CHAPTER 6
MAKING CAPITAL INVESTMENT DECISIONS

Answers to Concepts Review and Critical Thinking Questions

1. In this context, an opportunity cost refers to the value of an asset or other input that will be used in a project. The relevant cost is what the asset or input is actually worth today, not, for example, what it cost to acquire.

2. *a.* Yes, the reduction in the sales of the company's other products, referred to as erosion, should be treated as an incremental cash flow. These lost sales are included because they are a cost (a revenue reduction) that the firm must bear if it chooses to produce the new product.

    b. Yes, expenditures on plant and equipment should be treated as incremental cash flows. These are costs of the new product line. However, if these expenditures have already occurred (and cannot be recaptured through a sale of the plant and equipment), they are sunk costs and are not included as incremental cash flows.

    c. No, the research and development costs should not be treated as incremental cash flows. The costs of research and development undertaken on the product during the past three years are sunk costs and should not be included in the evaluation of the project. Decisions made and costs incurred in the past cannot be changed. They should not affect the decision to accept or reject the project.

    d. Yes, the annual depreciation expense must be taken into account when calculating the cash flows related to a given project. While depreciation is not a cash expense that directly affects cash flow, it decreases a firm's net income and hence, lowers its tax bill for the year. Because of this depreciation tax shield, the firm has more cash on hand at the end of the year than it would have had without expensing depreciation.

    e. No, dividend payments should not be treated as incremental cash flows. A firm's decision to pay or not pay dividends is independent of the decision to accept or reject any given investment project. For this reason, dividends are not an incremental cash flow to a given project. Dividend policy is discussed in more detail in later chapters.

    f. Yes, the resale value of plant and equipment at the end of a project's life should be treated as an incremental cash flow. The price at which the firm sells the equipment is a cash inflow, and any difference between the book value of the equipment and its sale price will create accounting gains or losses that result in either a tax credit or liability.

    g. Yes, salary and medical costs for production employees hired for a project should be treated as incremental cash flows. The salaries of all personnel connected to the project must be included as costs of that project.

3. Item (a) is a relevant cost because the opportunity to sell the land is lost if the new golf club is produced. Item (b) is also relevant because the firm must take into account the erosion of sales of existing products when a new product is introduced. If the firm produces the new club, the earnings from the existing clubs will decrease, effectively creating a cost that must be included in the decision. Item (c) is not relevant because the costs of research and development are sunk costs. Decisions made in the past cannot be changed. They are not relevant to the production of the new club.

4. For tax purposes, a firm would choose MACRS because it provides for larger depreciation deductions earlier. These larger deductions reduce taxes, but have no other cash consequences. Notice that the choice between MACRS and straight-line is purely a time value issue; the total depreciation is the same, only the timing differs.

5. It's probably only a mild over-simplification. Current liabilities will all be paid, presumably. The cash portion of current assets will be retrieved. Some receivables won't be collected, and some inventory will not be sold, of course. Counterbalancing these losses is the fact that inventory sold above cost (and not replaced at the end of the project's life) acts to increase working capital. These effects tend to offset one another.

6. Management's discretion to set the firm's capital structure is applicable at the firm level. Since any one particular project could be financed entirely with equity, another project could be financed with debt, and the firm's overall capital structure would remain unchanged. Financing costs are not relevant in the analysis of a project's incremental cash flows according to the stand-alone principle.

7. The EAC approach is appropriate when comparing mutually exclusive projects with different lives that will be replaced when they wear out. This type of analysis is necessary so that the projects have a common life span over which they can be compared. For example, if one project has a three-year life and the other has a five-year life, then a 15-year horizon is the minimum necessary to place the two projects on an equal footing, implying that one project will be repeated five times and the other will be repeated three times. Note the shortest common life may be quite long when there are more than two alternatives and/or the individual project lives are relatively long. Assuming this type of analysis is valid implies that the project cash flows remain the same over the common life, thus ignoring the possible effects of, among other things: (1) inflation, (2) changing economic conditions, (3) the increasing unreliability of cash flow estimates that occur far into the future, and (4) the possible effects of future technology improvement that could alter the project cash flows.

8. Depreciation is a non-cash expense, but it is tax-deductible on the income statement. Thus depreciation causes taxes paid, an actual cash outflow, to be reduced by an amount equal to the depreciation tax shield, t_cD. A reduction in taxes that would otherwise be paid is the same thing as a cash inflow, so the effects of the depreciation tax shield must be added in to get the total incremental aftertax cash flows.

9. There are two particularly important considerations. The first is erosion. Will the "essentialized" book simply displace copies of the existing book that would have otherwise been sold? This is of special concern given the lower price. The second consideration is competition. Will other publishers step in and produce such a product? If so, then any erosion is much less relevant. A particular concern to book publishers (and producers of a variety of other product types) is that the publisher only makes money from the sale of new books. Thus, it is important to examine whether the new book would displace sales of used books (good from the publisher's perspective) or new books (not good). The concern arises any time there is an active market for used product.

10. Definitely. The damage to Porsche's reputation is a factor the company needed to consider. If the reputation was damaged, the company would have lost sales of its existing car lines.

11. One company may be able to produce at lower incremental cost or market better. Also, of course, one of the two may have made a mistake!

12. Porsche would recognize that the outsized profits would dwindle as more products come to market and competition becomes more intense.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

   Basic

1. Using the tax shield approach to calculating OCF, we get:

   $OCF = (Sales - Costs)(1 - t_C) + t_C Depreciation$
   $OCF = [(\$4.75 \times 1,500) - (\$2.30 \times 1,500)](1 - 0.34) + 0.34(\$9,000/5)$
   $OCF = \$3,037.50$

   So, the NPV of the project is:

   $NPV = -\$9,000 + \$3,037.50(PVIFA_{14\%,5})$
   $NPV = \$1,427.98$

2. We will use the bottom-up approach to calculate the operating cash flow for each year. We also must be sure to include the net working capital cash flows each year. So, the net income and total cash flow each year will be:

		Year 1	Year 2	Year 3	Year 4
Sales		$12,500	$13,000	$13,500	$10,500
Costs		2,700	2,800	2,900	2,100
Depreciation		6,000	6,000	6,000	6,000
EBT		$3,800	$4,200	$4,600	$2,400
Tax		1,292	1,428	1,564	816
Net income		$2,508	$2,772	$3,036	$1,584
OCF	0	$8,508	$8,772	$9,036	$7,584
Capital spending	–$24,000	0	0	0	0
NWC	–300	–350	–400	–300	1,350
Incremental cash flow	–$24,300	$8,158	$8,372	$8,736	$8,934

The NPV for the project is:

$$NPV = -\$24,300 + \$8,158 / 1.12 + \$8,372 / 1.12^2 + \$8,736 / 1.12^3 + \$8,934 / 1.12^4$$
$$NPV = \$1,553.87$$

3. Using the tax shield approach to calculating OCF, we get:

$$OCF = (Sales - Costs)(1 - t_C) + t_C Depreciation$$
$$OCF = (\$1,120,000 - 480,000)(1 - 0.35) + 0.35(\$1,400,000/3)$$
$$OCF = \$579,333.33$$

So, the NPV of the project is:

$$NPV = -\$1,400,000 + \$579,333.33(PVIFA_{12\%,3})$$
$$NPV = -\$8,539.09$$

4. The cash outflow at the beginning of the project will increase because of the spending on NWC. At the end of the project, the company will recover the NWC, so it will be a cash inflow. The sale of the equipment will result in a cash inflow, but we also must account for the taxes which will be paid on this sale. So, the cash flows for each year of the project will be:

Year	Cash Flow	
0	– $1,685,000	= –$1,400,000 – 285,000
1	579,333.33	
2	579,333.33	
3	1,010,583.33	= $579,333.33 + 285,000 + 225,000 + (0 – 225,000)(.35)

And the NPV of the project is:

$$NPV = -\$1,685,000 + \$579,333.33(PVIFA_{12\%,2}) + (\$1,010,583.33 / 1.12^3)$$
$$NPV = \$13,416.15$$

5. First we will calculate the annual depreciation for the equipment necessary for the project. The depreciation amount each year will be:

Year 1 depreciation = $1,400,000(0.3333) = $466,620
Year 2 depreciation = $1,400,000(0.4445) = $622,300
Year 3 depreciation = $1,400,000(0.1481) = $207,340

So, the book value of the equipment at the end of three years, which will be the initial investment minus the accumulated depreciation, is:

Book value in 3 years = $1,400,000 – ($466,620 + 622,300 + 207,340)
Book value in 3 years = $103,740

The asset is sold at a gain to book value, so this gain is taxable.

Aftertax salvage value = $225,000 + ($103,740 – 225,000)(0.35)
Aftertax salvage value = $182,559

To calculate the OCF, we will use the tax shield approach, so the cash flow each year is:

OCF = (Sales – Costs)$(1 - t_C) + t_C$Depreciation

Year	Cash Flow	
0	– $1,685,000	= –$1,400,000 – 285,000
1	579,317	= ($640,000)(.65) + 0.35($466,620)
2	633,805	= ($640,000)(.65) + 0.35($622,300)
3	956,128	= ($640,000)(.65) + 0.35($207,340) + $182,559 + 285,000

Remember to include the NWC cost in Year 0, and the recovery of the NWC at the end of the project. The NPV of the project with these assumptions is:

NPV = – $1,685,000 + $579,317/1.12 + $633,805/1.12^2 + $956,128/1.12^3
NPV = $18,065.81

6. First, we will calculate the annual depreciation of the new equipment. It will be:

Annual depreciation charge = $670,000/5
Annual depreciation charge = $134,000

The aftertax salvage value of the equipment is:

Aftertax salvage value = $50,000(1 – 0.35)
Aftertax salvage value = $32,500

Using the tax shield approach, the OCF is:

OCF = $240,000(1 – 0.35) + 0.35($134,000)
OCF = $202,900

Now we can find the project IRR. There is an unusual feature that is a part of this project. Accepting this project means that we will reduce NWC. This reduction in NWC is a cash inflow at Year 0. This reduction in NWC implies that when the project ends, we will have to increase NWC. So, at the end of the project, we will have a cash outflow to restore the NWC to its level before the project. We also must include the aftertax salvage value at the end of the project. The IRR of the project is:

NPV = 0 = –$670,000 + 85,000 + $202,900(PVIFA$_{IRR\%,5}$)
            + [($202,900 + 32,500 – 85,000) / (1+IRR)^5]

IRR = 20.06%

7. First, we will calculate the annual depreciation of the new equipment. It will be:

Annual depreciation = $375,000/5
Annual depreciation = $75,000

Now, we calculate the aftertax salvage value. The aftertax salvage value is the market price minus (or plus) the taxes on the sale of the equipment, so:

Aftertax salvage value = MV + (BV – MV)t_c

Very often, the book value of the equipment is zero as it is in this case. If the book value is zero, the equation for the aftertax salvage value becomes:

Aftertax salvage value $= MV + (0 - MV)t_c$
Aftertax salvage value $= MV(1 - t_c)$

We will use this equation to find the aftertax salvage value since we know the book value is zero. So, the aftertax salvage value is:

Aftertax salvage value $= \$40,000(1 - 0.34)$
Aftertax salvage value $= \$26,400$

Using the tax shield approach, we find the OCF for the project is:

OCF $= \$105,000(1 - 0.34) + 0.34(\$75,000)$
OCF $= \$94,800$

Now we can find the project NPV. Notice that we include the NWC in the initial cash outlay. The recovery of the NWC occurs in Year 5, along with the aftertax salvage value.

NPV $= -\$375,000 - 28,000 + \$94,800(PVIFA_{10\%,5}) + [(\$26,400 + 28,000) / 1.1^5]$
NPV $= -\$9,855.29$

8. To find the BV at the end of four years, we need to find the accumulated depreciation for the first four years. We could calculate a table with the depreciation each year, but an easier way is to add the MACRS depreciation amounts for each of the first four years and multiply this percentage times the cost of the asset. We can then subtract this from the asset cost. Doing so, we get:

    $BV_4 = \$7,100,000 - 7,100,000(0.2000 + 0.3200 + 0.1920 + 0.1152)$
    $BV_4 = \$1,226,880$

    The asset is sold at a gain to book value, so this gain is taxable.

    Aftertax salvage value $= \$1,400,000 + (\$1,226,880 - 1,400,000)(.35)$
    Aftertax salvage value $= \$1,339,408$

9. We will begin by calculating the initial cash outlay, that is, the cash flow at Time 0. To undertake the project, we will have to purchase the equipment and increase net working capital. So, the cash outlay today for the project will be:

Equipment	–$3,800,000
NWC	–150,000
Total	–$3,950,000

Using the bottom-up approach to calculating the operating cash flow, we find the operating cash flow each year will be:

Sales	$2,500,000
Costs	625,000
Depreciation	950,000
EBT	$925,000
Tax	323,750
Net income	$601,250

The operating cash flow is:

OCF = Net income + Depreciation
OCF = $601,250 + 950,000
OCF = $1,551,250

To find the NPV of the project, we add the present value of the project cash flows. We must be sure to add back the net working capital at the end of the project life, since we are assuming the net working capital will be recovered. So, the project NPV is:

$NPV = -\$3,950,000 + \$1,551,250(PVIFA_{16\%,4}) + \$150,000 / 1.16^4$
NPV = $473,521.38

10. We will need the aftertax salvage value of the equipment to compute the EAC. Even though the equipment for each product has a different initial cost, both have the same salvage value. The aftertax salvage value for both is:

Both cases: aftertax salvage value = $20,000(1 – 0.35) = $13,000

To calculate the EAC, we first need the OCF and NPV of each option. The OCF and NPV for Techron I is:

OCF = – $35,000(1 – 0.35) + 0.35($215,000/3) = $2,333.33

$NPV = -\$215,000 + \$2,333.33(PVIFA_{12\%,3}) + (\$13,000/1.12^3) = -\$200,142.58$

$EAC = -\$200,142.58 / (PVIFA_{12\%,3}) = -\$83,329.16$

And the OCF and NPV for Techron II is:

OCF = – $44,000(1 – 0.35) + 0.35($270,000/5) = –$9,700

$NPV = -\$270,000 - \$9,700(PVIFA_{12\%,5}) + (\$13,000/1.12^5) = -\$297,589.78$

$EAC = -\$297,589.78 / (PVIFA_{12\%,5}) = -\$82,554.30$

The two milling machines have unequal lives, so they can only be compared by expressing both on an equivalent annual basis, which is what the EAC method does. Thus, you prefer the Techron II because it has the lower (less negative) annual cost.

11. First, we will calculate the depreciation each year, which will be:

D_1 = $640,000(0.2000) = $128,000
D_2 = $640,000(0.3200) = $204,800
D_3 = $640,000(0.1920) = $122,880
D_4 = $640,000(0.1150) = $73,728

The book value of the equipment at the end of the project is:

BV_4 = $640,000 – ($128,000 + 204,800 + 122,880 + 73,728) = $110,592

The asset is sold at a loss to book value, so this creates a tax refund.
After-tax salvage value = $70,000 + ($110,592 – 70,000)(0.35) = $84,207.20

So, the OCF for each year will be:

OCF_1 = $270,000(1 – 0.35) + 0.35($128,000) = $220,300.00
OCF_2 = $270,000(1 – 0.35) + 0.35($204,800) = $247,180.00
OCF_3 = $270,000(1 – 0.35) + 0.35($122,880) = $218,508.00
OCF_4 = $270,000(1 – 0.35) + 0.35($73,728) = $201,304.80

Now we have all the necessary information to calculate the project NPV. We need to be careful with the NWC in this project. Notice the project requires $20,000 of NWC at the beginning, and $3,500 more in NWC each successive year. We will subtract the $20,000 from the initial cash flow and subtract $3,500 each year from the OCF to account for this spending. In Year 4, we will add back the total spent on NWC, which is $30,500. The $3,500 spent on NWC capital during Year 4 is irrelevant. Why? Well, during this year the project required an additional $3,500, but we would get the money back immediately. So, the net cash flow for additional NWC would be zero. With all this, the equation for the NPV of the project is:

$$NPV = -\$640,000 - 20,000 + (\$220,300 - 3,500)/1.14 + (\$247,180 - 3,500)/1.14^2$$
$$+ (\$218,508 - 3,500)/1.14^3 + (\$201,304.80 + 30,500 + 84,207.20)/1.14^4$$
$$NPV = \$49,908.03$$

12. If we are trying to decide between two projects that will not be replaced when they wear out, the proper capital budgeting method to use is NPV. Both projects only have costs associated with them, not sales, so we will use these to calculate the NPV of each project. Using the tax shield approach to calculate the OCF, the NPV of System A is:

OCF_A = –$85,000(1 – 0.34) + 0.34($290,000/4)
OCF_A = –$31,450

NPV_A = –$290,000 – $31,450(PVIFA$_{11\%,4}$)
NPV_A = –$387,571.92

And the NPV of System B is:

$$OCF_B = -\$75{,}000(1 - 0.34) + 0.34(\$405{,}000/6)$$
$$OCF_B = -\$26{,}550$$

$$NPV_B = -\$405{,}000 - \$26{,}550(PVIFA_{11\%,6})$$
$$NPV_B = -\$517{,}320.78$$

If the system will not be replaced when it wears out, then System A should be chosen, because it has the less negative NPV.

13. If the equipment will be replaced at the end of its useful life, the correct capital budgeting technique is EAC. Using the NPVs we calculated in the previous problem, the EAC for each system is:

$$EAC_A = -\$387{,}571.92 / (PVIFA_{11\%,4})$$
$$EAC_A = -\$124{,}924.64$$

$$EAC_B = -\$517{,}320.78 / (PVIFA_{11\%,6})$$
$$EAC_B = -\$122{,}282.51$$

If the conveyor belt system will be continually replaced, we should choose System B since it has the less negative EAC.

14. Since we need to calculate the EAC for each machine, sales are irrelevant. EAC only uses the costs of operating the equipment, not the sales. Using the bottom up approach, or net income plus depreciation, method to calculate OCF, we get:

	Machine A	Machine B
Variable costs	–$4,200,000	–$3,600,000
Fixed costs	–195,000	–165,000
Depreciation	–483,333	–633,333
EBT	–$4,878,333	–$4,398,333
Tax	1,707,417	1,539,417
Net income	–$3,170,917	–$2,858,917
+ Depreciation	483,333	633,333
OCF	–$2,687,583	–$2,225,583

The NPV and EAC for Machine A is:

$$NPV_A = -\$2{,}900{,}000 - \$2{,}687{,}583(PVIFA_{10\%,6})$$
$$NPV_A = -\$14{,}605{,}126.07$$

$$EAC_A = -\$14{,}605{,}126.07 / (PVIFA_{10\%,6})$$
$$EAC_A = -\$3{,}353{,}444.74$$

And the NPV and EAC for Machine B is:

$NPV_B = -\$5,700,000 - 2,225,583(PVIFA_{10\%,9})$
$NPV_B = -\$18,517,187.42$

$EAC_B = -\$18,517,187.42 / (PVIFA_{10\%,9})$
$EAC_B = -\$3,215,334.41$

You should choose Machine B since it has a less negative EAC.

15. When we are dealing with nominal cash flows, we must be careful to discount cash flows at the nominal interest rate, and we must discount real cash flows using the real interest rate. Project A's cash flows are in real terms, so we need to find the real interest rate. Using the Fisher equation, the real interest rate is:

$1 + R = (1 + r)(1 + h)$
$1.13 = (1 + r)(1 + .04)$
$r = .0865$ or 8.65%

So, the NPV of Project A's real cash flows, discounting at the real interest rate, is:

$NPV = -\$50,000 + \$30,000 / 1.0865 + \$25,000 / 1.0865^2 + \$20,000 / 1.0865^3$
$NPV = \$14,378.65$

Project B's cash flow are in nominal terms, so the NPV discounted at the nominal interest rate is:

$NPV = -\$65,000 + \$29,000 / 1.13 + \$38,000 / 1.13^2 + \$41,000 / 1.13^3$
$NPV = \$18,838.35$

We should accept Project B if the projects are mutually exclusive since it has the highest NPV.

16. To determine the value of a firm, we can simply find the present value of the firm's future cash flows. No depreciation is given, so we can assume depreciation is zero. Using the tax shield approach, we can find the present value of the aftertax revenues, and the present value of the aftertax costs. The required return, growth rates, price, and costs are all given in real terms. Subtracting the costs from the revenues will give us the value of the firm's cash flows. We must calculate the present value of each separately since each is growing at a different rate. First, we will find the present value of the revenues. The revenues in year 1 will be the number of bottles sold, times the price per bottle, or:

Aftertax revenue in year 1 in real terms = $(2,800,000 \times \$1.25)(1 - 0.34)$
Aftertax revenue in year 1 in real terms = $2,310,000

Revenues will grow at six percent per year in real terms forever. Apply the growing perpetuity formula, we find the present value of the revenues is:

PV of revenues = $C_1 / (R - g)$
PV of revenues = $\$2,310,000 / (0.10 - 0.06)$
PV of revenues = $57,750,000

The real aftertax costs in year 1 will be:

Aftertax costs in year 1 in real terms = $(2,800,000 \times \$0.90)(1 - 0.34)$
Aftertax costs in year 1 in real terms = $1,663,200

Costs will grow at five percent per year in real terms forever. Applying the growing perpetuity formula, we find the present value of the costs is:

PV of costs = $C_1 / (R - g)$
PV of costs = $1,663,200 / (0.10 - 0.05)
PV of costs = $33,264,000

Now we can find the value of the firm, which is:

Value of the firm = PV of revenues – PV of costs
Value of the firm = $57,750,000 – 33,264,000
Value of the firm = $24,486,000

17. To calculate the nominal cash flows, we increase each item in the income statement by the inflation rate, except for depreciation. Depreciation is a nominal cash flow, so it does not need to be adjusted for inflation in nominal cash flow analysis. Since the resale value is given in nominal terms as of the end of year 5, it does not need to be adjusted for inflation. Also, no inflation adjustment is needed for net working capital since it already expressed in nominal terms. Note that an increase in required net working capital is a negative cash flow whereas a decrease in required net working capital is a positive cash flow. We first need to calculate the taxes on the salvage value. Remember, to calculate the taxes paid (or tax credit) on the salvage value, we take the book value minus the market value, times the tax rate, which, in this case, would be:

Taxes on salvage value = $(BV - MV)t_C$
Taxes on salvage value = ($0 – 45,000)(.34)
Taxes on salvage value = –$15,300

So, the nominal aftertax salvage value is:

Market price	$45,000
Tax on sale	–15,300
Aftertax salvage value	$29,700

Now we can find the nominal cash flows each year using the income statement. Doing so, we find:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Sales		$245,000	$252,350	$259,921	$267,718	$275,750
Expenses		70,000	72,100	74,263	76,491	78,786
Depreciation		73,000	73,000	73,000	73,000	73,000
EBT		$102,000	$107,250	$112,658	$118,227	$123,964
Tax		34,680	36,465	38,304	40,197	42,148
Net income		$67,320	$70,785	$74,354	$78,030	$81,816
OCF		$140,320	$143,785	$147,354	$151,030	$154,816
Capital spending	–$365,000					29,700
NWC	–10,000					10,000
Total cash flow	–$375,000	$140,320	$143,785	$147,354	$151,030	$194,516

18. The present value of the company is the present value of the future cash flows generated by the company. Here we have real cash flows, a real interest rate, and a real growth rate. The cash flows are a growing perpetuity, with a negative growth rate. Using the growing perpetuity equation, the present value of the cash flows is:

$PV = C_1 / (R – g)$
$PV = \$190,000 / [.11 – (–.04)]$
$PV = \$1,266,666.67$

19. To find the EAC, we first need to calculate the NPV of the incremental cash flows. We will begin with the aftertax salvage value, which is:

Taxes on salvage value $= (BV – MV)t_C$
Taxes on salvage value $= (\$0 – 18,000)(.34)$
Taxes on salvage value $= –\$6,120$

Market price	$18,000
Tax on sale	–6,120
Aftertax salvage value	$11,880

Now we can find the operating cash flows. Using the tax shield approach, the operating cash flow each year will be:

$OCF = –\$8,600(1 – 0.34) + 0.34(\$94,000/3)$
$OCF = \$4,977.33$

So, the NPV of the cost of the decision to buy is:

$NPV = –\$94,000 + \$4,977.33(PVIFA_{12\%,3}) + (\$11,880/1.12^3)$
$NPV = –\$73,589.34$

In order to calculate the equivalent annual cost, set the NPV of the equipment equal to an annuity with the same economic life. Since the project has an economic life of three years and is discounted at 12 percent, set the NPV equal to a three-year annuity, discounted at 12 percent.

$\text{EAC} = -\$73,589.34 / (\text{PVIFA}_{12\%,3})$
$\text{EAC} = -\$30,638.84$

20. We will calculate the aftertax salvage value first. The aftertax salvage value of the equipment will be:

Taxes on salvage value = $(\text{BV} - \text{MV})t_C$
Taxes on salvage value = ($\$0 - 60,000)(.34)$
Taxes on salvage value = $-\$20,400$

Market price	$60,000
Tax on sale	–20,400
Aftertax salvage value	$39,600

Next, we will calculate the initial cash outlay, that is, the cash flow at Time 0. To undertake the project, we will have to purchase the equipment. The new project will decrease the net working capital, so this is a cash inflow at the beginning of the project. So, the cash outlay today for the project will be:

Equipment	–$360,000
NWC	80,000
Total	–$280,000

Now we can calculate the operating cash flow each year for the project. Using the bottom up approach, the operating cash flow will be:

Saved salaries	$105,000
Depreciation	72,000
EBT	$33,000
Taxes	11,220
Net income	$21,780

And the OCF will be:

$\text{OCF} = \$21,780 + 72,000$
$\text{OCF} = \$93,780$

Now we can find the NPV of the project. In Year 5, we must replace the saved NWC, so:

$\text{NPV} = -\$280,000 + \$93,780(\text{PVIFA}_{12\%,5}) + (\$39,600 - 80,000) / 1.12^5$
$\text{NPV} = \$35,131.87$

21. Replacement decision analysis is the same as the analysis of two competing projects, in this case, keep the current equipment, or purchase the new equipment. We will consider the purchase of the new machine first.

Purchase new machine:

The initial cash outlay for the new machine is the cost of the new machine, plus the increased net working capital. So, the initial cash outlay will be:

Purchase new machine	–$18,000,000
Net working capital	–250,000
Total	–$18,250,000

Next, we can calculate the operating cash flow created if the company purchases the new machine. The saved operating expense is an incremental cash flow. Additionally, the reduced operating expense is a cash inflow, so it should be treated as such in the income statement. The pro forma income statement, and adding depreciation to net income, the annual operating cash flow created by purchasing the new machine will be:

Operating expense	$6,700,000
Depreciation	4,500,000
EBT	$2,200,000
Taxes	858,000
Net income	$1,342,000
OCF	$5,842,000

So, the NPV of purchasing the new machine, including the recovery of the net working capital, is:

$\text{NPV} = -\$18,250,000 + \$5,842,000(\text{PVIFA}_{10\%,4}) + \$250,000 / 1.10^4$
$\text{NPV} = \$439,107.30$

And the IRR is:

$0 = -\$18,250,000 + \$5,842,000(\text{PVIFA}_{\text{IRR},4}) + \$250,000 / (1 + \text{IRR})^4$

Using a spreadsheet or financial calculator, we find the IRR is:

$\text{IRR} = 11.10\%$

Now we can calculate the decision to keep the old machine:

Keep old machine:

The initial cash outlay for the old machine is the market value of the old machine, including any potential tax consequence. The decision to keep the old machine has an opportunity cost, namely, the company could sell the old machine. Also, if the company sells the old machine at its current value, it will receive a tax benefit. Both of these cash flows need to be included in the analysis. So, the initial cash flow of keeping the old machine will be:

Keep machine	–$4,500,000
Taxes	–585,000
Total	–$5,085,000

Next, we can calculate the operating cash flow created if the company keeps the old machine. There are no incremental cash flows from keeping the old machine, but we need to account for the cash flow effects of depreciation. The income statement, adding depreciation to net income to calculate the operating cash flow will be:

Depreciation	$1,500,000
EBT	–$1,500,000
Taxes	–585,000
Net income	–$915,000
OCF	$585,000

So, the NPV of the decision to keep the old machine will be:

$$NPV = -\$5,085,000 + \$585,000(PVIFA_{10\%,4})$$
$$NPV = -\$3,230,628.71$$

And the IRR is:

$$0 = -\$5,085,000 + \$585,000(PVIFA_{IRR,4})$$

Using a spreadsheet or financial calculator, we find the IRR is:

$$IRR = -25.15\%$$

There is another way to analyze a replacement decision that is often used. It is an incremental cash flow analysis of the change in cash flows from the existing machine to the new machine, assuming the new machine is purchased. In this type of analysis, the initial cash outlay would be the cost of the new machine, the increased NWC, and the cash inflow (including any applicable taxes) of selling the old machine. In this case, the initial cash flow under this method would be:

Purchase new machine	–$18,000,000
Net working capital	–250,000
Sell old machine	4,500,000
Taxes on old machine	585,000
Total	–$13,165,000

The cash flows from purchasing the new machine would be the saved operating expenses. We would also need to include the change in depreciation. The old machine has a depreciation of $1.5 million per year, and the new machine has a depreciation of $4.5 million per year, so the increased depreciation will be $3 million per year. The pro forma income statement and operating cash flow under this approach will be:

Operating expense savings	$6,700,000
Depreciation	3,000,000
EBT	$3,700,000
Taxes	1,443,000
Net income	$2,257,000
OCF	$5,257,000

The NPV under this method is:

$$NPV = –\$13,165,000 + \$5,257,000(PVIFA_{10\%,4}) + \$250,000 / 1.10^4$$
$$NPV = \$3,669,736.02$$

And the IRR is:

$$0 = –\$13,165,000 + \$5,257,000(PVIFA_{IRR,4}) + \$250,000 / (1 + IRR)^4$$

Using a spreadsheet or financial calculator, we find the IRR is:

$$IRR = 22.23\%$$

So, this analysis still tells us the company should purchase the new machine. This is really the same type of analysis we originally did. Consider this: Subtract the NPV of the decision to keep the old machine from the NPV of the decision to purchase the new machine. You will get:

$$Differential\ NPV = \$439,107.30 – (–\$3,230,628.71) = \$3,669,736.02$$

This is the exact same NPV we calculated when using the second analysis method.

22. We can find the NPV of a project using nominal cash flows or real cash flows. Either method will result in the same NPV. For this problem, we will calculate the NPV using both nominal and real cash flows. The initial investment in either case is $270,000 since it will be spent today. We will begin with the nominal cash flows. The revenues and production costs increase at different rates, so we must be careful to increase each at the appropriate growth rate. The nominal cash flows for each year will be:

	Year 0	Year 1	Year 2	Year 3
Revenues		$105,000.00	$110,250.00	$115,762.50
Costs		$30,000.00	31,800.00	33,708.00
Depreciation		38,571.43	38,571.43	38,571.43
EBT		$36,428.57	$39,878.57	$43,483.07
Taxes		12,385.71	13,558.71	14,784.24
Net income		$24,042.86	$26,319.86	$28,698.83
OCF		$62,614.29	$64,891.29	$67,270.26
Capital spending	–$270,000			
Total cash flow	–$270,000	$62,614.29	$64,891.29	$67,270.26

	Year 4	Year 5	Year 6	Year 7
Revenues	$121,550.63	$127,628.16	$134,009.56	$140,710.04
Costs	35,730.48	37,874.31	40,146.77	42,555.57
Depreciation	38,571.43	38,571.43	38,571.43	38,571.43
EBT	$47,248.72	$51,182.42	$55,291.37	$59,583.04
Taxes	16,064.56	17,402.02	18,799.07	20,258.23
Net income	$31,184.15	$33,780.40	$36,492.30	$39,324.81
OCF	$69,755.58	$72,351.83	$75,063.73	$77,896.24
Capital spending				
Total cash flow	$69,755.58	$72,351.83	$75,063.73	$77,896.24

Now that we have the nominal cash flows, we can find the NPV. We must use the nominal required return with nominal cash flows. Using the Fisher equation to find the nominal required return, we get:

$(1 + R) = (1 + r)(1 + h)$
$(1 + R) = (1 + .08)(1 + .05)$
$R = .1340$ or 13.40%

So, the NPV of the project using nominal cash flows is:

$$NPV = -\$270{,}000 + \$62{,}614.29 \,/\, 1.1340 + \$64{,}891.29 \,/\, 1.1340^2 + \$67{,}270.26 \,/\, 1.1340^3$$
$$+ \,\$69{,}755.58 \,/\, 1.1340^4 + \$72{,}351.83 \,/\, 1.1340^5 + \$75{,}063.73 \,/\, 1.1340^6 + \$77{,}896.24 \,/\, 1.1340^7$$
$$NPV = \$30{,}170.71$$

We can also find the NPV using real cash flows and the real required return. This will allow us to find the operating cash flow using the tax shield approach. Both the revenues and expenses are growing annuities, but growing at different rates. This means we must find the present value of each separately. We also need to account for the effect of taxes, so we will multiply by one minus the tax rate. So, the present value of the aftertax revenues using the growing annuity equation is:

PV of aftertax revenues = $C \{[1/(r-g)] - [1/(r-g)] \times [(1+g)/(1+r)]^t\}(1-t_C)$
PV of aftertax revenues = $\$105{,}000\{[1/(.134-.05)] - [1/(.134-.05)] \times [(1+.05)/(1+.134)]^7\}(1-.34)$
PV of aftertax revenues = $\$343{,}620.42$

And the present value of the aftertax costs will be:

PV of aftertax costs = $C \{[1/(r-g)] - [1/(r-g)] \times [(1+g)/(1+r)]^t\}(1-t_C)$
PV of aftertax costs = $\$30{,}000\{[1/(.134-.06)] - [1/(.134-.06)] \times [(1+.06)/(1+.134)]^7\}(1-.34)$
PV of aftertax costs = $\$100{,}734.11$

Now we need to find the present value of the depreciation tax shield. The depreciation amount in the first year is a real value, so we can find the present value of the depreciation tax shield as an ordinary annuity using the real required return. So, the present value of the depreciation tax shield will be:

PV of depreciation tax shield = $(\$270{,}000/7)(.34)(PVIFA_{13.40\%,7})$
PV of depreciation tax shield = $\$57{,}284.40$

Using the present value of the real cash flows to find the NPV, we get:

NPV = Initial cost + PV of revenues – PV of costs + PV of depreciation tax shield
NPV = $-\$270{,}000 + \$343{,}620.42 - 100{,}734.11 + 57{,}284.40$
NPV = $\$30{,}170.71$

Notice, the NPV using nominal cash flows or real cash flows is identical, which is what we would expect.

23. Here we have a project in which the quantity sold each year increases. First, we need to calculate the quantity sold each year by increasing the current year's quantity by the growth rate. So, the quantity sold each year will be:

Year 1 quantity = 7,000
Year 2 quantity = 7,000(1 + .08) = 7,560
Year 3 quantity = 7,560(1 + .08) = 8,165
Year 4 quantity = 8,165(1 + .08) = 8,818
Year 5 quantity = 8,818(1 + .08) = 9,523

Now we can calculate the sales revenue and variable costs each year. The pro forma income statements and operating cash flow each year will be:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues		$336,000.00	$362,880.00	$391,910.40	$423,263.23	$457,124.29
Fixed costs		95,000.00	95,000.00	95,000.00	95,000.00	95,000.00
Variable costs		140,000.00	151,200.00	163,296.00	176,359.68	190,468.45
Depreciation		35,000.00	35,000.00	35,000.00	35,000.00	35,000.00
EBT		$66,000.00	$81,680.00	$98,614.40	$116,903.55	$136,655.84
Taxes		22,440.00	27,771.20	33,528.90	39,747.21	46,462.98
Net income		$43,560.00	$53,908.80	$65,085.50	$77,156.34	$90,192.85
OCF		$78,560.00	$88,908.80	$100,085.50	$112,156.34	$125,192.85
Capital spending	–$175,000					
NWC	–35,000					35,000
Total cash flow	–$210,000	$78,560.00	$88,908.80	$100,085.50	$112,156.34	$160,192.85

So, the NPV of the project is:

NPV = –$210,000 + 75,860 / 1.25 + $88,908.80 / 1.25^2 + $100,085.50 / 1.25^3 + $112,156.34 / 1.25^4
    + $160,192.85 / 1.25^5
NPV = $59,424.64

We could also have calculated the cash flows using the tax shield approach, with growing annuities and ordinary annuities. The sales and variable costs increase at the same rate as sales, so both are growing annuities. The fixed costs and depreciation are both ordinary annuities. Using the growing annuity equation, the present value of the revenues is:

PV of revenues = $C \{[1/(r-g)] - [1/(r-g)] \times [(1+g)/(1+r)]^t\}$
PV of revenues = $336,000\{[1/(.25-.08)] - [1/(.25-.08)] \times [(1+.08)/(1+.25)]^5\}$
PV of revenues = $1,024,860.43

And the present value of the variable costs will be:

PV of variable costs = $C \{[1/(r-g)] - [1/(r-g)] \times [(1+g)/(1+r)]^t\}$
PV of variable costs = $140,000\{[1/(.25-.08)] - [1/(.25-.08)] \times [(1+.08)/(1+.25)]^5\}$
PV of variable costs = $427,025.18

The fixed costs and depreciation are both ordinary annuities. The present value of each is:

PV of fixed costs = $C(\{1 - [1/(1+r)]^t\} / r)$
PV of fixed costs = $95,000(PVIFA_{25\%,5})$
PV of fixed costs = $255,481.60

PV of depreciation = $C(\{1 - [1/(1 + r)]^t \} / r)$
PV of depreciation = $35,000(PVIFA_{25\%,5})$
PV of depreciation = $94,124.80

Now, we can use the depreciation tax shield approach to find the NPV of the project, which is:

NPV = –$210,000 + ($1,024,860.43 – 427,025.18 – 255,481.60)(1 – .34) + ($94,124.80)(.34)
      + $35,000 / 1.25^5
NPV = $59,424.64

24. We will begin by calculating the aftertax salvage value of the equipment at the end of the project's life. The aftertax salvage value is the market value of the equipment minus any taxes paid (or refunded), so the aftertax salvage value in four years will be:

Taxes on salvage value = $(BV - MV)t_C$
Taxes on salvage value = ($0 – 300,000)(.38)
Taxes on salvage value = –$114,000

Market price	$300,000
Tax on sale	–114,000
Aftertax salvage value	$186,000

Now we need to calculate the operating cash flow each year. Note, we assume that the net working capital cash flow occurs immediately. Using the bottom up approach to calculating operating cash flow, we find:

	Year 0	Year 1	Year 2	Year 3	Year 4
Revenues		$1,842,500	$2,062,500	$2,502,500	$1,705,000
Fixed costs		350,000	350,000	350,000	350,000
Variable costs		276,375	309,375	375,375	255,750
Depreciation		1,033,230	1,377,950	459,110	229,710
EBT		$182,895	$25,175	$1,318,015	$869,540
Taxes		69,500	9,567	500,846	330,425
Net income		$113,395	$15,609	$817,169	$539,115
OCF		$1,146,625	$1,393,559	$1,276,279	$768,825
Capital spending	–$3,100,000				186,000
Land	–900,000				1,200,000
NWC	–120,000				120,000
Total cash flow	–$4,120,000	$1,146,625	$1,393,559	$1,276,279	$2,274,825

Notice the calculation of the cash flow at time 0. The capital spending on equipment and investment in net working capital are cash outflows. The aftertax selling price of the land is also a cash outflow. Even though no cash is actually spent on the land because the company already owns it, the aftertax cash flow from selling the land is an opportunity cost, so we need to include it in the analysis. With all the project cash flows, we can calculate the NPV, which is:

$$NPV = -\$4,120,000 + \$1,146,625 / 1.13 + \$1,393,559 / 1.13^2 + \$1,246,279 / 1.13^3$$
$$+ \$2,274,825 / 1.13^4$$
$$NPV = \$265,791.25$$

The company should accept the new product line.

25. Replacement decision analysis is the same as the analysis of two competing projects, in this case, keep the current equipment, or purchase the new equipment. We will consider the purchase of the new machine first.

Purchase new machine:

The initial cash outlay for the new machine is the cost of the new machine. We can calculate the operating cash flow created if the company purchases the new machine. The maintenance cost is an incremental cash flow, so using the pro forma income statement, and adding depreciation to net income, the operating cash flow created each year by purchasing the new machine will be:

Maintenance cost	$330,000
Depreciation	860,000
EBT	–$1,190,000
Taxes	–476,000
Net income	–$714,000
OCF	$146,000

Notice the taxes are negative, implying a tax credit. The new machine also has a salvage value at the end of five years, so we need to include this in the cash flows analysis. The aftertax salvage value will be:

Sell machine	$800,000
Taxes	–320,000
Total	$480,000

The NPV of purchasing the new machine is:

$$NPV = -\$4,300,000 + \$146,000(PVIFA_{8\%,5}) + \$480,000 / 1.08^5$$
$$NPV = -\$3,390,384.40$$

Notice the NPV is negative. This does not necessarily mean we should not purchase the new machine. In this analysis, we are only dealing with costs, so we would expect a negative NPV. The revenue is not included in the analysis since it is not incremental to the machine. Similar to an EAC analysis, we will use the machine with the least negative NPV. Now we can calculate the decision to keep the old machine:

Keep old machine:

The initial cash outlay for the keeping the old machine is the market value of the old machine, including any potential tax. The decision to keep the old machine has an opportunity cost, namely, the company could sell the old machine. Also, if the company sells the old machine at its current value, it will incur taxes. Both of these cash flows need to be included in the analysis. So, the initial cash flow of keeping the old machine will be:

Keep machine	–$2,200,000
Taxes	320,000
Total	–$1,880,000

Next, we can calculate the operating cash flow created if the company keeps the old machine. We need to account for the cost of maintenance, as well as the cash flow effects of depreciation. The pro forma income statement, adding depreciation to net income to calculate the operating cash flow will be:

Maintenance cost	$845,000
Depreciation	280,000
EBT	–$1,125,000
Taxes	–450,000
Net income	–$675,000
OCF	–$395,000

The old machine also has a salvage value at the end of five years, so we need to include this in the cash flows analysis. The aftertax salvage value will be:

Sell machine	$120,000
Taxes	–48,000
Total	$72,000

So, the NPV of the decision to keep the old machine will be:

$NPV = –\$1,880,000 – \$395,000(PVIFA_{8\%,5}) + \$72,000 / 1.08^5$
$NPV = –\$3,408,118.47$
The company should buy the new machine since it has a greater NPV.

There is another way to analyze a replacement decision that is often used. It is an incremental cash flow analysis of the change in cash flows from the existing machine to the new machine, assuming the new machine is purchased. In this type of analysis, the initial cash outlay would be the cost of the new machine, and the cash inflow (including any applicable taxes) of selling the old machine. In this case, the initial cash flow under this method would be:

Purchase new machine	–$4,300,000
Sell old machine	2,200,000
Taxes on old machine	–320,000
Total	–$2,420,000

The cash flows from purchasing the new machine would be the difference in the operating expenses. We would also need to include the change in depreciation. The old machine has a depreciation of $280,000 per year, and the new machine has a depreciation of $860,000 per year, so the increased depreciation will be $580,000 per year. The pro forma income statement and operating cash flow under this approach will be:

Maintenance cost	–$515,000
Depreciation	580,000
EBT	–$65,000
Taxes	–26,000
Net income	–$39,000
OCF	$541,000

The salvage value of the differential cash flow approach is more complicated. The company will sell the new machine, and incur taxes on the sale in five years. However, we must also include the lost sale of the old machine. Since we assumed we sold the old machine in the initial cash outlay, we lose the ability to sell the machine in five years. This is an opportunity loss that must be accounted for. So, the salvage value is:

Sell machine	$800,000
Taxes	–320,000
Lost sale of old	–120,000
Taxes on lost sale of old	48,000
Total	$408,000

The NPV under this method is:

NPV = –$2,420,000 + $541,000(PVIFA$_{8\%,5}$) + $408,000 / 1.08
NPV = $17,734.07

So, this analysis still tells us the company should purchase the new machine. This is really the same type of analysis we originally did. Consider this: Subtract the NPV of the decision to keep the old machine from the NPV of the decision to purchase the new machine. You will get:

Differential NPV = –$3,390,384.40 – (–3,408,118.47) = $17,734.07

This is the exact same NPV we calculated when using the second analysis method.

26. Here we are comparing two mutually exclusive assets, with inflation. Since each will be replaced when it wears out, we need to calculate the EAC for each. We have real cash flows. Similar to other capital budgeting projects, when calculating the EAC, we can use real cash flows with the real interest rate, or nominal cash flows and the nominal interest rate. Using the Fisher equation to find the real required return, we get:

$(1 + R) = (1 + r)(1 + h)$
$(1 + .14) = (1 + r)(1 + .05)$
$r = .0857$ or 8.57%

This is the interest rate we need to use with real cash flows. We are given the real aftertax cash flows for each asset, so the NPV for the XX40 is:

$$NPV = -\$900 - \$120(PVIFA_{8.57\%,3})$$
$$NPV = -\$1,206.09$$

So, the EAC for the XX40 is:

$$-\$1,206.09 = EAC(PVIFA_{8.57\%,3})$$
$$EAC = -\$472.84$$

And the EAC for the RH45 is:

$$NPV = -\$1,400 - \$95(PVIFA_{8.57\%,5})$$
$$NPV = -\$1,773.66$$

$$-\$1,773.66 = EAC(PVIFA_{8.57\%,5})$$
$$EAC = -\$450.94$$

The company should choose the RH45 because it has the greater EAC.

27. The project has a sales price that increases at 5 percent per year, and a variable cost per unit that increases at 6 percent per year. First, we need to find the sales price and variable cost for each year. The table below shows the price per unit and the variable cost per unit each year.

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales price	$40.00	$42.00	$44.10	$46.31	$48.62
Cost per unit	$15.00	$15.90	$16.85	$17.87	$18.94

Using the sales price and variable cost, we can now construct the pro forma income statement for each year. We can use this income statement to calculate the cash flow each year. We must also make sure to include the net working capital outlay at the beginning of the project, and the recovery of the net working capital at the end of the project. The pro forma income statement and cash flows for each year will be:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues		$800,000.00	$840,000.00	$882,000.00	$926,100.00	$972,405.00
Fixed costs		195,000.00	195,000.00	195,000.00	195,000.00	195,000.00
Variable costs		300,000.00	318,000.00	337,080.00	357,304.80	378,743.09
Depreciation		195,000.00	195,000.00	195,000.00	195,000.00	195,000.00
EBT		$110,000.00	$132,000.00	$154,920.00	$178,795.20	$203,661.91
Taxes		37,400.00	44,880.00	52,672.80	60,790.37	69,245.05
Net income		$72,600.00	$87,120.00	$102,247.20	$118,004.83	$134,416.86
OCF		$267,600.00	$282,120.00	$297,247.20	$313,004.83	$329,416.86
Capital spending	–$975,000					
NWC	–25,000					25,000
Total cash flow	–$1,000,000	$267,600.00	$282,120.00	$297,247.20	$313,004.83	$354,416.86

With these cash flows, the NPV of the project is:

$$\text{NPV} = -\$1,000,000 + \$267,600 / 1.11 + \$282,120 / 1.11^2 + \$297,247.20 / 1.11^3$$
$$+ \$313,004.83 / 1.11^4 + \$354,416.86 / 1.11^5$$
$$\text{NPV} = \$103,915.73$$

We could also answer this problem using the depreciation tax shield approach. The revenues and variable costs are growing annuities, growing at different rates. The fixed costs and depreciation are ordinary annuities. Using the growing annuity equation, the present value of the revenues is:

PV of revenues = $C \{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
PV of revenues = $\$800,000\{[1/(.11 - .05)] - [1/(.11 - .05)] \times [(1 + .05)/(1 + .11)]^5\}$
PV of revenues = $3,234,520.16

And the present value of the variable costs will be:

PV of variable costs = $C \{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
PV of variable costs = $\$300,000\{[1/(.11 - .06)] - [1/(.11 - .06)] \times [(1 + .06)/(1 + .11)]^5\}$
PV of variable costs = $1,234,969.52

The fixed costs and depreciation are both ordinary annuities. The present value of each is:

PV of fixed costs = $C(\{1 - [1/(1 + r)]^t\} / r)$
PV of fixed costs = $\$195,000(\{1 - [1/(1 + .11)]^5\} / .11)$
PV of fixed costs = $720,699.92

PV of depreciation = $C(\{1 - [1/(1 + r)]^t\} / r)$
PV of depreciation = $\$195,000(\{1 - [1/(1 + .11)]^5\} / .11)$
PV of depreciation = $720,699.92

Now, we can use the depreciation tax shield approach to find the NPV of the project, which is:

NPV = –$1,000,000 + ($3,234,520.16 – 1,234,696.52 – 720,699.92)(1 – .34) + ($720,699.92)(.34)
$\qquad$ + $25,000 / 1.11^5$
NPV = $103,915.73

   Challenge

28. Probably the easiest OCF calculation for this problem is the bottom up approach, so we will construct an income statement for each year. Beginning with the initial cash flow at time zero, the project will require an investment in equipment. The project will also require an investment in NWC of $1,500,000. So, the cash flow required for the project today will be:

Capital spending	–$23,000,000
Change in NWC	–1,500,000
Total cash flow	–$24,500,000

Now we can begin the remaining calculations. Sales figures are given for each year, along with the price per unit. The variable costs per unit are used to calculate total variable costs, and fixed costs are given at $2,400,000 per year. To calculate depreciation each year, we use the initial equipment cost of $23 million, times the appropriate MACRS depreciation each year. The remainder of each income statement is calculated below. Notice at the bottom of the income statement we added back depreciation to get the OCF for each year. The section labeled "Net cash flows" will be discussed below:

Year	1	2	3	4	5
Ending book value	$19,713,300	$14,080,600	$10,057,900	$7,185,200	$5,131,300
Sales	$28,635,000	$31,740,000	$35,880,000	$33,810,000	$28,980,000
Variable costs	15,770,000	17,480,000	19,760,000	18,620,000	15,960,000
Fixed costs	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000
Depreciation	3,286,700	5,632,700	4,022,700	2,872,700	2,053,900
EBIT	7,178,300	6,227,300	9,697,300	9,917,300	8,566,100
Taxes	2,512,405	2,179,555	3,394,055	3,471,055	2,998,135
Net income	4,665,895	4,047,745	6,303,245	6,446,245	5,567,965
Depreciation	3,286,700	5,632,700	4,022,700	2,872,700	2,053,900
Operating cash flow	$7,952,595	$9,680,445	$10,325,945	$9,318,945	$7,621,865

Net cash flows

	1	2	3	4	5
Operating cash flow	$7,952,595	$9,680,445	$10,325,945	$9,318,945	$7,621,865
Change in NWC	–465,750	–621,000	310,500	724,500	1,551,750
Capital spending					4,785,955
Total cash flow	$7,486,845	$9,059,445	$10,636,445	$10,043,445	$13,959,570

After we calculate the OCF for each year, we need to account for any other cash flows. The other cash flows in this case are NWC cash flows and capital spending, which is the aftertax salvage of the equipment. The required NWC is 15 percent of the sales increase in the next year. We will work through the NWC cash flow for Year 1. The total NWC in Year 1 will be 15 percent of sales increase from Year 1 to Year 2, or:

Increase in NWC for Year 1 = .15($31,740,000 – 28,635,000)
Increase in NWC for Year 1 = $465,750

Notice that the NWC cash flow is negative. Since the sales are increasing, we will have to spend more money to increase NWC. In Year 4, the NWC cash flow is positive since sales are declining. And, in Year 5, the NWC cash flow is the recovery of all NWC the company still has in the project.

To calculate the aftertax salvage value, we first need the book value of the equipment. The book value at the end of the five years will be the purchase price, minus the total depreciation. So, the ending book value is:

Ending book value = $23,000,000 – ($3,286,700 + 5,632,700 + 4,022,700 + 2,872,700 + 2,053,900)
Ending book value = $5,131,300

The market value of the used equipment is 20 percent of the purchase price, or $4.6 million, so the aftertax salvage value will be:

Aftertax salvage value = $4,600,000 + ($5,131,300 − 4,600,000)(.35)
Aftertax salvage value = $4,785,955

The aftertax salvage value is included in the total cash flows as capital spending. Now we have all of the cash flows for the project. The NPV of the project is:

$$NPV = -\$24,500,000 + \$7,486,845/1.18 + \$9,059,445/1.18^2 + \$10,636,445/1.18^3$$
$$+ \$10,043,445/1.18^4 + \$13,959,570/1.18^5$$
$$NPV = \$6,106,958.94$$

And the IRR is:

$$IRR = 0 = -\$24,500,000 + \$7,486,845/(1 + IRR) + \$9,059,445/(1 + IRR)^2 + \$10,636,445/(1 + IRR)^3$$
$$+ \$10,043,445/(1 + IRR)^4 + \$13,959,570/(1 + IRR)^5$$
$$IRR = 27.54\%$$

We should accept the project.

29. To find the initial pretax cost savings necessary to buy the new machine, we should use the tax shield approach to find the OCF. We begin by calculating the depreciation each year using the MACRS depreciation schedule. The depreciation each year is:

$D_1 = \$640,000(0.3333) = \$213,312$
$D_2 = \$640,000(0.4445) = \$284,480$
$D_3 = \$640,000(0.1481) = \$94,784$
$D_4 = \$640,000(0.0741) = \$47,424$

Using the tax shield approach, the OCF each year is:

$OCF_1 = (S − C)(1 − 0.35) + 0.35(\$213,312)$
$OCF_2 = (S − C)(1 − 0.35) + 0.35(\$284,480)$
$OCF_3 = (S − C)(1 − 0.35) + 0.35(\$94,784)$
$OCF_4 = (S − C)(1 − 0.35) + 0.35(\$47,424)$
$OCF_5 = (S − C)(1 − 0.35)$

Now we need the aftertax salvage value of the equipment. The aftertax salvage value is:

After-tax salvage value = $60,000(1 − 0.35) = $39,000

To find the necessary cost reduction, we must realize that we can split the cash flows each year. The OCF in any given year is the cost reduction (S − C) times one minus the tax rate, which is an annuity for the project life, and the depreciation tax shield. To calculate the necessary cost reduction, we would require a zero NPV. The equation for the NPV of the project is:

$$NPV = 0 = - \$640,000 - 55,000 + (S − C)(0.65)(PVIFA_{12\%,5}) + 0.35(\$213,312/1.12$$
$$+ \$284,480/1.12^2 + \$94,784/1.12^3 + \$47,424/1.12^4) + (\$55,000 + 39,000)/1.12^5$$

Solving this equation for the sales minus costs, we get:

$(S - C)(0.65)(PVIFA_{12\%,5}) = \$461,465.41$
$(S - C) = \$196,946.15$

30. To find the bid price, we need to calculate all other cash flows for the project, and then solve for the bid price. The aftertax salvage value of the equipment is:

Aftertax salvage value = $\$150,000(1 - 0.35) = \$97,500$

Now we can solve for the necessary OCF that will give the project a zero NPV. The equation for the NPV of the project is:

$NPV = 0 = -\$1,800,000 - 130,000 + OCF(PVIFA_{14\%,5}) + [(\$130,000 + 97,500) / 1.14^5]$

Solving for the OCF, we find the OCF that makes the project NPV equal to zero is:

$OCF = \$1,811,843.63 / PVIFA_{14\%,5} = \$527,760.24$

The easiest way to calculate the bid price is the tax shield approach, so:

$OCF = \$527,760.24 = [(P - v)Q - FC\ ](1 - t_C) + t_C D$
$\$527,760.24 = [(P - \$8.50)(140,000) - \$265,000\ ](1 - 0.35) + 0.35(\$1,800,000/5)$
$P = \$14.81$

31. *a.* This problem is basically the same as the previous problem, except that we are given a sales price. The cash flow at Time 0 for all three parts of this question will be:

Capital spending	–$1,800,000
Change in NWC	–130,000
Total cash flow	–$1,930,000

We will use the initial cash flow and the salvage value we already found in that problem. Using the bottom up approach to calculating the OCF, we get:

Assume price per unit = $16 and units/year = 140,000

Year	1	2	3	4	5
Sales	$2,240,000	$2,240,000	$2,240,000	$2,240,000	$2,240,000
Variable costs	1,190,000	1,190,000	1,190,000	1,190,000	1,190,000
Fixed costs	265,000	265,000	265,000	265,000	265,000
Depreciation	360,000	360,000	360,000	360,000	360,000
EBIT	$425,000	$425,000	$425,000	$425,000	$425,000
Taxes (35%)	148,750	148,750	148,750	148,750	148,750
Net Income	$276,250	$276,250	$276,250	$276,250	$276,250
Depreciation	360,000	360,000	360,000	360,000	360,000
Operating CF	$636,250	$636,250	$636,250	$636,250	$636,250

Year	1	2	3	4	5
Operating CF	$636,250	$636,250	$636,250	$636,250	$636,250
Change in NWC					130,000
Capital spending					97,500
Total CF	$636,250	$636,250	$636,250	$636,250	$863,750

With these cash flows, the NPV of the project is:

NPV = – $1,800,000 – 130,000 + $636,250(PVIFA$_{14\%,5}$) + [($130,000 + 97,500) / 1.14^5]
NPV = $372,454.14

If the actual price is above the bid price that results in a zero NPV, the project will have a positive NPV. As for the cartons sold, if the number of cartons sold increases, the NPV will increase, and if the costs increase, the NPV will decrease.

b. To find the minimum number of cartons sold to still breakeven, we need to use the tax shield approach to calculating OCF, and solve the problem similar to finding a bid price. Using the initial cash flow and salvage value we already calculated, the equation for a zero NPV of the project is:

NPV = 0 = – $1,800,000 – 130,000 + OCF(PVIFA$_{14\%,5}$) + [($130,000 + 97,500) / 1.14^5]

So, the necessary OCF for a zero NPV is:

OCF = $1,811,843.63 / PVIFA$_{14\%,5}$ = $527,760.24

Now we can use the tax shield approach to solve for the minimum quantity as follows:

OCF = $527,760.24 = [(P – v)Q – FC](1 – t_C) + t_CD
$527,760.24 = [($16.00 – 8.50)Q – 265,000](1 – 0.35) + 0.35($1,800,000/5)
Q = 117,746

As a check, we can calculate the NPV of the project with this quantity. The calculations are:

Year	1	2	3	4	5
Sales	$1,883,931	$1,883,931	$1,883,931	$1,883,931	$1,883,931
Variable costs	1,000,838	1,000,838	1,000,838	1,000,838	1,000,838
Fixed costs	265,000	265,000	265,000	265,000	265,000
Depreciation	360,000	360,000	360,000	360,000	360,000
EBIT	$258,093	$258,093	$258,093	$258,093	$258,093
Taxes (35%)	90,332	90,332	90,332	90,332	90,332
Net Income	$167,760	$167,760	$167,760	$167,760	$167,760
Depreciation	360,000	360,000	360,000	360,000	360,000
Operating CF	$527,760	$527,760	$527,760	$527,760	$527,760

Year	1	2	3	4	5
Operating CF	$527,760	$527,760	$527,760	$527,760	$527,760
Change in NWC	0	0	0	0	130,000
Capital spending	0	0	0	0	97,500
Total CF	$527,760	$527,760	$527,760	$527,760	$755,260

$$\text{NPV} = -\$1,800,000 - 130,000 + \$527,760 \,(\text{PVIFA}_{14\%,5}) + [(\$130,000 + 97,500) / 1.14^5] \approx \$0$$

Note that the NPV is not exactly equal to zero because we had to round the number of cartons sold; you cannot sell one-half of a carton.

c.   To find the highest level of fixed costs and still breakeven, we need to use the tax shield approach to calculating OCF, and solve the problem similar to finding a bid price. Using the initial cash flow and salvage value we already calculated, the equation for a zero NPV of the project is:

$$\text{NPV} = 0 = -\$1,800,000 - 130,000 + \text{OCF}(\text{PVIFA}_{14\%,5}) + [(\$130,000 + 97,500) / 1.14^5]$$
$$\text{OCF} = \$1,811,843.63 / \text{PVIFA}_{14\%,5} = \$527,760.24$$

Notice this is the same OCF we calculated in part *b*. Now we can use the tax shield approach to solve for the maximum level of fixed costs as follows:

$$\text{OCF} = \$527,760.24 = [(P{-}v)Q - \text{FC}\,](1 - t_C) + t_C\text{D}$$
$$\$527,760.24 = [(\$16.00 - \$8.50)(140,000) - \text{FC}](1 - 0.35) + 0.35(\$1,800,000/5)$$
$$\text{FC} = \$431,907.33$$

As a check, we can calculate the NPV of the project with this quantity. The calculations are:

Year	1	2	3	4	5
Sales	$2,240,000	$2,240,000	$2,240,000	$2,240,000	$2,240,000
Variable costs	1,190,000	1,190,000	1,190,000	1,190,000	1,190,000
Fixed costs	431,907	431,907	431,907	431,907	431,907
Depreciation	360,000	360,000	360,000	360,000	360,000
EBIT	$258,093	$258,093	$258,093	$258,093	$258,093
Taxes (35%)	90,332	90,332	90,332	90,332	90,332
Net Income	$167,760	$167,760	$167,760	$167,760	$167,760
Depreciation	360,000	360,000	360,000	360,000	360,000
Operating CF	$527,760	$527,760	$527,760	$527,760	$527,760

Year	1	2	3	4	5
Operating CF	$527,760	$527,760	$527,760	$527,760	$527,760
Change in NWC	0	0	0	0	130,000
Capital spending	0	0	0	0	97,500
Total CF	$527,760	$527,760	$527,760	$527,760	$755,260

$$\text{NPV} = -\$1,800,000 - 130,000 + \$527,760(\text{PVIFA}_{14\%,5}) + [(\$130,000 + 97,500) / 1.14^5] \approx \$0$$

32. We need to find the bid price for a project, but the project has extra cash flows. Since we don't already produce the keyboard, the sales of the keyboard outside the contract are relevant cash flows. Since we know the extra sales number and price, we can calculate the cash flows generated by these sales. The cash flow generated from the sale of the keyboard outside the contract is:

	Year 1	Year 2	Year 3	Year 4
Sales	$820,000	$2,460,000	$2,870,000	$1,435,000
Variable costs	420,000	1,260,000	1,470,000	735,000
EBT	$400,000	$1,200,000	$1,400,000	$700,000
Tax	160,000	480,000	560,000	280,000
Net income (and OCF)	$240,000	$720,000	$840,000	$420,000

So, the addition to NPV of these market sales is:

NPV of market sales = $240,000/1.13 + $720,000/1.13^2 + $840,000/1.13^3 + $420,000/1.13^4
NPV of market sales = $1,616,010.99

You may have noticed that we did not include the initial cash outlay, depreciation, or fixed costs in the calculation of cash flows from the market sales. The reason is that it is irrelevant whether or not we include these here. Remember that we are not only trying to determine the bid price, but we are also determining whether or not the project is feasible. In other words, we are trying to calculate the NPV of the project, not just the NPV of the bid price. We will include these cash flows in the bid price calculation. Whether we include these costs in this initial calculation is irrelevant since you will come up with the same bid price if you include these costs in this calculation, or if you include them in the bid price calculation.

Next, we need to calculate the aftertax salvage value, which is:

Aftertax salvage value = $200,000(1 – .40) = $120,000

Instead of solving for a zero NPV as is usual in setting a bid price, the company president requires an NPV of $100,000, so we will solve for a NPV of that amount. The NPV equation for this project is (remember to include the NWC cash flow at the beginning of the project, and the NWC recovery at the end):

NPV = $100,000 = –$3,400,000 – 75,000 + 1,616,010.99 + OCF (PVIFA$_{13\%,4}$) + [($120,000 + 75,000) / 1.13^4]

Solving for the OCF, we get:

OCF = $1,839,391.85 / PVIFA$_{13\%,4}$ = $618,392.87

Now we can solve for the bid price as follows:

OCF = $618,392.87 = [(P – v)Q – FC](1 – t_C) + t_CD
$618,392.87 = [(P – $105)(15,000) – $700,000](1 – 0.40) + 0.40($3,400,000/4)
P = $182.60

33. *a.* Since the two computers have unequal lives, the correct method to analyze the decision is the EAC. We will begin with the EAC of the new computer. Using the depreciation tax shield approach, the OCF for the new computer system is:

OCF = ($85,000)(1 − .38) + ($580,000 / 5)(.38) = $96,780

Notice that the costs are positive, which represents a cash inflow. The costs are positive in this case since the new computer will generate a cost savings. The only initial cash flow for the new computer is the cost of $780,000. We next need to calculate the aftertax salvage value, which is:

Aftertax salvage value = $130,000(1 − .38) = $80,600

Now we can calculate the NPV of the new computer as:

NPV = −$580,000 + $96,780(PVIFA$_{14\%,5}$) + $80,600 / 1.14^5
NPV = −$205,885.31

And the EAC of the new computer is:

EAC = − $205,885.31 / (PVIFA$_{14\%,5}$) = −$59,971.00

Analyzing the old computer, the only OCF is the depreciation tax shield, so:

OCF = $90,000(.38) = $34,200

The initial cost of the old computer is a little trickier. You might assume that since we already own the old computer there is no initial cost, but we can sell the old computer, so there is an opportunity cost. We need to account for this opportunity cost. To do so, we will calculate the aftertax salvage value of the old computer today. We need the book value of the old computer to do so. The book value is not given directly, but we are told that the old computer has depreciation of $90,000 per year for the next three years, so we can assume the book value is the total amount of depreciation over the remaining life of the system, or $270,000. So, the aftertax salvage value of the old computer is:

Aftertax salvage value = $230,000 + ($270,000 − 230,000)(.38) = $245,200

This is the initial cost of the old computer system today because we are forgoing the opportunity to sell it today. We next need to calculate the aftertax salvage value of the computer system in two years since we are "buying" it today. The aftertax salvage value in two years is:

Aftertax salvage value = $60,000 + ($90,000 − 60,000)(.38) = $71,400

Now we can calculate the NPV of the old computer as:

NPV = −$245,200 + $34,200(PVIFA$_{14\%,2}$) + 71,400 / 1.14^2
NPV = −$133,944.23

And the EAC of the old computer is:

$$\text{EAC} = -\$133{,}944.23 / (\text{PVIFA}_{14\%,2}) = -\$81{,}342.95$$

If we are going to replace the system in two years no matter what our decision today, we should instead replace it today since the EAC is lower.

b.   If we are only concerned with whether or not to replace the machine now, and are not worrying about what will happen in two years, the correct analysis is NPV. To calculate the NPV of the decision on the computer system now, we need the difference in the total cash flows of the old computer system and the new computer system. From our previous calculations, we can say the cash flows for each computer system are:

t	New computer	Old computer	Difference
0	–$580,000	$245,200	–$334,800
1	96,780	–34,200	62,580
2	96,780	–105,600	–8,820
3	96,780	0	96,780
4	96,780	0	96,780
5	177,380	0	177,380

Since we are only concerned with marginal cash flows, the cash flows of the decision to replace the old computer system with the new computer system are the differential cash flows. The NPV of the decision to replace, ignoring what will happen in two years is:

$$\text{NPV} = -\$334{,}800 + \$62{,}580/1.14 - \$8{,}820/1.14^2 + \$96{,}780/1.14^3 + \$96{,}780/1.14^4$$
$$+ \$177{,}380/1.14^5$$
$$\text{NPV} = -\$71{,}941.08$$

If we are not concerned with what will happen in two years, we should not replace the old computer system.

34.   To answer this question, we need to compute the NPV of all three alternatives, specifically, continue to rent the building, Project A, or Project B. We would choose the project with the highest NPV. If all three of the projects have a positive NPV, the project that is more favorable is the one with the highest NPV

There are several important cash flows we should not consider in the incremental cash flow analysis. The remaining fraction of the value of the building and depreciation are not incremental and should not be included in the analysis of the two alternatives. The $1,450,000 purchase price of the building is a same for all three options and should be ignored. In effect, what we are doing is finding the NPV of the future cash flows of each option, so the only cash flow today would be the building modifications needed for Project A and Project B. If we did include these costs, the effect would be to lower the NPV of all three options by the same amount, thereby leading to the same conclusion. The cash flows from renting the building after year 15 are also irrelevant. No matter what the company chooses today, it will rent the building after year 15, so these cash flows are not incremental to any project.

We will begin by calculating the NPV of the decision of continuing to rent the building first.

Continue to rent:

Rent	$61,000
Taxes	20,740
Net income	$40,260

Since there is no incremental depreciation, the operating cash flow is simply the net income. So, the NPV of the decision to continue to rent is:

NPV = $40,260(PVIFA$_{12\%,15}$)
NPV = $274,205.40

Product A:

Next, we will calculate the NPV of the decision to modify the building to produce Product A. The income statement for this modification is the same for the first 14 years, and in Year 15, the company will have an additional expense to convert the building back to its original form. This will be an expense in Year 15, so the income statement for that year will be slightly different. The cash flow at time zero will be the cost of the equipment, and the cost of the initial building modifications, both of which are depreciable on a straight-line basis. So, the pro forma cash flows for Product A are:

Initial cash outlay:

Building modifications	–$95,000
Equipment	–195,000
Total cash flow	–$280,000

	Years 1-14	Year 15
Revenue	$180,000	$180,000
Expenditures	70,000	70,000
Depreciation	19,333	19,333
Restoration cost	0	55,000
EBT	$90,667	$35,667
Tax	30,827	12,127
NI	$59,840	$23,540
OCF	$79,173	$42,873

The OCF each year is net income plus depreciation. So, the NPV for modifying the building to manufacture Product A is:

NPV = –$280,000 + $79,173(PVIFA$_{12\%,14}$) + $42,873 / 1.12^{15}
NPV = $242,606.97

Product B:

Now we will calculate the NPV of the decision to modify the building to produce Product B. The income statement for this modification is the same for the first 14 years, and in year 15, the company will have an additional expense to convert the building back to its original form. This will be an expense in year 15, so the income statement for that year will be slightly different. The cash flow at time zero will be the cost of the equipment, and the cost of the initial building modifications, both of which are depreciable on a straight-line basis. So, the pro forma cash flows for Product B are:

Initial cash outlay:

Building modifications	–$125,000
Equipment	–230,000
Total cash flow	–$355,000

	Years 1-14	Year 15
Revenue	$215,000	$215,000
Expenditures	90,000	90,000
Depreciation	23,667	23,667
Restoration cost	0	80,000
EBT	$101,333	$21,333
Tax	34,453	7,253
NI	$66,880	$14,080
OCF	$90,547	$37,747

The OCF each year is net income plus depreciation. So, the NPV for modifying the building to manufacture Product B is:

$NPV = -\$355,000 + \$90,547(PVIFA_{12\%,14}) + \$37,747 / 1.12^{15}$
$NPV = \$252,054.71$

Since renting has the highest NPV, the company should continue to rent the building.

We could have also done the analysis as the incremental cash flows between Product A and continuing to rent the building, and the incremental cash flows between Product B and continuing to rent the building. The results of this type of analysis would be:

NPV of differential cash flows between Product A and continuing to rent:

$NPV = NPV_{Product\ A} - NPV_{Rent}$
$NPV = \$242,606.97 - 274,205.40$
$NPV = -\$31,598.43$

NPV of differential cash flows between Product B and continuing to rent:

$NPV = NPV_{Product\ B} - NPV_{Rent}$
$NPV = \$252,054.71 - 274,205.40$
$NPV = -\$22,150.69$

Since the differential NPV of both products and renting is negative, the company should continue to rent, which is the same as our original result.

35. The discount rate is expressed in real terms, and the cash flows are expressed in nominal terms. We can answer this question by converting all of the cash flows to real dollars. We can then use the real interest rate. The real value of each cash flow is the present value of the year 1 nominal cash flows, discounted back to the present at the inflation rate. So, the real value of the revenue and costs will be:

Revenue in real terms = $265,000 / 1.06 = $250,000.00
Labor costs in real terms = $185,000 / 1.06 = $174,528.30
Other costs in real terms = $55,000 / 1.06 = $51,886.79
Lease payment in real terms = $90,000 / 1.06 = $84,905.66

Revenues, labor costs, and other costs are all growing perpetuities. Each has a different growth rate, so we must calculate the present value of each separately. Using the real required return, the present value of each of these is:

$PV_{Revenue}$ = $250,000.00 / (0.10 – 0.04) = $4,166,666.67
$PV_{Labor\ costs}$ = $174,528.30 / (0.10 – 0.03) = $2,493,261.46
$PV_{Other\ costs}$ = $51,886.79 / (0.10 – 0.01) = $576,519.92

The lease payments are constant in nominal terms, so they are declining in real terms by the inflation rate. Therefore, the lease payments form a growing perpetuity with a negative growth rate. The real present value of the lease payments is:

$PV_{Lease\ payments}$ = $84,905.66 / [0.10 – (–0.06)] = $530,660.38

Now we can use the tax shield approach to calculate the net present value. Since there is no investment in equipment, there is no depreciation; therefore, no depreciation tax shield, so we will ignore this in our calculation. This means the cash flows each year are equal to net income. There is also no initial cash outlay, so the NPV is the present value of the future aftertax cash flows. The NPV of the project is:

NPV = ($PV_{Revenue}$ – $PV_{Labor\ costs}$ – $PV_{Other\ costs}$ – $PV_{Lease\ payments}$)$(1 – t_C)$
NPV = ($4,166,666.67 – 2,493,261.46 – 576,519.92 – 530,660.38)(1 – .34)
NPV = $373,708.45

Alternatively, we could have solved this problem by expressing everything in nominal terms. This approach yields the same answer as given above. However, in this case, the computation would have been impossible. The reason is that we are dealing with growing perpetuities. In other problems, when calculating the NPV of nominal cash flows, we could simply calculate the nominal cash flow each year since the cash flows were finite. Because of the perpetual nature of the cash flows in this problem, we cannot calculate the nominal cash flows each year until the end of the project. When faced with two alternative approaches, where both are equally correct, always choose the simplest one.

36. We are given the real revenue and costs, and the real growth rates, so the simplest way to solve this problem is to calculate the NPV with real values. While we could calculate the NPV using nominal values, we would need to find the nominal growth rates, and convert all values to nominal terms. The real labor costs will increase at a real rate of two percent per year, and the real energy costs will increase at a real rate of three percent per year, so the real costs each year will be:

	Year 1	Year 2	Year 3	Year 4
Real labor cost each year	$15.75	$16.07	$16.39	$16.71
Real energy cost each year	$3.80	$3.91	$4.03	$4.15

Remember that the depreciation tax shield also affects a firm's aftertax cash flows. The present value of the depreciation tax shield must be added to the present value of a firm's revenues and expenses to find the present value of the cash flows related to the project. The depreciation the firm will recognize each year is:

Annual depreciation = Investment / Economic Life
Annual depreciation = $165,000,000 / 4
Annual depreciation = $41,250,000

Depreciation is a nominal cash flow, so to find the real value of depreciation each year, we discount the real depreciation amount by the inflation rate. Doing so, we find the real depreciation each year is:

Year 1 real depreciation = $41,250,000 / 1.05 = $39,285,714.29
Year 2 real depreciation = $41,250,000 / 1.05^2 = $37,414,965.99
Year 3 real depreciation = $41,250,000 / 1.05^3 = $35,633,300.94
Year 4 real depreciation = $41,250,000 / 1.05^4 = $33,936,477.09

Now we can calculate the pro forma income statement each year in real terms. We can then add back depreciation to net income to find the operating cash flow each year. Doing so, we find the cash flow of the project each year is:

	Year 0	Year 1	Year 2	Year 3	Year 4
Revenues		$69,300,000.00	$74,250,000.00	$84,150,000.00	$79,200,000.00
Labor cost		17,640,000.00	19,278,000.00	22,285,368.00	21,393,953.28
Energy cost		798,000.00	880,650.00	1,028,012.10	996,567.02
Depreciation		39,285,714.29	37,414,965.99	35,633,300.94	33,936,477.09
EBT		$11,576,285.71	$16,676,384.01	$25,203,318.96	$22,873,002.61
Taxes		3,935,937.14	5,669,970.56	8,569,128.45	7,776,820.89
Net income		$7,640,348.57	$11,006,413.45	$16,634,190.51	$15,096,181.72
OCF		$46,926,062.86	$48,421,379.44	$52,267,491.45	$49,032,658.81
Capital spending	–$165,000,000				
Total CF	–$165,000,000	$46,926,062.86	$48,421,379.44	$52,267,491.45	$49,032,658.81

We can use the total cash flows each year to calculate the NPV, which is:

$$NPV = -\$165,000,000 + \$46,926,062.86 / 1.04 + \$48,421,379.44 / 1.04^2 + \$52,267,491.45 / 1.04^3$$
$$+ \$49,032,658.81 / 1.04^4$$
$$NPV = \$13,268,433.31$$

37. Here we have the sales price and production costs in real terms. The simplest method to calculate the project cash flows is to use the real cash flows. In doing so, we must be sure to adjust the depreciation, which is in nominal terms. We could analyze the cash flows using nominal values, which would require calculating the nominal discount rate, nominal price, and nominal production costs. This method would be more complicated, so we will use the real numbers. We will first calculate the NPV of the headache only pill.

Headache only:

We can find the real revenue and production costs by multiplying each by the units sold. We must be sure to discount the depreciation, which is in nominal terms. We can then find the pro forma net income, and add back depreciation to find the operating cash flow. Discounting the depreciation each year by the inflation rate, we find the following cash flows each year:

	Year 1	Year 2	Year 3
Sales	$25,050,000	$25,050,000	$25,050,000
Production costs	12,300,000	12,300,000	12,300,000
Depreciation	7,443,366	7,226,569	7,016,086
EBT	$5,306,634	$5,523,431	$5,733,914
Tax	1,804,256	1,877,967	1,949,531
Net income	$3,502,379	$3,645,465	$3,784,383
OCF	$10,945,744	$10,872,033	$10,800,469

And the NPV of the headache only pill is:

$$NPV = -\$23,000,000 + \$10,945,744 / 1.07 + \$10,872,033 / 1.07^2 + \$10,800,469 / 1.07^3$$
$$NPV = \$5,542,122.70$$

Headache and arthritis:

For the headache and arthritis pill project, the equipment has a salvage value. We will find the aftertax salvage value of the equipment first, which will be:

Market value	$1,000,000
Taxes	–340,000
Total	$660,000

Remember, to calculate the taxes on the equipment salvage value, we take the book value minus the market value, times the tax rate. Using the same method as the headache only pill, the cash flows each year for the headache and arthritis pill will be:

	Year 1	Year 2	Year 3
Sales	$37,575,000	$37,575,000	$37,575,000
Production costs	20,925,000	20,925,000	20,925,000
Depreciation	10,355,987	10,054,356	9,761,511
EBT	$6,294,013	$6,595,644	$6,888,489
Tax	2,139,964	2,242,519	2,342,086
Net income	$4,154,049	$4,353,125	$4,546,403
OCF	$14,510,036	$14,407,481	$14,307,914

So, the NPV of the headache and arthritis pill is:

$NPV = -\$32,000,000 + \$14,510,036 / 1.07 + \$14,407,481 / 1.07^2 + (\$14,307,914 + 660,000) / 1.07^3$
$NPV = \$6,363,109.18$

The company should manufacture the headache and arthritis remedy since the project has a higher NPV.

38. Since the project requires an initial investment in inventory as a percentage of sales, we will calculate the sales figures for each year first. The incremental sales will include the sales of the new table, but we also need to include the lost sales of the existing model. This is an erosion cost of the new table. The lost sales of the existing table are constant for every year, but the sales of the new table change every year. So, the total incremental sales figure for the five years of the project will be:

	Year 1	Year 2	Year 3	Year 4	Year 5
New	$10,980,000	$11,895,000	$15,250,000	$14,335,000	$12,810,000
Lost sales	–1,125,000	–1,125,000	–1,125,000	–1,125,000	–1,125,000
Total	$9,855,000	$10,770,000	$14,125,000	$13,210,000	$11,685,000

Now we will calculate the initial cash outlay that will occur today. The company has the necessary production capacity to manufacture the new table without adding equipment today. So, the equipment will not be purchased today, but rather in two years. The reason is that the existing capacity is not being used. If the existing capacity were being used, the new equipment would be required, so it would be a cash flow today. The old equipment would have an opportunity cost if it could be sold. As there is no discussion that the existing equipment could be sold, we must assume it cannot be sold. The only initial cash flow is the cost of the inventory. The company will have to spend money for inventory in the new table, but will be able to reduce inventory of the existing table. So, the initial cash flow today is:

New table	–$1,098,000
Old table	112,500
Total	–$985,500

In year 2, the company will have a cash outflow to pay for the cost of the new equipment. Since the equipment will be purchased in two years rather than now, the equipment will have a higher salvage value. The book value of the equipment in five years will be the initial cost, minus the accumulated depreciation, or:

Book value = $18,000,000 – 2,572,200 – 4,408,200 – 3,148,200
Book value = $7,871,400

The taxes on the salvage value will be:

Taxes on salvage = ($7,871,400 – 7,400,000)(.40)
Taxes on salvage = $188,560

So, the aftertax salvage value of the equipment in five years will be:

Sell equipment	$7,400,000
Taxes	188,560
Salvage value	$7,588,560

Next, we need to calculate the variable costs each year. The variable costs of the lost sales are included as a variable cost savings, so the variable costs will be:

	Year 1	Year 2	Year 3	Year 4	Year 5
New	$4,941,000	$5,352,750	$6,862,500	$6,450,750	$5,764,500
Lost sales	–450,000	–450,000	–450,000	–450,000	–450,000
Variable costs	$4,491,000	$4,902,750	$6,412,500	$6,000,750	$5,314,500

Now we can prepare the rest of the pro forma income statements for each year. The project will have no incremental depreciation for the first two years as the equipment is not purchased for two years. Adding back depreciation to net income to calculate the operating cash flow, we get:

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	$9,855,000	$10,770,000	$14,125,000	$13,210,000	$11,685,000
VC	4,491,000	4,902,750	6,412,500	6,000,750	5,314,500
Fixed costs	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000
Dep.	0	0	2,572,200	4,408,200	3,148,200
EBT	$3,464,000	$3,967,250	$3,240,300	$901,050	$1,322,300
Tax	1,385,600	1,586,900	1,296,120	360,420	528,920
NI	$2,078,400	$2,380,350	$1,944,180	$540,630	$793,380
+Dep.	0	0	2,572,200	4,408,200	3,148,200
OCF	$2,078,400	$2,380,350	$4,516,380	$4,948,830	$3,941,580

Next, we need to account for the changes in inventory each year. The inventory is a percentage of sales. The way we will calculate the change in inventory is the beginning of period inventory minus the end of period inventory. The sign of this calculation will tell us whether the inventory change is a cash inflow, or a cash outflow. The inventory each year, and the inventory change, will be:

	Year 1	Year 2	Year 3	Year 4	Year 5
Beginning	$1,098,000	$1,189,500	$1,525,000	$1,433,500	$1,281,000
Ending	1,189,500	1,525,000	1,433,500	1,281,000	0
Change	–$91,500	–$335,500	$91,500	$152,500	$1,281,000

Notice that we recover the remaining inventory at the end of the project. The total cash flows for the project will be the sum of the operating cash flow, the capital spending, and the inventory cash flows, so:

	Year 1	Year 2	Year 3	Year 4	Year 5
OCF	$2,078,400	$2,380,350	$4,516,380	$4,948,830	$3,941,580
Equipment	0	–18,000,000	0	0	7,588,560
Inventory	–91,500	–335,500	91,500	152,500	1,281,000
Total	$1,986,900	–$15,955,150	$4,607,880	$5,101,330	$12,811,140

The NPV of the project, including the inventory cash flow at the beginning of the project, will be:

$$NPV = -\$985,500 + \$1,986,900 / 1.11 - \$15,955,150 / 1.11^2 + \$4,607,880 / 1.11^3$$
$$+ \$5,101,330 / 1.11^4 + \$12,811,140 / 1.11^5$$
$$NPV = \$2,187,376.60$$

The company should go ahead with the new table.

b. You can perform an IRR analysis, and would expect to find three IRRs since the cash flows change signs three times.

c. The profitability index is intended as a "bang for the buck" measure; that is, it shows how much shareholder wealth is created for every dollar of initial investment. This is usually a good measure of the investment since most projects have conventional cash flows. In this case, the largest investment is not at the beginning of the project, but later in its life, so while the interpretation is the same, it really does not measure the bang for the dollar invested.