(3500) [< or >] $20 (3500)

$74,500 > $70,000

Purchase this item

2-35 Strategy: Select the design which minimizes total cost for 125,000 units/year (Rule 2). Ignore the sunk costs because they do not affect the analysis of future costs.

(a) Design A

Total cost/125,000 units = (12 hrs/1,000 units)($18.60/hr)(125,000)
+ (5 hrs/1,000 units)($16.90/hr)(125,000)
= $38,463, or $0.3077/unit

Design B

Total cost/125,000 units = (7 hrs/1,000 units)($18.60/hr)(125,000)
+ (7 hrs/1,000 units)($16.90/hr)(125,000)
= $33,175, or $0.2654/unit

Select Design B

(b) Savings of Design B over Design A are:

Annual savings (125,000 units) = $38,463 − $33,175 = $5,288

Or, savings/unit = $0.3077 − $0.2654 = $0.0423/unit.

2-36 Profit per day = Revenue per day – Cost per day

= (Production rate)(Production time)($30/part)[1-(% rejected+% tested)/100]

– (Production rate)(Production time)($4/part) – (Production time)($40/hr)

Process 1: Profit per day = (35 parts/hr)(4 hrs/day)($30/part)(1-0.2) –

(35 parts/hr)(4 hrs/day)($4/part) – (4 hrs/day)($40/hr)

= $2640/day

Process 2: Profit per day = (15 parts/hr)(7 hrs/day)($30/part) (1-0.09) –

(15 parts/hr)(7 hrs/day)($4/part) – (7 hrs/day)($40/hr)

= $2155.60/day

Process 1 should be chosen to maximize profit per day.

2-37 At 70 mph your car gets 0.8 (30 mpg) = 24 mpg and at 80 mph it gets 0.6(30 mpg) = 18 mpg. The extra cost of fuel at 80 mph is:

$$(400 \text{ miles}/18\text{mpg} – 400 \text{ miles}/24 \text{ mpg})(\$4.00 \text{ per gallon}) = \$22.22$$

The reduced time to make the trip at 80 mph is about 45 minutes. Is this a good tradeoff in your opinion? What other factors are involved?

2-38 **(a)** Operation 1 cycle time = 1 hr + 0.333 hr = 1.333 hr/cycle

Cycles/day = (8hr/day)(1 cycle/ 1.333 hr) = 6 cycle/day

Value added = (2000 parts/cycle)(6 cycles/day)($0.40/part)

= $4,800/day

Cost_1 = 8 hr/day ($20/hr) = $160/day

Value – cost = $4,800 - $160 = $4,640/day

Operation 2 cycle time = 2 hr + 0.5 hr = 2.5 hr/cycle

Cycles/day = (8hr/day)(1 cycle/ 2.5 hr) = 3.2 cycle/day

Value added = (3500 parts/cycle)(3.2 cycles/day)($0.40/part)

= $4,480/day

Cost_2 = 8 hr/day ($11/hr) = $88/day

Value – cost = $4,480 - $88 = $4,392/day

Select Operation 1 to maximize profit

(b) Output/day for Operation 1 = 12,000 parts and output/.day for Operation 2 = 11,200 parts. Downtime for Operation 1 = 6 x 20 min = 120 minutes/day and downtime for Operation 2 = 3.2 x 30 = 96 minutes/day. So increased production for Operation 1 is being traded off for increased tool changing time (downtime), and the balance is favorable for Operation 1 compared to Operation 2.

2-39 Apache: (24 hr/day)(7 days/wk) – 4 = 164 hrs/wk uptime

(90 hits/min) (60 min/hour) = 5,400 hits/hr

(5,400 hits/hr) (164 hrs/wk) = 885,600 hits/wk @ $0.015/hit

= $13,284/wk

Profit/yr. = ($13,284/wk)(52 wk/yr) = $690,768

Windows IIS: (24 hr/day)(7 days/wk) – 0.75 = 167.25 hrs/wk uptime

(5,400 hits/hr) (167.25 hrs/wk) = 903,150 hits/wk @ $0.015/hit

= $13,547.25/wk

Profit/yr. = ($13,547.25/wk)(52 wk/yr) - $5,000 = $699,457

Go with Windows software.

2-40 Option A (Purchase):

C_T = (10,000 items)($8.50/item) = $85,000

Option B (Manufacture):

Direct Materials	=	$5.00/item
Direct Labor	=	$1.50/item
Overhead	=	$3.00/item
		$9.50/item

C_T = (10,000 items)($9.50/item) = $95,000

Choose Option A (Purchase Item).

2-41 The two alternatives are "no jig with a skilled machinist" and "use a jig with a lesser skilled machinist."

No jig: (1.5 min/housing)/(60 min/hr)($25/hr)(4000 housings) = $2,500

With jig: (2 min/housing)/(60 min/hr)($15/hr)(4000 housings) + $500 = $2,500

Alternatives are equally attractive.

2-42 Assumptions: You can sell all the metal that is recovered

Method 1:

Recovered ore	= (0.62)(100,000 tons)	= 62,000 tons
Removal cost	= (62,000 tons)($23/ton)	= $1,426,000
Processing cost	= (62,000 tons)($40/ton)	= $2,480,000
Recovered metal	= (300 lbs/ton)(62,000 tons)	= 18,600,000 lbs
Revenues	= (18,600,000 lbs)($0.8 / lb)	= $14,880,000

Profit = Revenues - Cost = $14,880,000 - ($1,426,000 + $2,480,000)
= $10,974,000

Method 2:

Recovered ore	= (0.5)(100,000 tons)	= 50,000 tons
Removal cost	= (50,000 tons)($15/ton)	= $750,000
Processing cost	= (50,000 tons)($40/ton)	= $2,000,000
Recovered metal	= (300 lbs/ton)(50,000 tons)	= 15,000,000 lbs
Revenues	= (15,000,000 lbs)($0.8 / lb)	= $12,000,000

Profit = Revenues - Cost = $12,000,000 - ($750,000 + $2,000,000)
= $9,250,000

Select Method 1 (62% recovered) to maximize total profit from the mine.

2-43 Profit per ounce (Method A) = $1,750 - $550 / [(0.90 oz. per ton)(0.90)] = $1,750 - $679

= $1,071 per ounce

Profit per ounce (Method B) = $1,750 - $400 / [(0.9 oz. per ton)(0.60) =$1,750 - $741

= $1,009 per ounce

Therefore, by a slim margin we should recommend Method A.

2-44	**(a)** False;	**(d)** False;	**(g)** False;	**(j)** False;	**(m)** True;	**(p)** False;	**(s)** False
	(b) False;	**(e)** True;	**(h)** True;	**(k)** True;	**(n)** True;	**(q)** True;	
	(c) True;	**(f)** True;	**(i)** True;	**(l)** False;	**(o)** True;	**(r)** True;	

2-45 **(a)** $$\text{Loss} = \frac{(1{,}750{,}000\ \text{Btu})\left(\dfrac{\text{lb coal}}{12{,}000\ \text{Btu}}\right)}{0.30} = 486\ \text{lbs of coal}$$

(b) 486 pounds of coal produces (486)(1.83) = 889 pounds of CO_2 in a year.

2-46 **(a)** Let X = breakeven point in miles

Fuel cost (car dealer option) = ($2.00/gal)(1 gal/20 miles) = $0.10/mile

Motor Pool Cost = Car Dealer Cost

$(\$0.36/\text{mi})X = (6\ \text{days})(\$30/\text{day}) + (\$0.20/\text{mi} + \$0.10/\text{mi})X$

$\$0.36X = 180 + \$0.30X$ and X = <u>3,000 miles</u>

(b) 6 days (100 miles/day) = 600 free miles

If the total driving distance is less than 600 miles, then the breakeven point equation is given by:

($0.36/mi)X = (6 days)($30 /day) + ($0.10/mi)X

X = 692.3 miles > 600 miles

This is outside of the range [0, 600], thus renting from State Tech Motor Pool is best for distances less than 600 miles.

If driving more than 600 miles, then the breakeven point can be determined using the following equation:

($0.36/mi)X = (6 days)($30 /day) + ($0.20/mi)(X - 600 mi) + ($0.10/mi)X

X = <u>1,000 miles</u> The true breakeven point is 1000 miles.

(c) The car dealer was correct in stating that there is a breakeven point at 750 miles. If driving less than 900 miles, the breakeven point is:

($0.34/mi)X = (6 days)($30 /day) + ($0.10/mi)X

X = 750 miles < 900 miles

However, if driving more than 900 miles, there is another breakeven point.

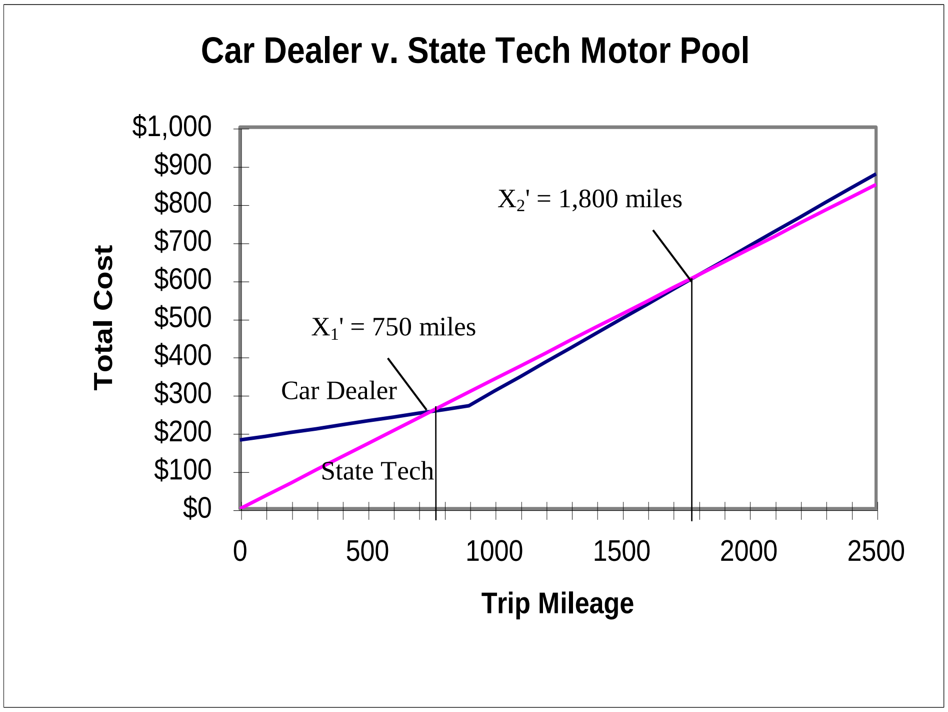
($0.34/mi)X = (6 days)($30/day) + ($0.28/mi)(X-900 mi) + ($0.10/mi)X

X = 1800 miles > 900 miles

The car dealer is correct, but only if the group travels in the range between 750 miles and 1,800 miles. Since the group is traveling more than 1,800 miles, it is better for them to rent from State Tech Motor Pool.

This problem is unique in that there are two breakeven points. The following graph shows the two points.

2-46 *continued*



2-47 This problem is location specific. We'll assume the problem setting is in Tennessee. The eight years ($2,400 / $300) to recover the initial investment in the stove is expensive (i.e. excessive) by traditional measures. But the annual cost savings could increase due to inflation. Taking pride in being "green" is one factor that may affect the homeowner's decision to purchase a corn-burning stove.

2-48

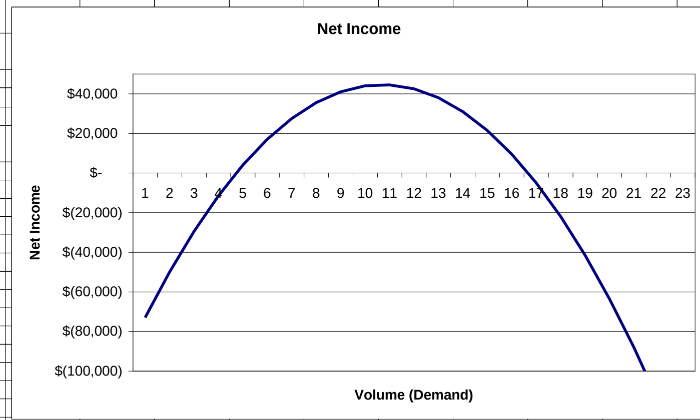
Fixed cost/ mo. =	$ 73,000	Demand Start point (D) =	0
Variable cost/unit =	$ 83	Demand Increment =	250
a =	$ 180		
b =	$ 0.02		

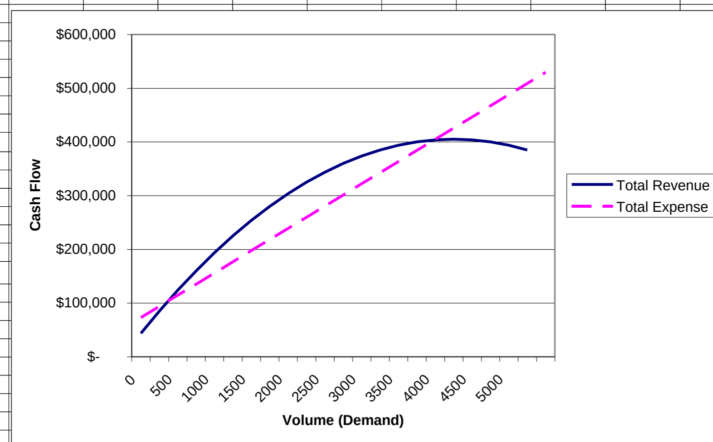
Monthly Demand	Price per Unit	Total Revenue	Total Expense	Net income
0	$ 180	$ -	$ 73,000	$ (73,000)
250	$ 175	$ 43,750	$ 93,750	$ (50,000)
500	$ 170	$ 85,000	$ 114,500	$ (29,500)
750	$ 165	$ 123,750	$ 135,250	$ (11,500)
1000	$ 160	$ 160,000	$ 156,000	$ 4,000
1250	$ 155	$ 193,750	$ 176,750	$ 17,000
1500	$ 150	$ 225,000	$ 197,500	$ 27,500
1750	$ 145	$ 253,750	$ 218,250	$ 35,500
2000	$ 140	$ 280,000	$ 239,000	$ 41,000
2250	$ 135	$ 303,750	$ 259,750	$ 44,000
2500	$ 130	$ 325,000	$ 280,500	$ 44,500
2750	$ 125	$ 343,750	$ 301,250	$ 42,500
3000	$ 120	$ 360,000	$ 322,000	$ 38,000
3250	$ 115	$ 373,750	$ 342,750	$ 31,000
3500	$ 110	$ 385,000	$ 363,500	$ 21,500
3750	$ 105	$ 393,750	$ 384,250	$ 9,500
4000	$ 100	$ 400,000	$ 405,000	$ (5,000)
4250	$ 95	$ 403,750	$ 425,750	$ (22,000)
4500	$ 90	$ 405,000	$ 446,500	$ (41,500)
4750	$ 85	$ 403,750	$ 467,250	$ (63,500)
5000	$ 80	$ 400,000	$ 488,000	$ (88,000)
5250	$ 75	$ 393,750	$ 508,750	$ (115,000)
5500	$ 70	$ 385,000	$ 529,500	$ (144,500)

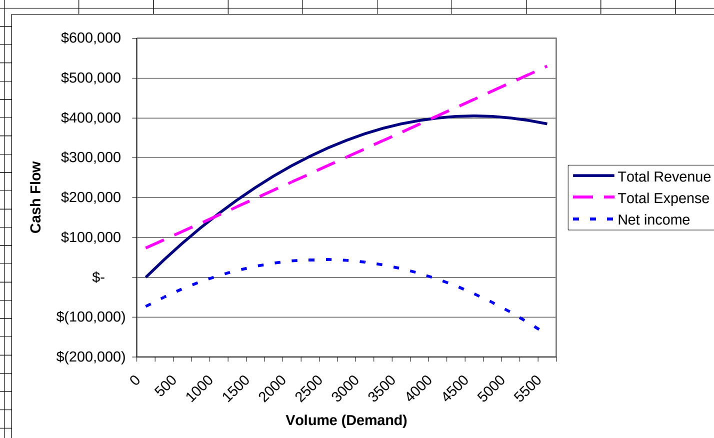
Summary of impact of changes in cost components on optimum demand and profitable range of demand.

Percent Change

C_F	c_v	D*	D_1'	D_2'
-10%	-10%	2,633	724	4541
0%	-10%	2,633	824	4443
10%	-10%	2,633	928	4339
-10%	0%	2,425	816	4036
0%	0%	2,425	932	3918
10%	0%	2,425	1060	3790
-10%	10%	2,218	940	3495
0%	10%	2,218	1092	3343
10%	10%	2,218	1268	3167







Reducing fixed costs has no impact on the optimum demand value, but does broaden the profitable range of demand. Reducing variable costs increase the optimum demand value as well as the range of profitable demand.

2-49 New annual heating load = (230 days)(72 °F – 46 °F) = 5,980 degree days. Now, 136.7×10^6 Btu are lost with no insulation. The following U-factors were used in determining the new heating load for the various insulation thicknesses.

	U-factor	Heating Load
R11	0.2940	101.3×10^6 Btu
R19	0.2773	95.5×10^6 Btu
R30	0.2670	92×10^6 Btu
R38	0.2630	90.6×10^6 Btu

	\$/kWhr	\$/10^6 Btu
Energy Cost	\$0.086	\$25.20

	R11	R19	R30	R38
Investment Cost	\$ 900	\$ 1,350	\$ 1,950	\$ 2,400
Annual Heating Load (10^6 Btu)	101.3	95.5	92	90.6
Cost of Heat Loss/yr	\$2,553	\$2,406	\$2,318	\$2,283
Cost of Heat Loss over 25 years	\$63,814	\$60,160	\$57,955	\$57,073
Total Life Cycle Cost	\$64,714	\$61,510	\$59,905	\$59,473

2-50 In this problem we observe that "an ounce of prevention is worth a pound of cure." The ounce of prevention is the total annual cost of daylight use of headlights, and the pound of cure is postponement of an auto accident because of continuous use of headlights. Clearly, we desire to postpone an accident forever for a very small cost.

The key factors in the case study are the cost of an auto accident and the frequency of an auto accident. By avoiding an accident, a driver "saves" its cost. In postponing an accident for as long as possible, the "annual cost" of an accident is reduced, which is a good thing. So as the cost of an accident increases, for example, a driver can afford to spend more money each year to prevent it from happening through continuous use of headlights. Similarly, as the acceptable frequency of an accident is lowered, the total annual cost of prevention (daytime use of headlights) can also decrease, perhaps by purchasing less expensive headlights or driving less mileage each year.

Based on the assumptions given in the case study, the cost of fuel has a modest impact on the cost of continuous use of headlights. The same can be said for fuel efficiency. If a vehicle gets only 15 miles to the gallon of fuel, the total annual cost would increase by about 65%. This would then reduce the acceptable value of an accident to "at least one accident being avoided during the next 16 years." To increase this value to a more acceptable level, we would need to reduce the cost of fuel, for instance. Many other scenarios can be developed.

2-51 Suppose my local car dealer tells me that it costs no more than \$0.03 per gallon of fuel to drive with my headlights on all the time. For the case study, this amounts to (500 gallons of fuel per year) x \$0.03 per gallon = \$15 per year. So the cost effectiveness of continuous use of headlights is roughly six times better than for the situation in the case study.

2-52 $p = 400 - D^2$

$TR = p \cdot D = (400 - D^2)\, D = 400D - D^3$

$TC = \$1125 + \$100 \cdot D$

Total Profit / month = TR – TC = $400D - D^3 - \$1125 - \$100D$

$= -D^3 + 300D - 1125$

$\frac{dTP}{dD} = -3D^2 + 300 = 0$ ➔ $D^2 = 100$ ➔ $D^* =$ $\underline{10 \text{ units}}$

$\frac{d^2TP}{dD^2} = -6D$; at $D = D^*$, $\frac{d^2TP}{dD^2} = -60$

Negative, therefore maximizes profit.

Select (a)

2-53 $-D^3 + 300D - 1125 = 0$ for breakeven

At D = 15 units; $-15^3 + 300(15) - 1125 = 0$

Select (b)

2-54 C_F = \$100,000 + \$20,000 = \$120,000 per year
C_V = \$15 + \$10 = \$25 per unit
p = \$40 per unit

$$D' = \frac{C_F}{p - c_v} = \frac{\$120{,}000}{(\$40 - \$25)} = \underline{8{,}000 \text{ units/yr}}$$

<u>Select (c)</u>

2-55 Profit = $pD - (C_F + C_V D)$

At D = 10,000 units/yr,

Profit/yr = (40)(10,000) – [120,000 + (25)(10,000)] = $30,000

Select (e)

2-56 Profit = $pD - (C_F + C_VD)$

$60{,}000 = 35D - (120{,}000 + 25D)$

$180{,}000 = 10D$; D = <u>18,000 units/yr</u>

<u>Select (d)</u>

2-57 Annual profit/loss = Revenue - (Fixed costs + Variable costs)

= \$300,000 – [\$200,000 + (0.60)(\$300,000)]
= \$300,000 – \$380,000
= –\$80,000

Select (d)

2-58 Savings in first year = (7,900,000 chips) (0.01 min/chip) (1 hr/60 min) ($8/hr + 5.50/hr) = $17,775

Select (d)