Engineering Economic Analysis 14th edition Newnan Solutions Manual

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Chapter 2: Engineering Costs and Cost Estimating

2-1

If firm uses 25,000 kWh/month, then cost is:
$0.18/kWh for first 10,000 kWh
$0.15/kWh for the remaining 15,000 kWh

Marginal Cost (cost for the next kw-hr) = **$0.15** since we are in the 2nd bracket of the cost structure.

Total Cost = $0.18/kWh * 10,000 kWh + $0.15/kWh * 15,000 kWh = $4,050
Average Cost = $4,050 / 25,000kWh = $0.162/kWh

2-2

(a) 650 parts
Average cost = $15
Marginal cost = $15

(b) 1250 parts
Average cost = ((1000)($15) + (250)($13)) / 1250 = $ 14.60
Marginal cost = $13

(c) 2500 parts
Average cost = ((1000)($15) + (1500)($13)) / 2500 = $13.80
Marginal cost = $11

(d) 3500 parts
Average cost = ((1000)($15) + (1500)($13) + 1000($11)) / 3500 = $13.00
Marginal cost = $11

2-3

(a) 125 hours
Average cost = 0
Marginal cost = 0

(b) 225 hours
Average cost = (25)($180) / 225 = $20
Marginal cost = $180

(c) 325 hours
Average cost = (125)($180) / 325 = $69.23 = $69
Marginal cost = $180

2-4

Unit Manufacturing Cost

(a) Daytime Shift = ($2,300,000 + $9,500,000)/25,000
= $472/unit

(b) Two Shifts = [($2,800,000 + (1 + 1.15) ($9,500,000)]/50,000
= $465/unit

<u>Adding a second shift would decrease unit cost.</u>

2-5

Labor intensive process costs = $338,000 + $143x
Automated process costs = $1,244,000 + $92.5x
Given that the sales price of product is same no matter what proccess, we can compute the unit volume required for the costs to be equivalent:
$338,000 + $143x = $1,244,000 + $92.5x
50.5x = $906,000
So, at x = 17,941 units, the automate process becomes more profitable than the labor intensive manual process.

2-6

a) x = annual production units
Total Cost of Product A = Total Cost of Product B
$15,000 + $0.20 x = $5,000 + $0.50 x
x = $10,000/$0.30 = <u>33,333 units of annual production</u>

b) Need to examine the benefits of each product and their performance in light of their environmental impact.

2-7

Set the cost equal to the income to determine the number of units needed to break even over a 5 year period:
Costs = $288,000/yr*5yrs - $41,000 + $48,300/yr*5yrs + $14.55/unit*X units
Costs = $1,640,500 + $14.55*X
Income = $39.75/unit*X units
($39.75-$14.55)*X = $1,640,500
X = $1,640,500 /$25.20/unit = 65,099 units

2-8

The basic cost of production can be expressed as:
Cost = Regular Time Production Cost + Overtime Production Cost

Regular time production cost = 80 units/hr
Overtime production = 80*(0.90) = 72 units/hr

So, the hour required to produce the specified number of units can be determined as: #units/(80 units/hr) = # hrs of production required.
If this time is greater than 8 we will have overtime, if less than 5 we will use 5 hours.

Units to Produce	Hours Required	Reg Hrs Worked	Over Time hrs Required	Over Time hrs Worked	Cost Reg Time	Cost Ovr Time	Total Cost	Average Cost/Unit	Marginal Cost/Unit
(a) 350	4.38	5.00	0.00	0.00	$21,250	$0	$21,250	$60.71	$0
(b) 500	6.25	6.25	0.00	0.00	$26,563	$0	$26,563	$53.13	$53.13
(c) 640	8.00	8.00	0.00	0.00	$34,000	$0	$34,000	$53.13	$79.69
(d) 850	10.63	8.00	2.63	2.92	$34,000	$16,734	$50,734	$59.69	$79.69

Average cost/unit = Total Cost/units produced.
a) Marginal Cost = $0 since there is extra capacity in production. Only 4.38 of the 5 available hours have been used. So, no extra cost to produce another unit.
b) Marginal cost = ($4,250/hr)/(80unit/hr) = $53.125/unit
c) Since the 640 units required a total of 8 hours, the next unit will require the use of overtime. Marginal Cost = ($4,250/hr)(1+0.35)/(80*0.9unit/hr) = $79.69/unit
d) We are in overtime area at this level, so marginal cost is same as part (c), $79.69/unit.

2-9

Car: (1 gal/20 miles) * $3/gal * (1/1 person) = $0.15/mile*person

Air: (1 gal/0.2 miles) * $3/gal * (1/180 person) = $0.083/mile*person

Boat: (1 gal/2 miles) * $3/gal * (1/15 person) = $0.10/mile*person

2-10

If we ship 500 units and x = unit cost after price break, then:
400(2x) + 100(x) = 31,500 thus x= 31,500/900 = 35 units

a) Average cost per unit = $31,500/500 units = $63/unit
b) Cost per unit below price break point = $70
c) Marginal cost of 650th unit is $35

2-11

Given information: Sale Price = \$6,000/month per person
Fixed Cost = \$600,000/month
Variable Cost = \$4,000/month per person
X = number of senior citizens need to breakeven

a) At the breakeven point:
Total Revenue = Total Cost = Total Fixed Cost + Total Variable Cost

\$6,000 X = \$600,000 + \$4,000 X
\$2,000 X = \$600,000
X = \$600,000/\$2,000 = <u>300 people</u>

Note: Contribution towards profit = Sales Price – Variable Cost = \$2,000/person per month

b) X = 350 people
Profit = Sales Revenue – Total Costs
Profit = \$6,000 (350) - \$600,000 - \$4,000 (350) = \$100,000/month

Annual profit at 350 residents on average = \$100,000/mon * 12 mon/yr
= <u>\$1,200,000 per year</u>

2-12

Given information: Sale Price = \$1.40/bar
Fixed Cost = \$215,000/year
Variable Cost = Materials Cost/bar + Labor Cost/bar.
Variable Cost = (\$0.25 + 0.02 + 0.03) + \$0.15 = \$0.45/bar
X = number of bars made and sold per year

a) At the Breakeven Point:
Total Revenue = Total Cost = Total Fixed Cost + Total Variable Cost

\$1.40 X = \$250,000 + \$0.45 X
\$0.95 X = \$215,000 so, X = \$215,000/\$0.95 = <u>226,316 bars/year</u>

Note: Contribution towards profit = Sales Price – Variable Cost = \$0.95/bar

b) X = 300,000. Since this sales level is higher than the breakeven quantity, the firm should make a profit.
Profit = Sales Revenue – Total Costs
Profit = \$1.40(270,000) – (\$215,000 + \$0.45(270,000)) = <u>\$41,500</u> for year 1

c) Moving food related production offshore required careful consideration to regulations for that country. Are they as stringent? Will consumers have the same level of protection afforded by FDA laws within the US? Given the short shelf life of many foods, how will product shipment time impact potential spoilage issues?

2-13

(a) Monthly Bill:

50 × 30	= 1,500 kWh @ \$0.126	= \$189.00
	= 1,300 kWh @ \$0.106	= \$137.80
Total	= 2,800 kWh	= \$326.80

Average Cost = \$326.80/2,800 = \$0.1167/kWh
Marginal Cost (cost for the next kw-hr) = \$0.106 because the 2,801st kWh is in the 2nd bracket of the cost structure.
(\$0.106 for 1,501–3,000 kWh)

(b) Incremental cost of an additional 1,200 kWh/month:

200 kWh × \$0.106	= \$21.20
1,000 kWh × \$0.090	= \$90.00
1,200 kWh	\$111.20

This would be \$111.20/1,200 kWh = \$0.0927/kWh

(c) New equipment:
Assuming the basic conditions are 30 HP and 2,800 kWh/month. The extra 10HP will mean that the first cost bracket rises to 2000 kWh at a price of \$0.126/kWh.
Monthly bill with new equipment installed:

50 × 40 = 2,000 kWh at \$0.126	= \$252.00
900 kWh at \$0.106	= \$95.40
2,900 kw-hr	= \$347.40

Incremental cost of energy = \$347.40 – \$326.80 = \$20.60
Incremental unit cost = \$20.60/100 = \$0.2060/kWh

2-14

x = no. of maps dispensed per year
a) Fixed Cost (I) = \$1,000
b) Fixed Cost (II) = \$5,000
c) Variable Costs (I) = 0.900
d) Variable Costs (II) = 0.100
e) Set Total Cost (I) = Total Cost (II)
$\$1,000 + 0.90\,x = \$5,000 + 0.10\,x$
$x = \$4,000/\$0.80/\text{map} = 5,000$ maps dispensed per year.
Students can visually verify this from the figure.
f) System I is recommended if the annual need for maps is <5,000
g) System II is recommended if the annual need for maps is >5,000
h) Average Cost @ 3,000 maps:
TC(I) = (0.9) (3.0) + 1.0 = 3.7/3.0 = \$1.23 per map
TC(II) = (0.1) (3.0) + 5.0 = 5.3/3.0 = \$1.77 per map
Marginal Cost is the variable cost for each alternative, thus:
Marginal Cost (I) = \$0.90 per map
Marginal Cost (II) = \$0.10 per map

2-15

x = number of campers

a) Total Cost = Fixed Cost + Variable Cost
= \$192,000 + \$320 (12) x
Total Revenue = \$480 (12) x

b) Breakeven when Total Cost = Total Revenue
\$192,000 + \$3,840 x = \$5,760 x
\$192,000 = \$1,920 x
x = 100 campers to breakeven

c) Capacity is 200 campers
80% of capacity is 160 campers
@ 160 campers x = 160

Total Cost = \$192,000 + \$320 (12) (160) = \$806,400
Total Revenue = \$480 (12) (160) = \$921,600
Profit = Revenue – Cost = \$921,600 − \$806,400 = \$115,200

d) At 80% capacity
Marginal cost = \$3,840/camper
Average Cost = \$806,400/160campers = \$5,040

e) Pros: (1) It would allow persons to attend that would otherwise be unable due to a lack of funds, and (2) would help to balance the diversity of the campers better representing society.
Cons: (1) Why should those persons considered "better off" be penalized for their financial position, and (2) it will increase the complexity in determining what to charge, as well as collecting information in order to appropriately evaluate the economic status of each camper.

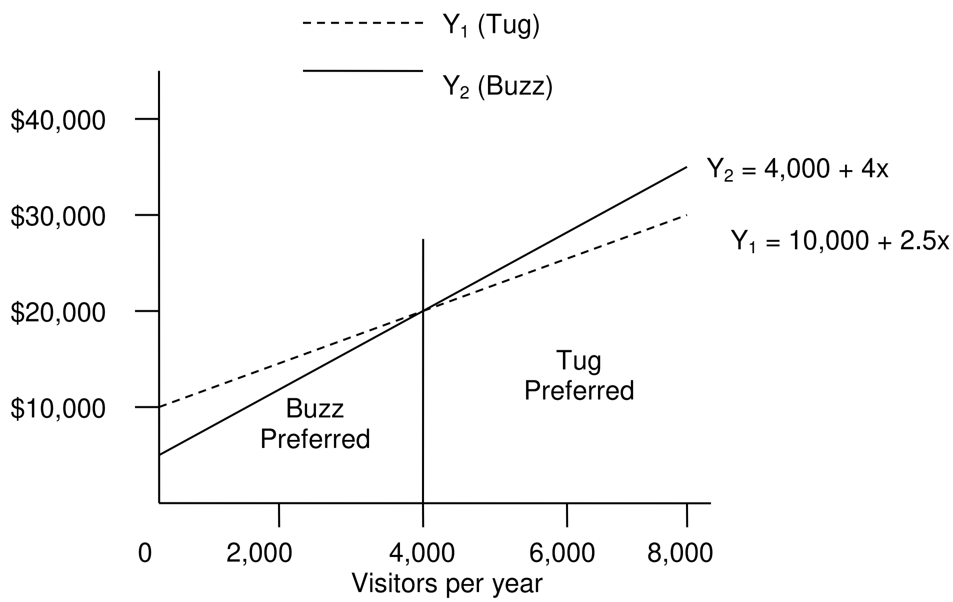
2-16

(a) x = number of visitors per year
Breakeven when: Total Costs (Tugger) = Total Costs (Buzzer)
\$10,000 + \$2.5 x = \$4,000 + \$4.00 x
x = 4000 visitors is the breakeven quantity

(b) See the figure below that plots costs as a function of the number of visitors:

X	Y1 (Tug)	Y2 (Buzz)
0	10,000	4,000
4,000	20,000	20,000
8,000	30,000	36,000

Note: See figure on next page.



2-17

x = annual production

(a) Total Revenue = ($200,000/1,000) x = $200 x

(b) Total Cost = $100,000 + ($100,000/1,000) x = $100,000 + $100 x

(c) Set Total Cost = Total Revenue
$200 x = $100,000 + $100 x
$100 x = $100,000
x = $100,000/$100 = 1,000 units per year
The student can visually verify this from the figure.

(d) Total Revenue = $200 (1,500) = $300,000
Total Cost = $100,000 + $100 (1,500) = $250,000
Profit = $300,000 − $250,000 = $50,000

(e) Given that the slope of the cost equation is $100, the cost for one more unit is:
Marginal Cost = $100
At 1500 units, the Total Cost = $100,000 + $100(1,500) = $250,000
Average Cost = $250,000/1500 units = $166.67/unit

2-18

x = annual production
Let's look at the graphical solution first, where the cost equations are:

Total Cost (A) = \$14 x + \$70,000
Total Cost (B) = \$7 x + \$115,000
Total Cost (C) = \$4 x + \$150,000

[See graph below]

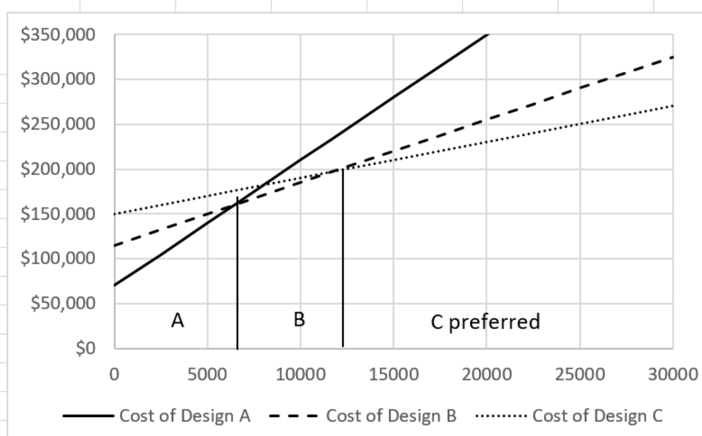
Quatro Hermanas wants to minimize costs over all ranges of x. From the graph we see that there are three breakeven points: A & B, B & C, and A & C. Only A & B and B & C are necessary to determine the minimum cost alternative over x. Mathematically, the breakeven points are:

A & B: \$14 x + \$70,000 = \$7 x + \$115,000 at x = 6248.6
B & C: \$7 x + \$115,000 = \$4 x + \$150,000 at x = 11,666.7

Thus our recommendation is, if:

$0 \le x < 6{,}249$ choose Alternative A
$6{,}249 < x \le 11{,}667$ choose Alternative B
$11{,}667 < x \le 30{,}000$ choose Alternative C

Annual Production Rate	Cost of Design A	Cost of Design B	Cost of Design C
0	**\$70,000**	\$115,000	\$150,000
2500	**\$105,000**	\$132,500	\$160,000
5000	**\$140,000**	\$150,000	\$170,000
6429	\$160,006	**\$160,003**	\$175,716
10000	\$210,000	**\$185,000**	\$190,000
11667	\$233,338	\$196,669	**\$196,668**
15000	\$280,000	\$220,000	**\$210,000**
17500	\$315,000	\$237,500	**\$220,000**
20000	\$350,000	\$255,000	**\$230,000**
22500	\$385,000	\$272,500	**\$240,000**
25000	\$420,000	\$290,000	**\$250,000**
27500	\$455,000	\$307,500	**\$260,000**
30000	\$490,000	\$325,000	**\$270,000**



2-19

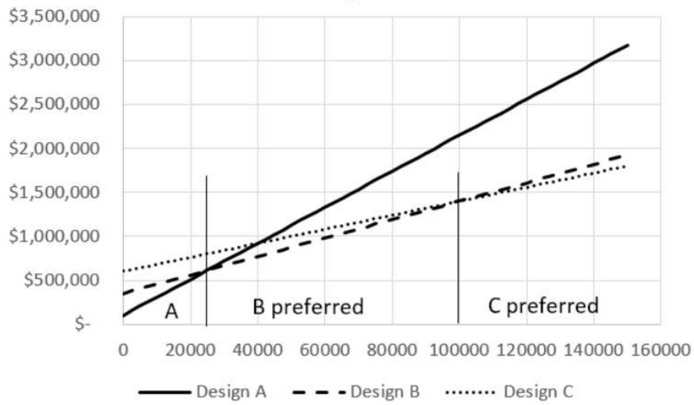
x = annual production rate

a) There are three breakeven points for total costs for the three alternatives
A & B: \$20.5 x + \$100,000 = \$10.5 x + \$350,000 at x = 25,000
B & C: \$10.5 x + \$350,000 = \$8 x + \$600,000 at x = 100,000
A & C: \$20.5 x + \$100,000 = \$8 x + \$600,000 at x = 40,000

We want to minimize costs over the range of x, thus the A & C breakeven point is not of interest. Looking at figure below we see that if:
0 < x ≤ 25,000 choose A
25,000 ≤ x ≤ 100,000 choose B
100,000 ≤ x ≤ 150,000 choose C

b) See graph below for Solution:

X	A	B	C
0	\$100	\$350	\$600
25	612.5	612.5	800
50	1,125	875	1,000
100	2,150	1,400	1,400
150	3,175	1,925	1,800



c) If one of the alternative designs had an ethical issue then in the range of production where it was favored, we would need to further consider its validity based on the ethical issues at hand. The design itself may be entirely eliminated from consideration, or some changes made to the design to address the issues.

2-20

x = units/year
By hand = Painting Machine
\$1.15x = \$16,000/4yr + \$0.18x
x = \$4,000/yr/\$0.97/unit = <u>4,124 units</u>

2-21

$C = \$3{,}000{,}000 - \$18{,}000Q + \$75Q^2$
where C = Total cost per year
Q = Number of units produced per year
Set the first derivative equal to zero and solve for Q.
$dC/dQ = -\$18{,}000 + \$150Q = 0$
$Q = \$18{,}000/\$150 = 120$

Therefore total cost is a minimum at Q equal to 120. This indicates that production below 120 units per year is most undesirable, as it costs more to produce 110 units than to produce 120 units.

Check the sign of the second derivative: $d^2C/dQ^2 = +\$150$

The + indicates the curve is concave upward, ensuring that Q = 120 is the point of a minimum.

Average unit cost at Q = 120/year:
$= [\$3{,}000{,}000 – \$18{,}000 (120) + \$75 (120)^2]/120 = \$16{,}000$
Average unit cost at Q = 110/year:
$= [\$3{,}000{,}000 – \$18{,}000 (110) + \$75 (120)^2]/110 = \$17{,}523$

One must note, of course, that 120 units per year is not necessarily the optimal level of production. Economists would remind us that the optimum point is where Marginal Cost = Marginal Revenue, and Marginal Cost is increasing. Since we do not know the Selling Price, we cannot know Marginal Revenue, and hence we cannot compute the optimum level of output.

We can say, however, that if the firm is profitable at the 110 units/year level, then it will be much more profitable at levels greater than 120 units.

2-22

x = annual production volume (demand) = D

a) Total Cost = \$10,875 + \$20 x
Total Revenue = (price per unit) (number sold)
= (-\$0.25 D + \$250) D and if D = x
$= -\$0.25\, x^2 + \$250\, x$

b) Set Total Cost = Total Revenue
$\$10{,}875 + \$20\, x = –\$0.25\, x^2 + \$250\, x$
$–\$0.25\, x^2 + \$230\, x – \$10{,}875 = 0$

This polynomial of degree 2 can be solved using the quadratic formula:
There will be two solutions:
$x = (-b \pm (b^2 - 4ac)^{1/2})/2a = (-\$230 \pm \$205)/-0.50$
Thus x = 870 and x = 50. There are two levels of x where TC = TR.

c) To maximize Total Revenue we will take the first derivative of the Total Revenue equation, set it equal to zero, and solve for x:

$TR = -\$0.25\ x^2 + \$250\ x$

$dTR/dx = -\$0.50\ x + \$250 = 0$

x = 500 is where we realize maximum revenue

d) Profit is revenue – cost, thus let's find the profit equation and do the same process as in part (c).

$$\begin{aligned}\text{Total Profit} &= (-\$0.25\ x^2 + \$250\ x) - (\$10{,}875 + \$20\ x)\\ &= -\$0.25\ x^2 + \$230\ x - \$10{,}875\end{aligned}$$

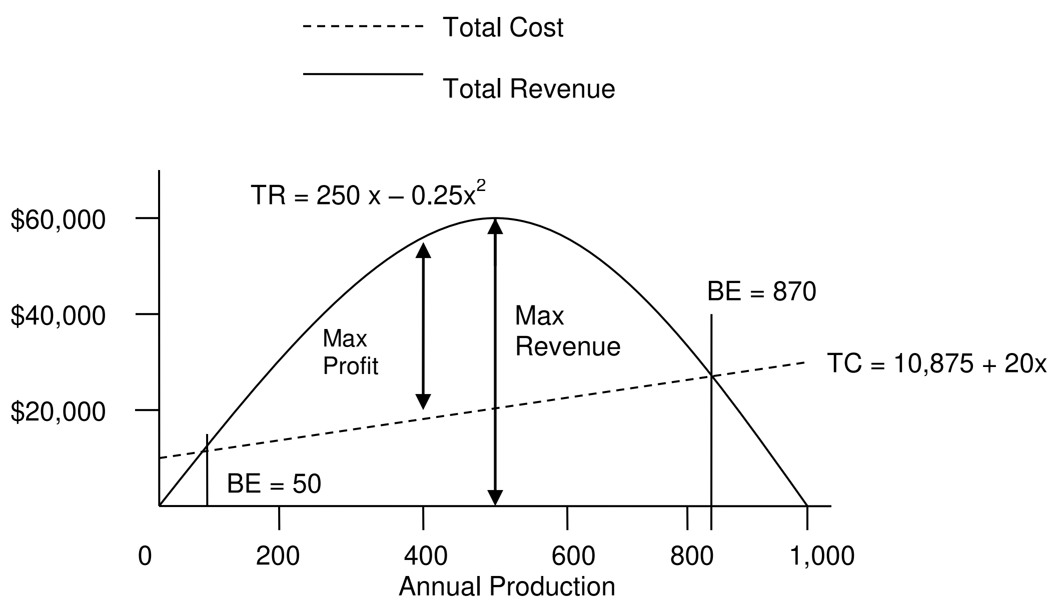
$dTP/dx = -\$0.50\ x + \$230 = 0$

x = 460 is where we realize our maximum profit

Max Profit $= -\$0.25\ (460)^2 + \$230\ (460) - \$10{,}875 = \$42{,}025$

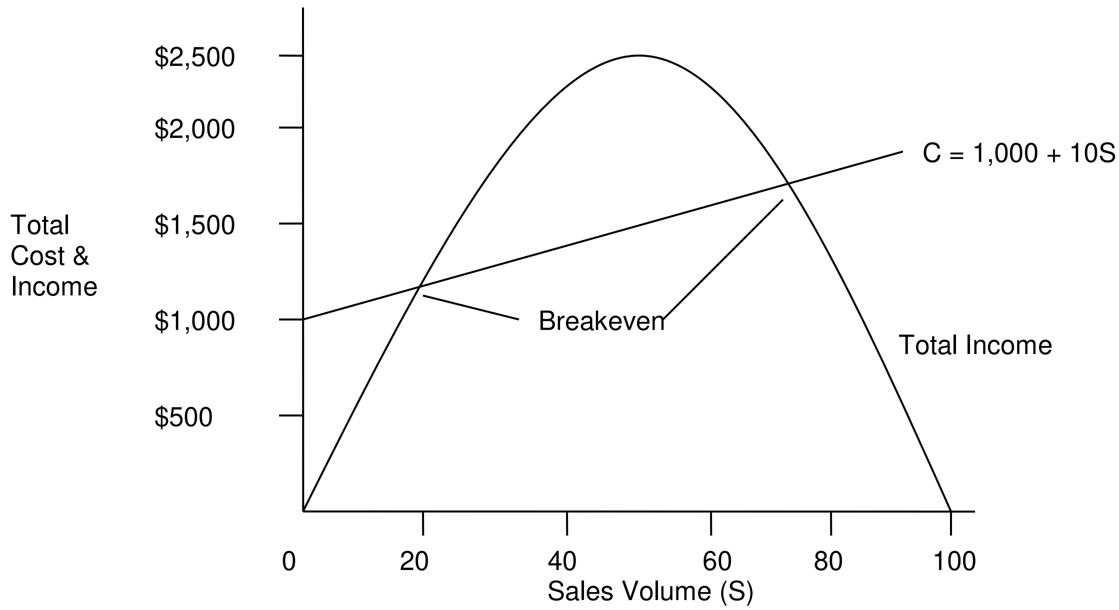
e) See the figure below. Your answers to (a) – (d) should make sense now.

X	Total Cost	Total Revenue
0	\$10,875	\$0
250	\$15,875	\$46,875
500	\$20,875	\$62,500
750	\$25,875	\$46,875
1,000	\$30,875	\$0



2-23

a)



b) For breakeven, set Profit = 0
$-S^2 + \$90S - \$1,000 = \$0$

$S = (-b \pm (b^2 - 4ac)^{1/2})/2a = (-\$90 \pm (\$90^2 - (4)(-1)(-1,000))^{1/2})/-2$
$= 12.98, 77.02$

c) For maximum profit
$dP/dS = -\$2S + \$90 = \$0$
$S = 45$ units

Answers: Breakeven at 13 and 77 units. Maximum profit at 45 units.

Alternative Solution: Trial & Error

Price	Sales Volume	Total Income	Total Cost	Profit
$20	80	$1,600	$1,800	−$200
$23	77	$1,771	$1,770	$0 (Breakeven)
$30	70	$2,100	$1,700	$400
$50	50	$2,500	$1,500	$1,000
$55	45	$2,475	$1,450	$1,025
$60	40	$2,400	$1,400	$1,000
$80	20	$1,600	$1,200	$400
$87	13	$1,131	$1,130	$0 (Breakeven)
$90	10	$900	$1,100	−$200

2-24

a) Sunk cost – since you did not sell it, this amount has no bearing on the future.
b) Book cost – no real dollars were exchanged, this value is for use in tax related computations.
c) Cash cost – a cash transaction to pay for the services of the consultant.
d) Cash cost – regular cash transactions for the utilities
e) Opportunity cost – the opportunity to make that money was forfeited due to the decision to be on leave.
f) Sunk cost – at this point in time, this floor space has no value and should not be considered in any future analysis.
g) Sunk cost – since you did not invest, this amount has no bearing on the future.

2-25

A cash cost is a cost in which there is a cash flow exchange between or among parties. This term derives from "cash" being given from one entity to another (persons, banks, divisions, etc.). With today's electronic banking capabilities, cash costs may or may not involve "cash." "Book costs" are costs that do not involve an exchange of "cash", rather, they are only represented on the accounting books of the firm. Book costs are not represented as before-tax cash flows.

Engineering economic analyses can involve both cash and book costs. Cash costs are the before-tax cash flows usually estimated for a project (such as initial costs, annual costs, and retirement costs) as well as costs due to financing (payments on principal and interest debt) and taxes. Cash costs are important in such cases. For the engineering economist the primary book cost that is of concern is equipment depreciation, which is accounted for in after-tax analyses.

2-26

Here the student may develop several different thoughts as it relates to life cycle costs. By life cycle costs the authors are referring to any cost associated with a product, good, or service from the time it is conceived, designed, constructed, implemented, delivered, supported and retired. Firms should be aware of and account for all activities and liabilities associated with a product through its entire life cycle. These costs and liabilities represent real cash flows for the firm — either at the time or sometime in the future.

2-27

Costs incurred:
- $600 purchase of refurbished notebook computer.
- $60 replace CD-ROM after two years.
- $30 purchase of wireless mouse.

Total cost of ownership: $690

Estimate benefits of ownership (over 4 years):
- $360 saved by playing games on weekends with friends instead of going to the movies.
- $200 saved by emailing instead of sending letters and making phone calls.
- $100 saved downloading music over the internet.
- $80 saved by doing business (like banking) over the internet instead of buying gas for the car.
- $30 saved by not buying paper and pens for note taking.

Total estimated benefits: $770. Yes, ownership has been worth it.

2-28

Figure 2-4 illustrates the difference between “dollars spent” and “dollars committed” over the life cycle of a project. The key point being that most costs are committed early in the life cycle, although they are not realized until later in the project. The implication of this effect is that if the firm wants to maximize value-per-dollar spent, the time to make important design decisions (and to account for all life cycle effects) is early in the life cycle. Figure 2-5 demonstrates “ease of making design changes” and “cost of design changes” over a project’s life cycle. The point of this comparison is that the early stages of the design cycle are the easiest and least costly periods to make changes. Both figures represent important effects for firms.

In summary, firms benefit from spending time, money and effort early in the life cycle. Effects resulting from early decisions impact the overall life cycle cost (and quality) of the product, good, or service. An integrated, cross-functional, enterprise-wide approach to product design serves the modern firm well.

2-29

Internal costs are incurred and paid by the firm and used to calculate the production cost. These costs impact pricing and ultimately profitability. In contrast external costs are outside the firm’s normal cost accounting and thus do not directly affect the price of goods/services. Green engineering focuses on reducing the company’s impact on the environment. Decisions about the product, material, and processing have an impact on the environment from the perspective of recycling, energy consumption in processing, and wastes. These decisions would impact internal costs and are quantitative in nature and somewhat easy to estimate. Impacts on external costs such as water quality, habitat, and community are very difficult to estimate and not directly observable particularly within a short time period.

2-30

Recurring Costs	Nonrecurring Costs
- Tuition	- Vehicle repair
- Room and board	- Doctor's fee
- Books	- Admission to out-of-town athletic event
- Gas for commuting	- Flash drive
- Automobile oil change	- Tattoo
- Morning coffee	- Flowers for girlfriend

2-31

If sell in December: Cost per use = (\$1450 – \$400) / 52 week* 2/week = \$10.10

If sell in May: Cost per use = (1450 – 200) / 72*2 = \$8.68

The cost to move it is roughly equal to 3 to 4 uses.

The longer you keep it and use it, its cost per use will continue to drop. Since there is no convenient gym at the new location and if you value the exercise that you get using the exercise equipment, then you should keep it. The moving cost is only 2.5% of its original cost (and presumably its replacement cost), so moving it is cheap. Sell it in December only if you absolutely need the \$400 and you feel the exercise is not bettering your health.

2-32

Choice A: Sell existing pump and replace it with right sized pump for total cost of \$90,000.
Choice B: Continue using existing pump and add a second to use in tandem for a total cost of \$100,000.

Criteria:
- <u>Initial Cost</u> – Choice A is better with a lower initial cost.
- <u>Recurring Maintenance Costs</u> – Choice A has lower annual maintenance cost.
- <u>Reliability</u> – Choice B is preferred due to redundancy (but if one pump fails, pumping will be at a reduced capacity which may not be any better than total failure).
- <u>Expandability</u> – the ability for the system pumping capacity to expand with growth may be a concern, but unable to determine based on problem statement.

Decision: From the information provided, I would choose Choice A due to its lower initial and recurring costs.

2-33

a) In this situation the owners would have both recurring costs (repeating costs per some time period) as well as nonrecurring costs (one-time costs). Below is a list of possible recurring and nonrecurring costs. Students may develop others.

Recurring Costs	Nonrecurring costs
- Annual inspection costs	- Initial construction costs
- Annual costs of permits	- Legal costs to establish rental
- Carpet replacement costs	- Drafting of rental contracts
- Internal/external paint costs	- Demolition costs
- Monthly trash removal costs	
- Monthly utilities costs	
- Annual costs for accounting/legal	
- Appliance replacements	
- Alarms, detectors, etc., costs	
- Remodeling costs (bath, bedroom)	
- Durable goods replacements (furnace, air-conditioner, etc.)	

b) Ethical standards for landlords include:
   - Follow all laws
   - Acting with good character
   - Serving the residents with integrity
   - Provide good customer service
   - Provide every qualified individual an equal opportunity (don't discriminate) – be transparent about the process and outcome
   - Make timely repairs using licensed repair persons
   - Provide a safe environment

   Some unethical practices that may arises include:
   - Charging a cleaning or damage fee when no really necessary
   - Entering the renter's property without their knowledge
   - Making temporary repairs or doing shoddy work

   Depending the contents of the lease, renters often must use small claims court or arbitration to confront issues with their landlord.

2-34

a) \$7000 The book cost results strictly from depreciation and can be more or less than the market value.

b) \$4000 The pump could be sold for this amount. If the pump is used instead, then it would be viewed as an opportunity foregone.

c) \$6000 – 4000 – 500 = \$1500 cheaper than buying the brass pump.

2-35

Internal cost to the automobile driver include: purchase price of the vehicle, insurance cost, fuel cost, costs for maintenance and repair of the vehicle, cost of tag, cost of license, parking cost, etc.

Public external societal costs include: damage to the roadways (leads to repair costs), environmental pollution from vehicle (noise and air), congestion costs, cost of accidents (vehicle, medical, and life in the case of fatalities), law enforcement costs, etc.

2-36

This is an example of a “sunk cost.” The $7,000 is a past cost and should not be allowed to alter a subsequent decision unless there is some real or perceived effect. Since either home is really an individual plan selected by the homeowner, each should be judged in terms of value to the homeowner vs. the cost. On this basis the stock plan house appears to be the preferred alternative.

2-37

Costs that are internal-to-the-firm:

- Surveying
- Land
- Legal
- Overhead
- Design
- Equipment

Costs that are external-to-society:

- Reduce water quality
- Roadway
- Lost animal habitat
- Public health
- Recreational loss
- Roadway congestion

- Construction
- Waste storage
- Labor
- Materials
- Administrative
- Health benefits
- Community
- Species extinction
- Reduced fisheries
- Air quality
- Noise pollution
- Virus tolerance

2-38

a) Current Process Expected Cost: If there is a 15% chance of the firm receiving a $350,000 fine, the expected fine in each 3 month period is 0.15*$350,000 = $52,500/quarter or $210,000 per year.

New Process Expected Cost: 0.06*($350,000/per)*(4 per/yr) = $84,000 per year

So, as long as the lease of the new process is <u>less than</u> $210,000 - $84,000 = $126,000, the company will come out ahead.

b) If the fees are an accurate assessment of the cost to remediate the harmful levels, then we would use those values:
Current Process Expected External Cost: $210,000 per year
New Process Expected Cost: $84,000 per year

2-39

a) The watts defines the amount of energy a light bulb uses. The lower the watts, the less energy used.
Incandescent:
Cost of Bulbs over 25,000 hrs: 25,000hrs/1250hr/bulb * $0.5/bulb = $10.00
Total Cost: 25,000hrs*(60 kilo-watts/1000)*$0.15/kWh + $10 = $235

	A	B	C	D	E	F
1	Time Period	25000	hours			
2	Electricity	$ 0.15	per kWh		(a)	
3		**Watts**	**Life**	**Cost/bulb**	**Cost of Bulbs**	**Total Cost**
4	Incandescent	60	1250	$ 0.50	$ 10.00	$ 235
5	CFL	14	8333	$ 2.00	$ 6.00	$ 59
6	LED	7	25000	$ 7.00	$ 7.00	$ 33

b) If light is only on for X% of the time, then 25,000 hours of use requires;
25,000 hrs / (5%*(24 hrs/day)*(365 days/year)) = 57.08 years
25,000 hrs / (30%*(24 hrs/day)*(365 days/year)) = 9.51 years
25,000 hrs / (60%*(24 hrs/day)*(365 days/year)) = 4.76 years

c) The homeowner should buy the LED bulb.

2-40

In this chapter, the authors list the following three factors as creating difficulties in making cost estimates: One-of-a-Kind Estimates, Time and Effort Available, and Estimator Expertise. Each of these factors could influence the estimate, or the estimating process, in different scenarios in different firms. One-of-a-kind estimating is a particularly challenging aspect for firms with little corporate-knowledge or suitable experience in an industry. Estimates, bids and budgets could potentially vary greatly in such circumstances. This is perhaps the most difficult of the factors to overcome. Time and effort can be influenced, as can estimator expertise. One-of-a-kind estimates pose perhaps the greatest challenge.

2-41

a) Gas Cost: (500 miles) (1 gal/25 mi) ($4/gal) = $80
   Wear and Tear: (500 miles) ($0.65/mi) = $325
   Total Cost = $80 + $325 = $405

b) (75 years) (365 days/year) (24 hours/day) = 657,000 hrs

c) Miles around Equator = 2 π (4,000 mi/2) = 12,566 mi
   12,566 mi (1 day/100 miles) = 125.7 days

d) Area of Kansas = (390) (200) = 78,000 mi^2
   Area of USA = (78,000) (50 states) = 3,900,000 mi^2

2-42

Level-1 seating = 2,500
Level-2 seating = (.80)2,500 = 2,000
Level-3 seating = (.80)1,600 = 1,600
Level-4 seating = (.80)1,280 = 1,280
Total attendance is thus (2,500+2,000+1,600+1,280) = 7,380
Given 4 sections at 2500 each, % filled = 7,380 /(4*2,500) = 74% full

2-43

Dining Room: Only need to refinish the existing flooring. This involves sanding the old stain & top coat ($1.50/ft^2$), applying a new stain ($1.00/ft^2$), and applying a new top coat of 2 layers of polyurethane ($1.00/ft^2$).
Total labor cost/ft^2 = $1.50 + $1.00 + $1.00 = $3.50/ft^2

The dining room area = 11 ft * 13 ft. = 143 ft^2
The wastage factor doesn't apply here since the wood is already in place.
Cost to refinish dining room = 143ft^2 * $3.50 = $500.50

Living Room: Requires the purchase of the wood flooring ($3.55/ft^2$) and then its installation ($1.50/ft^2$), applying a new stain ($1.00/ft^2$), and applying a new top coat of 2 layers of polyurethane ($1.00/ft^2$).
Total labor cost/ft^2 = $1.50 + $1.00 + $1.00 = $3.50/ft^2
Materials cost/ft^2 = $3.55/ft^2 for materials

The living room area = 12 ft * 12 ft = 144 ft^2
Including the 5% wastage factor of materials we get: 144*1.05 = 151.2 ft^2

Cost for materials = $3.55 * 151.2 = $536.76
Cost for labor = $3.50 * 144 = $504

Total Cost for both rooms = $500.50 + $536.76 + $504 = $1,541.26
Note: Always ask about the wastage factor and how it is applied before agreeing to the job!

2-44

Total Cost = Phone Unit Cost + Line Cost + One-Time Cost
= 80 phones*$155/phone + $7,800/mile(160miles) + $12,500 =
= $1,272,900

Cost to State = $1,272,900 (1 + 0.4) = $1,782,060

2-45

Cost (total) = Cost (paint) + Cost (labor) + Cost (fixed)
Number of Cans Needed = (6,000 ft^2/300 ft^2/can) (2 coats) = 40 cans

Cost (paint)= (10 cans) $15 = $150.00
= (15 cans) $12.50 = $187.50
= (15 cans) $12 = $180.00
Total Cost = $517.50

Cost (labor)= (5 painters) (8 hrs/day) (4.5 days/job) ($18/hr*painter) = $3,240
Cost (total) = $517.50 + $3,240 + $1,200 = $4,957.50 = $4,958

2-46

a) Unit Cost = $325,000/2,500 = $130/ft^2
b) i. If all items change proportionately, then:
Total Cost = ($130/ft^2) (4,500 ft^2) = $585,000
b) ii. For items that change proportionately to the size increase we multiply by:
4,500/2,500 = 1.8 all the others as per problem statement.
[See table below]

Cost Item	**2,500 ft^2 House Cost**	**Increase Factor**	**4,500 ft^2 House Cost**
1	($325,000) (0.07) = $22,750	× 1	$22,750
2	($325,000) (0.17) = $55,250	× 1	$55,250
3	($325,000) (0.19) = $61,750	× 1.8	$111,150
4	($325,000) (0.08) = $26,000	× 1.8	$46,800
5	($325,000) (0.14) = $45,500	× 1.5	$68,250
6	($325,000) (0.10) = $32,500	× 1.8	$58,500
7	($325,000) (0.09) = $29,250	× 1.8	$52,650
8	($325,000) (0.16) = $52,000	× 1.8	$93,600
		Total Cost	$508,950

2-47

a) Unit Profit = $197 (0.30)= $59 or
= Unit Sales Price − Unit Cost
= $197 (1.3) − $197 = $256 − $197 = $59

b) Overall Batch Cost = $197 (10,000) = $1,970,000

c) Of the 10,000 batch:
1. (10,000) (0.01) = 100 are scrapped in mfg.
2. (10,000 − 100) (0.03) = 297 of finished product go unsold
3. (9,900 − 297) (0.02) = 192 of sold product are returned
Total = 589 of original batch are not sold for profit

Total Batch Revenue = (10,000 − 589) $256 = $2,409,216
Overall Batch Profit = $2,409,216 - $1,970,000 = $439,216

d) Unit Cost = $63 (0.50) + $24 + $110 = $165.50
Batch Cost with Contract = 10,000 ($165.50) = $1,655,000
Difference in Batch Cost:
= BC without contract- BC with contract = $1,970,000 − $1,655,000
= $315,000

SungSam can afford to pay up to $315,000 for the contract.

2-48

Current size of the facility is 185,000 sq. ft. So the 25,000 sq.ft. expansion is a 13.51% growth. Therefore, using the power sizing model:
Cost for expansion = $\$17M\ (1.1351)^{0.62} - \$17M = \$1,389,860 = \$1.4M$

2-49

a) From Table 2-1 the power sizing exponent is 0.80.
   Cost = $\$85,000\ (2.0/1.0)^{0.8} = \$147,994$

b) Environmentally electrostatic precipitators are better than some approaches such as the Baghouse method for pollution abatement in terms of efficiency and energy consumption.

   Pros: high particulate collection efficiency over a wide range of particle sizes, ease of operation.

   Cons: expensive to buy and install, large in size, custom design and install (can't easily be moved to a different application, not viable for gaseous pollutants, high energy cost.

2-50

$C_A/C_B = I_A/I_B$
$C_{50\ YEARS\ AGO}/C_{TODAY} = AFCI_{50\ YEARS\ AGO}/AFCI_{TODAY}$
$C_{TODAY} = (1{,}989/127)\ (\$48) = \$752$

2-51

$I_{TODAY} = (90/12)\ (100) = 750$
$C_{LAST\ YEAR} = (600/750)\ (90) = \$72$

2-52

Equipment	Cost of New Equipment minus	Trade-In Value	= Net Cost
Varnish Bath	$(75/50)^{0.80}$ (3,500) = \$4,841	\$3,500 (0.15)	= \$4,316
Power Scraper	$(1.5/0.75)^{0.22}$ (250) = \$291	\$250 (0.15)	= \$254
Paint Booth	$(12/3)^{0.6}$ (3,000) = \$6,892	\$3,000 (0.15)	= \$6,442
		Total	\$11,012

b) Some ideas include:
1. She should first work to ensure that she procures only the solvents and lacquers she will use to reduce or eliminate any amounts left over.
2. She could look for other businesses in the immediate area that may be able to use her leftover materials.
3. Explore the use of newer more environmental friendly solvents and lacquers.
4. Collect the materials and take them to a hazardous materials processing center.

2-53

Equipment	Cost of New Equipment minus	Trade-In Value	= Net Cost
Varnish Bath	4,841 (171/154) = \$5,375	\$3,500 (0.15)	= \$4,850
Power Scraper	291 (900/780) = \$336	\$250 (0.15)	= \$298
Paint Booth	6892 (76/49) = \$10,690	\$3,000 (0.15)	= \$10,240
		Total	\$15,388

2-54

Scaling up cost: Cost of 3,500 g/hr centrifuge = $(3{,}500/1{,}250)^{0.75}$ (32,000) = \$67,159
Updating the cost: Cost of 3,500 model= \$67,159 (270/135) = \$134,318

2-55

Cost of VMIC − 50 today = 95,000 (350/235) = \$141,489
Using Power Sizing Model:

$(141{,}489/250{,}000) = (50/100)^x$

$\log(0.565956) = x \log(0.50)$

$x = 0.8212 = 0.82$

2-56

There are two issues here. First, you have cost information for a similar piece of equipment in the past, but the new equipment has a different capacity (Power-sizing model). Second, the prices have changed over time and to purchase the same piece of equipment now would cost you more (Cost Index model). The lifespan of the equipment and the interest rate for discounting purposes don't figure in at this time. They will be useful in evaluating the purchase once you have other cost and/or benefit data to consider. At this point, you just want to figure out the purchase price for the equipment of a different capacity if you bought it now.

We will first apply the Power Sizing model and then the Cost Index model:
Original price for the smaller capacity unit = $\$8{,}500(900/1500)^{0.3}$ = \$7,292
Price now for the smaller capacity unit = \$7,292 (195/111) = <u>\$12,811</u>

We can work it in the opposite order, applying the Cost Index model and then the Power Sizing model:
Price now for the original capacity unit = \$8,500(195/111) = \$14,932
Price now for the smaller capacity unit = $\$14{,}932(900/1500)^{0.3}$ = <u>\$12,811</u>

2-57

This problem involves a combination of the Per Unit cost estimating model and the Cost Index cost estimating model. The new shop is going to be larger.

Type of Space	Current Store ft^2	Proposed Store ft^2	Original Price/sq. ft.	Cost Index Then	Cost Index Now	Current Price/ft^2
Retail Space	1200	2400	\$75	153	140	\$68.63
Office space	400	1200	\$30	120	132	\$33.00

Retail Space Cost Now = Retail Space Cost Then (CI now/CI then)
Retail Space Cost Now = \$75/ft^2 (140/153) = \$68.63/ft^2
Office Space Cost Now = \$30/ft^2 (132/120) = \$33.00/ft^2

Total Estimated Cost Now = 2,400 ft^2 (\$68.63) + 1200 ft^2 (\$33.00)
Total Estimated Cost Now = \$164,712 + \$39,600 = \$204,312

2-58

$T_7 = T_1 \times 9^b$
$137 = 315 \times 9^b$
$0.435 = 9^b$ log 0.435 = b log (9) b = log (0.435)/log (9) = −0.379

b is defined as log (learning curve rate)/ log 2.0
b = [log (learning curve rate)/log 2.0] = −0.379

log (learning curve rate) = −0.114
learning curve rate = $10^{(-0.114)}$ = .769 = 77%

2-59

Initial task takes 20 min and the learning rate is 80%. We want to compute the time to complete the 6th task.

T_6 = 20 min x $6^{\log(0.80)/\log(2.0)}$ = 20 min x $6^{-.322}$ = 11.23 = 11.2 min

2-60

Time for the first pillar is

$T_8 = 225 = T_1 \times 8^{\log(0.68)/\log(2.0)}$

Solve for T_1 = 716 person hours

Time for the 25th pillar is

T_{25} = 716 x $25^{\log(0.68)/\log(2.0)}$ = 119 person hours

2-61

The first home took 3,500 hours, so at a 92% learning rate, the Nth house should take: T_N = 3,500 hours x $N^{\log(\text{learning rate})/\log(2.0)}$. However, we are interested in the time required to build the first 18 house. So we need to sum the times required to build each of the 18 houses given the different learning rates. These are given below:

	TN (Hours)			
	Parts(a-c)	Part (d)	Part e)	Part (f)
House	92%	70%	75%	80%
1	3500	3500	3500	3500
2	3220	2450	2625	2800
3	3067	1989	2218	2457
4	2962	1715	1969	2240
5	2884	1529	1795	2085
6	2821	1392	1664	1966
7	2770	1286	1561	1871
8	2725	1201	1477	1792
9	2687	1130	1406	1725
10	2653	1070	1346	1668
11	2623	1019	1294	1617
12	2596	974	1248	1573
13	2571	935	1207	1533
14	2548	900	1171	1497
15	2527	869	1137	1464
16	2507	840	1107	1434
17	2489	815	1080	1406
18	2472	791	1055	1380
Total	**49623**	**24404**	**28859**	**34007**

2-62

5 units/hr * (1hr/60 min) = 1 unit/12 min. Need to produce a unit in less than 12 min.
So, N = unit number that takes less than 12 minutes to produce
$5 = 43 \text{ min} \times N^{\log(0.76)/\log(2.0)}$
$(5/43) = N^{-0.3959}$
$N = (5/43)^{-1/0.3959} = 25.12$
So, by the 26th unit will be producing at a rate that is greater than 5 units/hour

2-63

The first installation took 75 hours, so at a 90% learning rate, the N^{th} installation should take: $T_N = 75 \text{ hours} \times N^{\log(\text{learning rate})/\log(2.0)}$

	A	B	C	D
1	Problem 2-59			
2				
3	75	Time to complete first task		
4				
5	N	Learning Rate	T_N (Hours)	
6	5	90%	59	
7	10	90%	53	
8	20	90%	48	
9				

d) AMCF's (Association of Management Consulting Firms) Code of Ethics can be found at the website: http://amcf.org. The two lists serve a similar purpose in providing a standard for persons in their respective fields. They both address integrity, honesty, and acting in the best interest of the client. The AMCF list is longer and categorizes their code into four groups and providing more specific guidelines than one finds in the NSPE list. Given AMCF addresses consulting firms specifically one of their categories covers fees. Given that engineers deal with products and structures, public safety and health is specifically address in their list as opposed to that of AMCF.

2-64

75% learning curve in use of SPC will reduce costs after 6 months to
Cost in 6 months = $(x)\ 12^{\log(0.75)/\log(2.0)} = 0.357x$

Thus costs have been reduced from x to 0.357x, that is a 64% reduction.

2-65

The first build took 20 hours, so at an 85% learning rate, the N^{th} installation should take: T_N = 20 hours x $N^{\log(0.85)/\log(2.0)}$

	A	B	C	D
1	20.00	Time to complete first task		
2				
3	N	Learning Rate	TN (Hours)	
4	1	85%	20	
5	2	85%	17	
6	3	85%	15	
7	4	85%	14	
8	5	85%	14	
9		Average	16.1	

2-66

We are given T_1 but we do not know the learning rate, R. We can solve for it using one of the given points:

$T_2 = T_1 \times 2^{\log(R)/\log(2.0)}$ $\quad$ $76 = 84 \times 2^{\log(R)/\log(2.0)}$

$\log_2(76/84) = \log(R)/\log(2)$ $\quad$ $\log(2)^* \log_2(76/84) = \log(R)$

$-0.04347 = \log(R)$ $\quad$ $R = 10^{-0.04347} = 0.9048 = 90.5\%$

With any real-world data, we will not be able to find a single learning rate that will actually fit all of the data. Another approach is to estimate the learning rate for the available data and average the results. Doing this results in a value of 81.7%

	A	B	C	D	E
1	84	Time to complete first task			
2					
3	**N**	**Target Time**	**Solve For Learning Rate**	**Est. Learning Rate**	**TN (Hours)**
4	1	84		81.8%	84
5	2	76	0.9048	81.8%	69
6	3	61	0.8172	81.8%	61
7	4	54	0.8018	81.8%	56
8	5	50	0.7998	81.8%	53
9	6	48	0.8053	81.8%	50
10	7	45	0.8007	81.8%	48
11	8	43	0.8000	81.8%	46
12	9			Steady State	43
13	10				43
14	11				43
15		Average Rate	0.8185	**Total Time**	**596**

Applying this learning rate, results in task times above. The total time to process 11 patients will be 596 hours.

2-67

The following is a list of car ownership items that would incur costs. Each could be estimated reasonably accurately with a little effort.

(1) License, registration, title, and insurance.
(2) Gas, oil changes, and tire replacement and/or rotation.
(3) Brake pad, brake rotor, belt, wiper, battery replacement.
(4) Exhaust system repair.
(5) Major system repair.
(6) Cooling system (Radiator leak, head gasket leak, hose leak, thermostat malfunction).
(7) Drive train (Transmission repair, clutch replacement, differential replacement).
(8) Brake system (Master and/or slave cylinder replacement, brake line leak).
(9) Fuel system (Fuel pump replacement, gas tank leak, fuel line leak, fuel filter replacement).

The following is a partial list of car ownership benefits. Each would be difficult to quantify in terms of dollars. Accuracy would be low.

(1) Commuting to school and to part-time job.
(2) Running errands, shopping, and dining out with friends.
(3) Visiting parents and relatives.
(4) Traveling to other cities for entertainment, getting to an airport, attending a professional meeting, going to a job interview.
(5) Going to an out-of-town athletic event.
(6) Lugging equipment to a remote site for research.
(7) Going to the post office to mail items.

2-68

The result of this bias is that the actual costs experienced will be higher while at the same time the benefits will actually be less. This type of bias in the estimates mean that an analyst using such values will see outcomes that are more favorable than what would actually be seen if the project was executed in reality.

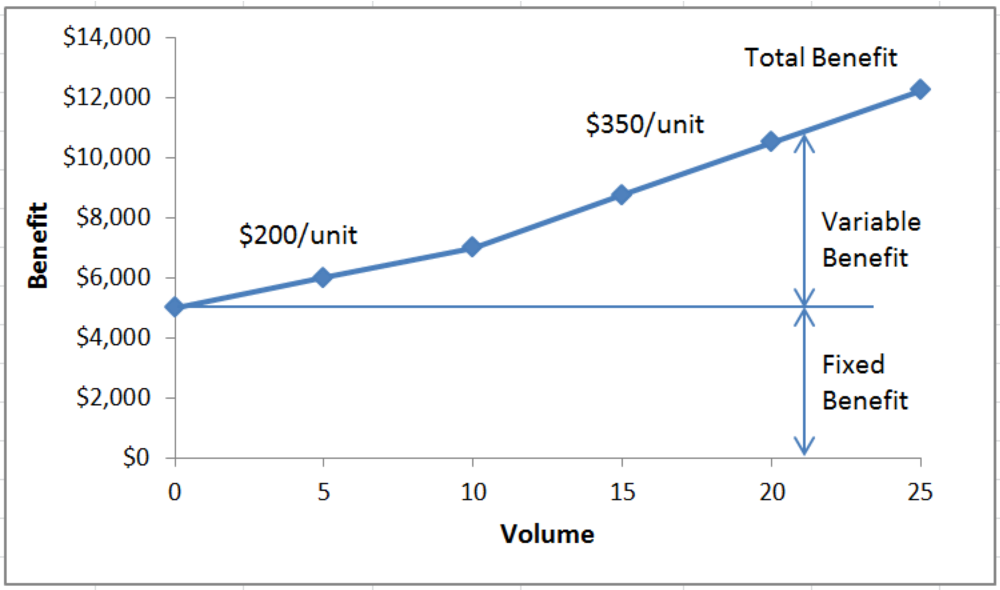
2-69

	Costs	Benefits
Recurring	• Electricity costs • Phone bill	• Increased productivity in both cases. I am able to function in the evening, and I am able to have timely communication with persons located nationwide.
Non-recurring	• Movie Rentals • Traffic Ticket	• Entertainment is good to balance work with play. • Encourage me to drive safely (also adds to financial coffers of the city)

2-70

Because all costs are the same for A and B, an economic analysis would focus solely on the difference in benefits between them. These are the incremental benefits—or difference in benefits.

For example, consider a performance based contract (PBC) where there is a base salary for projects A and B. The fixed benefit would be the difference between these two salaries (B-A = $5,000 in figure below). The variable portion would be the incremental difference in the benefit per unit provided as performance increases. In the figure below, this performance is measured on the basis of volume. Two different rates are shown as a function of volume ($200 for volumes up to 10 and $350/unit beyond that).



2-71

Students will develop their own examples, some might include:

- A coach or ball player who has incentives based on performance above some expected level such as wins in a season or homeruns or goals scored.
- A manager who is paid based on the total quality units shipped above a base amount.
- An hourly worker who is paid on a per-piece wage rate and is rewarded for production above a certain level.
- A sales representative whose monthly compensation is based on a fixed rate plus a commission on the number of units moved above some level.
- A waitress or bar tender who is provided a base salary but receive tips based on the number of tables or customers served.

2-72

The concepts, models, effects, and difficulties associated with "cost estimating" described in this chapter all have a direct (or near direct) translation for "estimating benefits." Differences between cost and benefit estimation include: (1) benefits tend to be over-estimated, whereas costs tend to be underestimated, and (2) most costs tend to occur during the beginning stages of the project, whereas benefits tend to accumulate later in the project life comparatively.

2-73

a) Estimates based on future events become less accurate the further out into the future they are pushed. The uncertainty and unpredictability of the future can never be grasped by an estimate. It would not be a bad idea to incorporate inflation in estimates. However, those making the decision based on estimates must realize that the values are only "educated guesses" and take that into account. Trying to consider factors such as the impact of economic climate and government regulations, although prudent is itself unpredictable as we have seen in the years from 2007 to 2011.
b) Public budgeting can result in support for such projects in the form of matching funds. This helps to offset the cost of the projects. However, the ability to secure such funding is not always guaranteed. If the project is funded, then the funding is based on estimates and therefore, the estimates will need to be conservative in order to ensure that adequate funds are available to cover the project's completion.

2-74

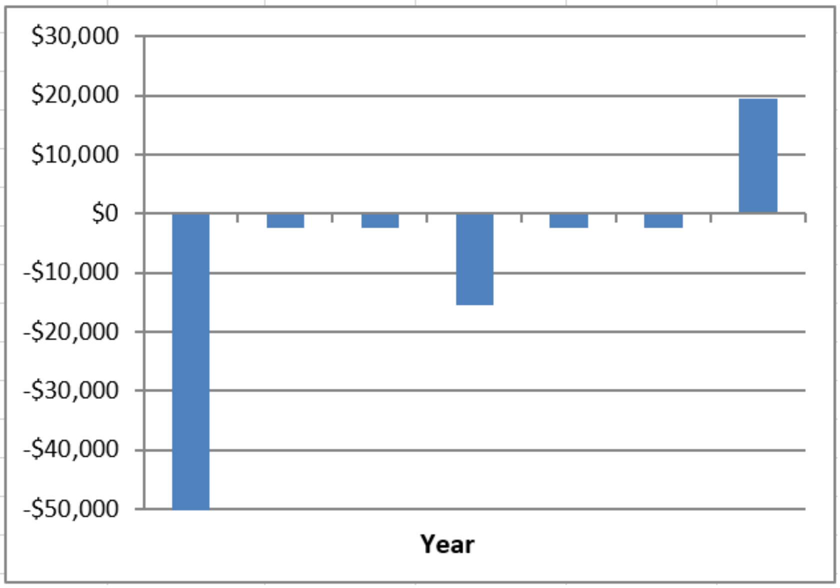
Next year the king will make \$10M + (68-40)(\$0.065M) = \$11.82 million

2-75

EOY	Payments	Maintenance	Market Value	Cash Flow
0	-\$7,500	\$0	\$0	-\$7,500
1	-\$8,000	-\$1,000	\$0	-\$9,000
2	-\$8,000	-\$2,000	\$0	-\$10,000
3	-\$8,000	-\$2,000	\$0	-\$10,000
4	\$0	-\$2,000	\$12,000	\$10,000

2-76

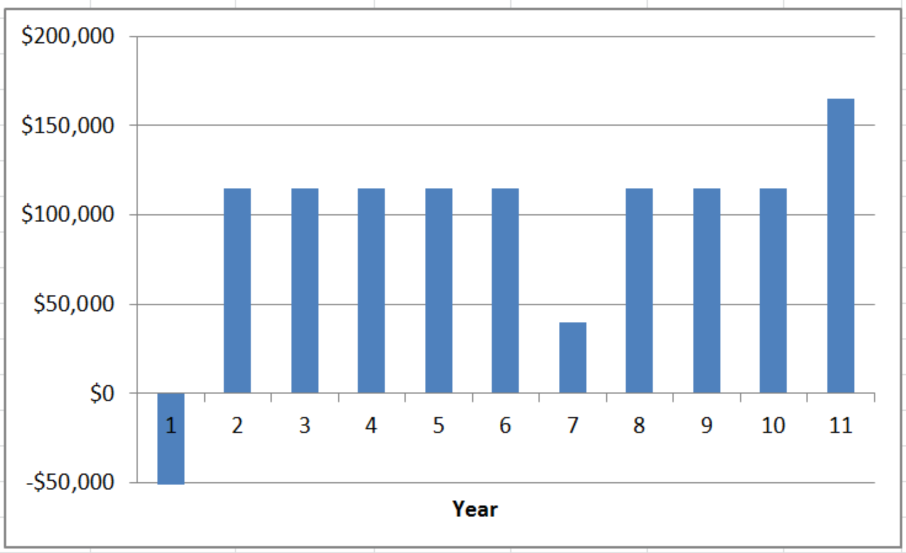
EOY	Capital Costs	O&M	Overhaul	Cash Flow
0	-$85,000			-$85,000
1		-$2,500		-$2,500
2		-$2,500		-$2,500
3		-$2,500		-$15,500
4		-$2,500	-$13,000	-$2,500
5		-$2,500		-$2,500
6	$22,000	-$2,500		$19,500



2-77

Problem 2-76

EOY	Capital Costs	O&M	Overhaul	Benefits	Cash Flow
0	-$300,000				-$300,000
1		-$85,000		$200,000	$115,000
2		-$85,000		$200,000	$115,000
3		-$85,000		$200,000	$115,000
4		-$85,000		$200,000	$115,000
5		-$85,000		$200,000	$115,000
6		-$85,000	-$75,000	$200,000	$40,000
7		-$85,000		$200,000	$115,000
8		-$85,000		$200,000	$115,000
9		-$85,000		$200,000	$115,000
10	$50,000	-$85,000		$200,000	$165,000



2-78

Each student's answers will be different depending on their particular school and life situation. As an example:

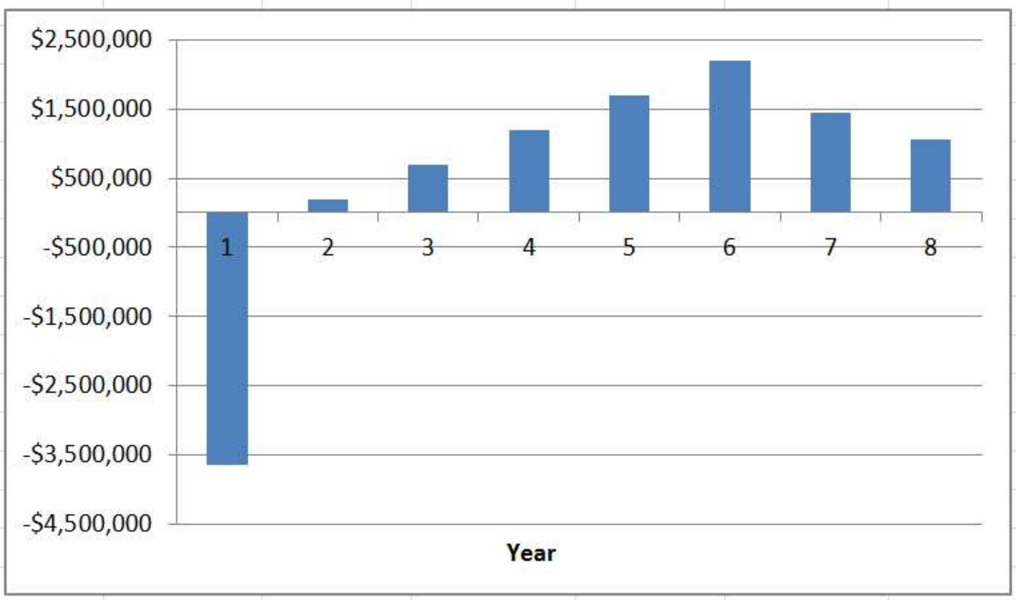
First Costs: tuition costs, fees, books, supplies, board (if paid ahead)
O & M Costs: monthly living expenses, rent (if applicable)
Salvage Value: selling books back to student union, etc.
Revenues: wages & tips, etc.
Overhauls: periodic (random or planned) mid-term expenses

The cash flow diagram is left to the student.

2-79

The data on the historical design costs are sunk costs and not included in the cash flow diagram.

	A	B	C	D	E	F	G
1	EOY	Capital Costs	O&M	Materials & Overhead	Revenue	Cash Flow	
2	$ -	-$3,650,000				-$3,650,000	
3	$ 1		-$50,000	-$1,750,000	$2,000,000	$200,000	
4	$ 2		-$50,000	-$1,750,000	$2,500,000	$700,000	
5	$ 3		-$50,000	-$1,750,000	$3,000,000	$1,200,000	
6	$ 4		-$50,000	-$1,750,000	$3,500,000	$1,700,000	
7	$ 5		-$50,000	-$1,750,000	$4,000,000	$2,200,000	
8	$ 6		-$50,000	-$1,750,000	$3,250,000	$1,450,000	
9	$ 7	$365,000	-$50,000	-$1,750,000	$2,500,000	$1,065,000	



2-80

Non-LEED Bid: Score = ($38M/$28M) * 100 + 0 points = 135.71 points

The cost to meet the LEED criteria is added to the firm's cost estimate:
LEED Bid: Score = ($38M/$28.875M) * 100 + 3 points = 134.60 points

Spending the money to meet the LEED criteria is NOT a good idea.

2-81

The total cost to consider would be the internal cost plus the specified percent of the external cost. This is shown in column D below as the "Adjusted Internal Cost"

	A	B	C	D
1	**Internal Cost**	**External Cost**	**% of External for Internal**	**Adjusted Internal Cost**
2	**a) Now**			
3	$ 25.00	$ 8.00	5%	$ 25.40
4	$ 26.20	$ 3.00	5%	$ 26.35
5	**b) Later**			
6	$ 25.00	$ 8.00	20%	$ 26.60
7	$ 26.20	$ 3.00	20%	$ 26.80