# Chapter 12: Developing Project Cash Flows

- Cost and Benefit Estimating
- Income Statement
- Cash Flow Statement
  - How to handle working capital
  - How to handle financing
- After-Tax Cash Flow Analysis
  - Approach 1: Cash Flows based on Income Statement
  - Approach 2: Traditional Method of Net Cash Flow Table
  - Generalized Cash Flow Approach



# Cost Estimating

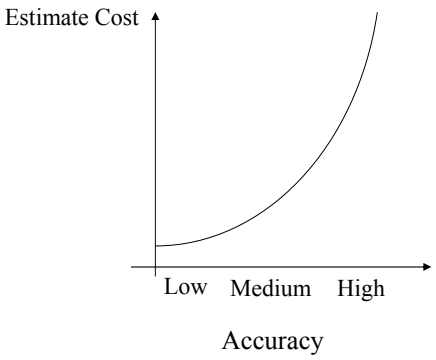
- Need estimates since we are making current decisions on future costs

| Type of Estimate | Comments |
|---|---|
| Rough estimates | Used for high-level planning. The intent is to quantify and consider the order of magnitude of the numbers involved. (Errors between –30% to +60%.) |
| Semi-detailed estimates | Used for budget purposes at a project's conceptual or preliminary design stages. (Errors between –15% to +20%) |
| Detailed estimates | Used during a project's detailed design and contract bidding phases. These estimates involve the most time and resources to develop. (Errors between –3% to +5%) |

- Will play a role in sensitivity analysis, risk, and uncertainty

## Cost Estimating

- It can be difficult to make good estimates. Compare the cost of an estimate with its expected accuracy






## Cost Estimating

"Per Unit" Estimating Model

- Uses a "per unit" factor such as a cost per person
- Works well for rough or order-of-magnitude type estimates, and is commonly used in the construction industry
- Note this model *does not account for economies of scale* (lower per unit costs for larger quantities)

"Segmenting" Estimating Model

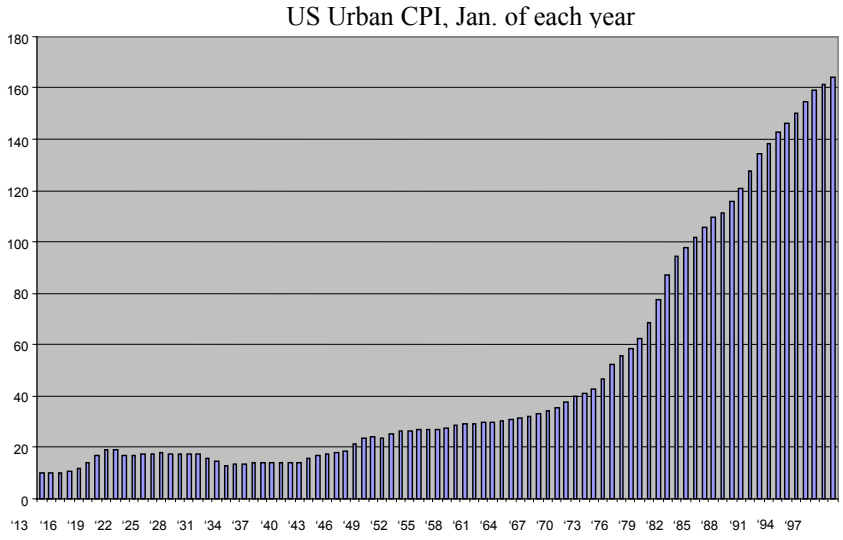
- An estimate is decomposed into its individual components
- Estimates made at lower levels, then these estimates are added together
- Work Breakdown Structure
  - Common for large processes, products, or projects
  - Spreadsheets can be very useful with this subject matter

## Cost Indices

- The U.S. Federal government publishes cost index data through the Department of Commerce Bureau of Statistics
- The Statistical Abstract of the United States publishes cost indexes for labor, construction, and materials
- Best-known example is the consumer price index (CPI), a measure of inflation
  - The measure is scaled, so it is only the relative values of any two measures that are meaningful
  - For example, in 1920, the measure was about 20; in 1997 it was about 160. The conclusion is that one would have to spend 160/20 or 8 times as much in 1997 as in 1920 for the same consumables
- Cost indices work in the same way as price indices
- Cost indices are dimensionless



## Cost Indices



## Power Sizing Model

- Power Sizing Model

  Cost of equipment A / Cost of equipment B =

  [Size or capacity of equipment A / Size or capacity of B]$^x$
  - A generalization of the cost index model
  - The power sizing model "scales up" or "scales down" previously known costs, accounting for economies of scale that are common in industrial plant and equipment costs
  - It does not adjust for changes in cost over time
- Example (Estimate the cost of a new heat exchanger)
  - We paid \$50,000 for a 1000 ft$^2$ heat exchanger 5 years ago
  - We need a 2500 ft$^2$ heat exchanger today
  - Heat exchangers with this capacity range have $x = 0.55$
  - The Heat Exchanger Cost Index (HECI) was 1306 five years ago, and is 1487 today



## Example: Power Sizing and Cost Indexing

- Power sizing formula
  - A for today and B for five years ago, x = 0.55
  - Cost of 2500 ft$^2$ heat exchanger =

    $50000(2500/1000)^{0.55} = \$82,800$
  - We have only adjusted so far for a change in size. We must still adjust for a change in costs over time
- Cost index formula
  - Equipment Cost today / Equipment Cost 5 years ago =

    Index Value today/Index value 5 years ago $\Rightarrow$
  - Equipment cost today $\approx (1487/1306) \times 82,800 = \$94,300$

## Estimating Benefits

- For the most part, we can use the same approach to estimate benefits as to estimate costs:
  - Fixed and variable benefits
  - Recurring and non-recurring benefits
  - Incremental benefits
  - Life-cycle benefits
  - Rough, semi-detailed, and detailed benefit estimates
  - Difficulties in estimation
  - Segmentation and index models
- Major differences between benefit and cost estimation:
  - Costs are most likely to be underestimated
  - Benefits are most likely to be overestimated
  - Costs tend to occur in the near future
  - Benefits tend to occur further in the future than costs



## Economic Analysis Before and After Taxes

Example

Giuliano's Pizza plans to spend $3,000 on a used truck for the shipping and receiving department of its local warehouse.

- Estimated life = 5 years. Estimated savings per year = $800
- Estimated salvage value = $750. Giuliano's is in the 34% tax bracket
- SL depreciation = (3000-750)/5 = $450 per year

| *Year* | *Before Tax Cash Flows* | *SL deprec.* | *ΔTaxable Income (a) – (b)* | *34% Income taxes: -0.34 (c)* | *After Tax Cash Flows (a) + (d)* |
|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) |
| 0 | -$3000 | | | | -$3000 |
| 1 | 800 | 450 | 350 | -$119 | $681 |
| 2 | 800 | 450 | 350 | -$119 | 681 |
| 3 | 800 | 450 | 350 | -$119 | 681 |
| 4 | 800 | 450 | 350 | -$119 | 681 |
| 5 | 800<br>SV(or MV) = 750 | 450<br>***BV = 750*** | 350<br>----- | -$119<br>----- | 681<br>+750 |

## Economic Analysis Before and After Taxes

Before Taxes: Cash flows in (a) have IRR = 15.69%

After Taxes: Cash flows in (e) have IRR = 10.55%

Important Notes

- Columns (b) and (c) are used for calculating the cash flow for income taxes!! They are not cash flows!!! Do not include these when calculating the "after tax cash flow"
- A minus (–) represents a *disbursement* of money; a plus (+) represents the *receipt* of money

Conclusion

- Before-tax analysis is only a starting point
- Income taxes are a major disbursement that cannot be ignored
- *Only the after-tax ROR (or any equivalent worth measure) is a meaningful value*



## Estimating the After-Tax Rate of Return

Example. You invest $10,000 and get a return of $1,000. You are in the 28% tax bracket, so U.S. takes $280, leaving you with $720.

After-tax ROR = (1 – Incremental tax rate) × (Before-tax ROR)

Before-tax ROR = 10%

After-tax ROR after taxes = 7.8% = (1 – 0.28) × ROR before taxes

Estimating after-tax ROR for *nondepreciable assets*

- Previous Example: After-tax ROR = (1 – 0.34)(15.69%) = 10.36%
- This is close to what we found before (10.55%)
- There is no shortcut method to compute the after-tax ROR from the before-tax ROR. Even for nondepreciable assets, the above formula is just a rough approximation

Estimating After-Tax MARR

(Before-tax MARR)[(1 - effective income tax rate)] ≈ after-tax MARR

# Example – Working Capital

Example (Inventory, No Depreciation)

A firm is losing sales because it cannot always make quick deliveries. By investing an extra $20,000 in inventory it is believed that the before-tax profit of the firm will be $1,000 more the first year. The second year before-tax extra profit will be $1,500. The extra profit is then expected to go up $500 more each year. The investment in extra inventory may be recovered at the end of a four-year analysis period by selling it and not replenishing the inventory. Assuming an incremental tax rate is 39%, we wish to find the ROR before taxes, and the ROR after taxes.

- ***Working capital*** – amount carried in cash, accounts receivable, and inventory that is available to meet daily operating needs
  - Treat working capital investments just like capital expenditures except that *no depreciation* is allowed
  - The investment in working capital is often assumed to be returned in full at the end of the project



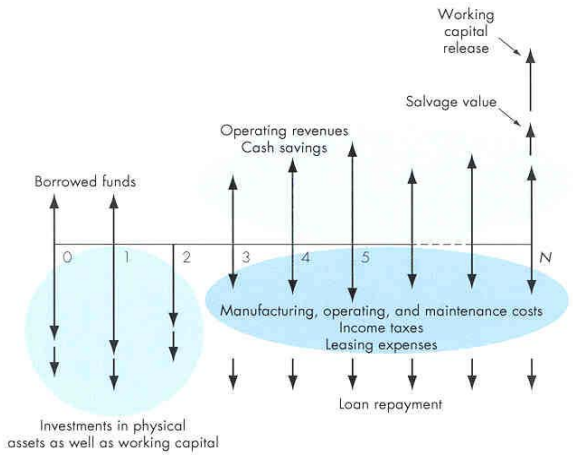
# Example – Working Capital

| *Year* | *Before Tax Cash Flow* | *SL deprec.* | *ΔTaxable Income (a) – (b)* | *34% Income taxes: -0.34 (c)* | *After Tax Cash Flow (a) + (d)* |
|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) |
| 0 | -$20,000 | | | | -$20,000 |
| 1 | 1,000 | ----- | $1,000 | -$390 | 610 |
| 2 | 1,500 | ----- | 1,500 | -$585 | 915 |
| 3 | 2,000 | ----- | 2,000 | -$780 | 1220 |
| 4 | 2,500<br>+20,000 | ----- | 2,500 | -$975 | 1,525<br>+20,000 |

- Before taxes: CFS (a) has IRR = 8.50% ☺
- After taxes: CFS (e) has IRR = 5.24%. ☹
- Can you calculate before-tax and after-tax PW?

- Key point: Inventory is not considered a depreciable asset, even though its value to the owner may decrease over time

## Types of Cash Flow Elements





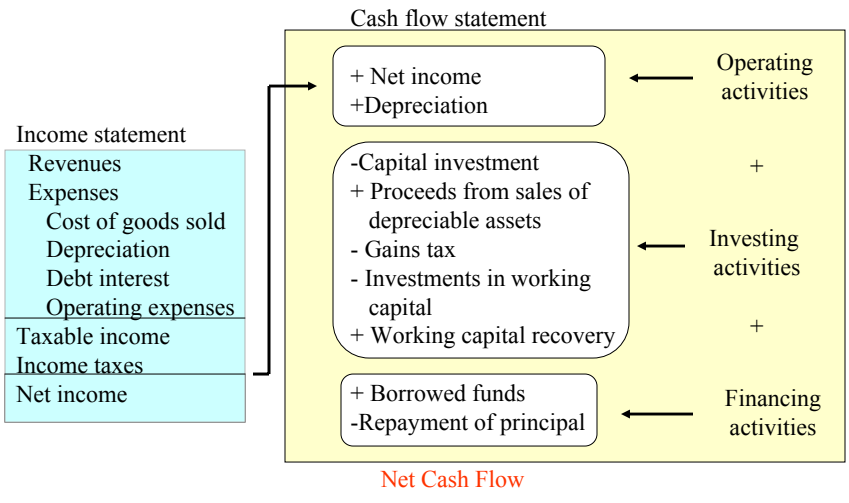

## Cash Flows from Operating Activities

| Approach 1<br>Income Statement Approach | Approach 2<br>Direct Cash Flow Approach |
|---|---|
| Operating revenues | Operating revenues |
| Cost of goods sold | - Cost of goods sold |
| Depreciation | |
| Operating expenses | - Operating expenses |
| Interest expenses | - Interest expenses |
| Taxable income | |
| Income taxes | - Income taxes |
| Net income | Cash flow from operation |
| + Depreciation | |

| Cash Flow Element | Other Terms Used in Business |
|---|---|
| Operating activities: | |
| Gross income | Gross revenue, Sales revenue, Gross profit, Operating revenue |
| Cost savings | Cost reduction |
| Manufacturing expenses | Cost of goods sold, Cost of revenue |
| O&M cost | Operating expenses |
| Operating income | Operating profit, Gross margin |
| Interest expenses | Interest payments, Debt cost |
| Income taxes | Income taxes owed, Tax credits received |
| Investing activities: | |
| Capital investment | Purchase of new equipment, Capital expenditure |
| Salvage value | Net selling price, Disposal value, Resale value |
| Investment in working capital | Working capital requirement |
| Working capital release | Working capital recovery |
| Gains taxes | Capital gains taxes, Ordinary gains taxes |
| Financing activities: | |
| Borrowed funds | Borrowed amounts, Loan amount |
| Principal repayments | Loan repayment |



# Determining the Cash Flow Statement



## Example 12.1 Operating and Investing Activities Only

- **Project Nature:** Installation of a new computer control system
- **Financial Data:**
  - Investment: $125,000
  - Project life: 5 years
  - Salvage value: $50,000
  - Annual labor savings: $100,000
  - Annual additional expenses:
    - Labor: $20,000, Material: $12,000, Overhead: $8,000
  - Depreciation Method: 7-year MACRS
  - Income tax rate: 40%
  - MARR: 15%
- **Questions:**
  1. Develop the project's cash flows over its project life
  2. Is this project justifiable at a MARR of 15%?
  3. What is the internal rate of return of this project?



## Step 1: Depreciation Calculations

- **Cost Basis = $125,000**
- **Recovery Period = 7-year MACRS**

| *N* | MACRS Rate | Depreciation Amount | Allowed Depreciation Amount |
|---|---|---|---|
| 1 | 14.29% | $17,863 | $17,863 |
| 2 | 24.49% | $30,613 | $30,613 |
| 3 | 17.49% | $21,863 | $21,863 |
| 4 | 12.49% | $15,613 | $15,613 |
| 5 | 8.93% | $11,150 | $5,575 |
| 6 | 8.92% | $11,150 | 0 |
| 7 | 8.93% | $11,150 | 0 |
| 8 | 4.46% | $5,575 | 0 |

With half-year convention

## Step 2: Gains (Losses) with Asset Disposal

- Salvage value = $50,000
- Book Value (year 5) = Cost Basis – Total Depreciation
  = $125,000 - $ 91,525
  = $ 33,475
- Taxable gains = Salvage Value – Book Value
  = $50,000 - $ 33,475
  = $16,525
- Gains taxes = (Taxable Gains)(Tax Rate)
  = $16,525 (0.40)
  = $6,610



## Example 12.1 – Income Statement

| *Income Statement* | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Revenues** | | $100,000 | $100,000 | $100,000 | $100,000 | $100,000 |
| **Expenses:** | | | | | | |
| **Labor** | | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| **Material** | | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| **Overhead** | | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 |
| **Depreciation** | | 17,863 | 30,613 | 21,863 | 15,613 | 5,581 |
| **Taxable Income** | | $42,137 | $29,387 | $38,137 | $44,387 | $54,419 |
| **Income Taxes (40%)** | | 16,855 | 11,755 | 15,255 | 17,755 | 21,768 |
| **Net Income** | | $25,282 | $17,632 | $22,882 | $26,632 | $32,651 |

# Example 12.1 – Cash Flow Statement

| *Cash Flow Statement* | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Operating Activities:** | | | | | | |
| **Net Income** | | $25,282 | $17,632 | $22,882 | $26,632 | $32,651 |
| **Depreciation** | | 17,863 | 30,613 | 21,863 | 15,613 | 5,581 |
| **Investment Activities:** | | | | | | |
| **Investment** | (125,000) | | | | | |
| **Salvage** | | | | | | 50,000 |
| **Gains Tax** | | | | | | (6,613) |
| **Net Cash Flow** | ($125,000) | $43,145 | $48,245 | $44,745 | $42,245 | $81,619 |



# Ex 12.1 – Net Cash Flow Table (Traditional Method)

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| | ***Before-Tax Cash Flows*** | | | | | | |
| Year End | Investment & Salvage Value | Revenue | Labor Material Overhead | Depreciation | Taxable Income | Income Taxes | ***After-Tax Cash Flow*** |
| 0 | -$125,000 | | | | | | -$125,000 |
| 1 | | $100,000 | -40,000 | $17,863 | 42,137 | -16,855 | $43,145 |
| 2 | | 100,000 | -40,000 | 30,613 | 29,387 | -11,755 | $48,245 |
| 3 | | 100,000 | -40,000 | 21,863 | 38,137 | -15,255 | $44,745 |
| 4 | | 100,000 | -40,000 | 15,613 | 44,387 | -17,755 | $42,245 |
| 5 | | 100,000 | -40,000 | 5,581 | 54,419 | -21,678 | $38,232 |
| | 50,000* | | | *BV = 33,475* | 16,525 | -6,613 | $43,387 |

***Salvage value**

**Note that**
**F = B+C+D-E**
**G = 0.4 * F**
**H= B+C+D+G**

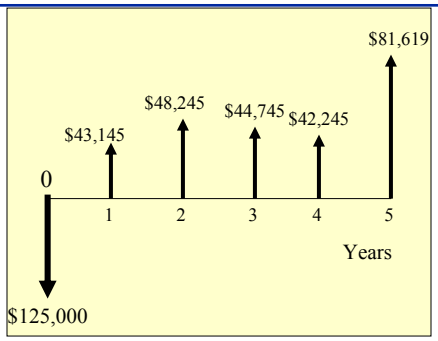
**Information required to calculate the income taxes**

# Example 12.1 – Additional Questions

2. Project Justified at MARR = 15%?

   PW(15%) = -$125,000 +
   +$43,145(*P*/*F*, 15%, 1) + . . . .
   + $81,620 (*P*/*F*, 15%, 5)
   = $43,151 > 0

   – Yes, Accept the Project !




3. Determine the project's IRR

- At $i = 25\%$

  PW(25%) = $7,351

- At $i = 30\%$

  PW (30%) = -$6,124

- IRR = 27.61% > 15%, Accept!!



# Projects Requiring Working Capital

- Working capital – amount carried in cash, accounts receivable, and inventory that is available to meet daily operating needs
- Treat working capital investments just like capital expenditures except that *no depreciation* is allowed

**(Example 12.2)**

| | |
|---|---|
| Price (revenue) per unit | $10 |
| Unit variable manufacturing costs | |
| Labor | $2 |
| Material | $1.20 |
| Overhead | $0.80 |
| Monthly volume | 833 units |
| Finished goods inventory to maintain | 2 – month supply |
| Raw materials inventory to maintain | 1 – month supply |
| Accounts payable | 30 days |
| Accounts receivable | 60 days |

# Example 12.2 – Working Capital Requirements

| During year 1 | Income /Expense Reported | Actual cash Received/paid | Difference |
|---|---|---|---|
| Sales | $100,000 (10,000 units) | $83,333 | -$16,666 |
| Expenses | $40,000 (10,000 units) | $46,665 (11,667 units) | +$6665 |
| Income taxes | $16,855 | $16,855 | 0 |
| Net amount | $43,145 | $19,814 | -$23,333 |

This differential amount must be invested at the beginning of the year

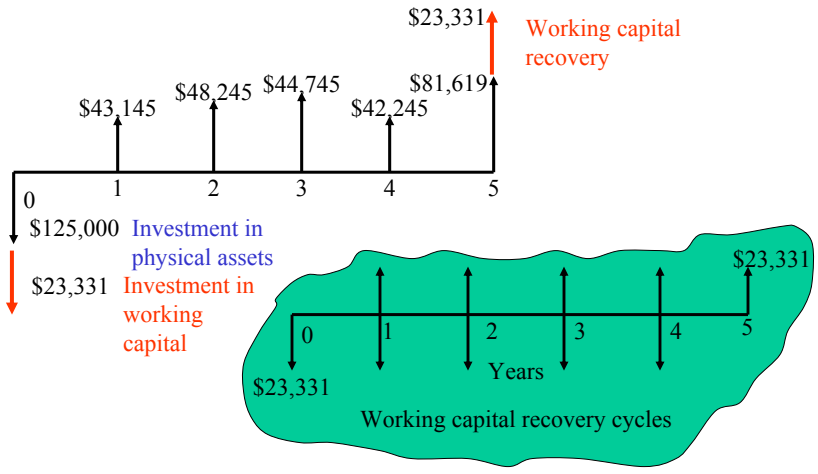


# Ex 12.3 – Cash Flow Statement with Working Capital

Item related to working capital investment

| Year | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Income Statement** | | | | | | |
| Revenues | | $100,000 | $100,000 | $100,000 | $100,000 | $100,000 |
| Expenses | | | | | | |
| Labor | | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| Material | | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| Overhead | | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 |
| Depreciation | | 17,863 | 30,613 | 21,863 | 15,613 | 5,581 |
| Taxable income | | $ 42,137 | $ 29,387 | $ 38,137 | $ 44,387 | $ 54,419 |
| Income taxes (40%) | | 16,855 | 11,755 | 15,255 | 17,755 | 21,768 |
| Net income | | $ 25,282 | $ 17,632 | $ 22,882 | $ 26,632 | $ 32,651 |
| **Cash Flow Statement** | | | | | | |
| Operating activities | | | | | | |
| Net income | | 25,282 | 17,632 | 22,882 | 26,632 | 32,651 |
| Depreciation | | 17,863 | 30,613 | 21,863 | 15,613 | 5,581 |
| Investment activities | | | | | | |
| Investment | (125,000) | | | | | |
| Salvage | | | | | | 50,000 |
| Gains tax | | | | | | (6,613) |
| Working capital | (23,331) | | | | | 23,331 |
| Net cash flow | $(148,331) | $ 43,145 | $ 48,245 | $ 44,745 | $ 42,245 | $104,950 |

## Ex 12.3 – Cash Flow Diagram with Working Capital






## Projects Financed with Borrowed Funds

- Key Issue
  - Interest payment is a tax-deductible expense
- What Needs to be Done
  - Once loan repayment schedule is known, determine the interest payment portion of the annual (or periodic) installment
- What about the Principal Payment?
  - Since the amount of borrowing is NOT viewed as income to the borrower, the repayment of principal is NOT viewed as expenses either– NO tax effect

# Example 12.4 – Financing (Borrowing)

**Amount financed: $62,500, or 50% of total capital expenditure**
**Financing rate: 10% per year**
**Annual installment: $A = \$62{,}500(A/P, 10\%, 5)$, or $16,487**

| End of Year | Beginning Balance | Interest Payment | Principal Payment | Ending Balance |
|---|---|---|---|---|
| 1 | $62,500 | $6,250 | $10,237 | $52,263 |
| 2 | 52,263 | 5,226 | 11,261 | 41,002 |
| 3 | 41,002 | 4,100 | 12,387 | 28,615 |
| 4 | 28,615 | 2,861 | 13,626 | 14,989 |
| 5 | 14,989 | 1,499 | 14,988 | 0 |

$16,487



# Example 12.4 – Financing (Borrowing)

Items related to financing activities

| Year | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Income Statement** | | | | | | |
| Revenues | | $100,000 | $100,000 | $100,000 | $100,000 | $100,000 |
| Expenses | | | | | | |
| Labor | | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| Material | | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| Overhead | | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 |
| Depreciation | | 17,863 | 30,613 | 21,863 | 15,613 | 5,581 |
| Debt interest | | 6,250 | 5,226 | 4,100 | 2,861 | 1,499 |
| Taxable income | | $ 35,887 | $ 24,161 | $ 34,037 | $ 41,526 | $ 52,920 |
| Income taxes (40%) | | 14,355 | 12,664 | 13,615 | 16,610 | 21,168 |
| Net income | | $ 21,532 | $ 14,497 | $ 20,422 | $ 24,916 | $ 31,752 |
| **Cash Flow Statement** | | | | | | |
| Operating activities | | | | | | |
| Net income | | 21,532 | 14,497 | 20,422 | 24,916 | 31,752 |
| Depreciation | | 17,863 | 30,613 | 21,863 | 15,613 | 5,581 |
| Investment activities | | | | | | |
| Investment | (125,000) | | | | | |
| Salvage | | | | | | 50,000 |
| Gains tax | | | | | | (6,613) |
| Working capital | (23,331) | | | | | 23,331 |
| Financing activities | | | | | | |
| Borrowed funds | 62,500 | | | | | |
| Principal repayment | | (10,237) | (11,261) | (12,387) | (13,626) | (14,988) |
| Net cash flow | $ (85,831) | $ 29,158 | $ 33,849 | $ 29,898 | $ 26,903 | $ 89,063 |

## Projects with Negative Taxable Income

- Negative taxable income (on a project) means you can reduce your total taxable income from by the amount of the loss, which results in a tax savings

| | Regular Business | Project | Combined Operation |
|---|---|---|---|
| Taxable income | $100M | (10M) | $90M |
| Income taxes (35%) | $35M | Tax Savings? | $31.5M |

**Tax Savings = $35M - $31.5M**
**= $3.5M**
**Or (10M)(0.35) = -$3.5M**



## Generalized Cash Flow Approach

- When to Use:
  - When undertaking a project does not change a company's marginal tax rate
- Pros
  - The cash flows can be generated more quickly
- Cons
  - The process is less intuitive and not commonly understood by business people

| Cash Flow Elements | End of Period 0 1 2 ... N |
|---|---|
| Investment activities | |
| $-P_n$ | |
| $+S_n - G_n$ | |
| $-W_n$ | |
| Operating activities | |
| $+(1-t_m)(R_n)$ | |
| $-(1-t_m)(E_n)$ | |
| $-(1-t_m)(I_n)$ | |
| $+t_m D_n$ | |
| Financing activities | |
| $+B_n$ | |
| $-PP_n$ | |
| Net cash flow | |
| $A_n$ | |

# Example 12.8

| | | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| **Investing activities** | Investment | $(125,000) | | | | | |
| | Net proceeds from sale | | | | | | $43,387 |
| | Investment in working capital | (23,331) | | | | | |
| | Recovery of working capital | | | | | | 23,331 |
| **Operating activities** | (1 – 0.40) (Revenue) | | $ 60,000 | $ 60,000 | $ 60,000 | $ 60,000 | $ 60,000 |
| | –(1 – 0.40) (Expenses) | | (24,000) | (24,000) | (24,000) | (24,000) | (24,000) |
| | –(1 – 0.40) (Debt interest) | | (3,750) | (3,136) | (2,460) | (1,717) | (899) |
| | +(0.40) (Depreciation) | | 7,145 | 12,245 | 8,745 | 6,245 | 2,232 |
| **Financing activities** | Borrowed funds | 62,500 | | | | | |
| | Principal repayment | | (10,237) | (11,261) | (12,387) | (13,626) | (14,988) |
| | Net cash flow | $ (85,831) | $ 29,158 | $ 33,849 | $ 29,898 | $ 26,903 | $ 89,063 |



# Extra Example 12-1

Certain new machinery when placed in service is estimated to cost $180,000. It is expected to reduce net annual operating expenses by $36,000 per year for 10 years and to have a $30,000 MV at the end of the tenth year. Assume the firm is in the federal taxable income bracket of $335,000 to $10,000,000, and the state income tax rate is 6%. This machinery is in the MACRS five-year property class.

(a) Develop the before-tax and after-tax cash flows.

(b) Calculate the before-tax and after-tax IRR.

(c) Calculate the after-tax PW (*after-tax* MARR = 10% per year).

## Extra Example 12-1

Solution



## Extra Example 12-2

An engineering consulting firm can purchase a fully configured CAD workstation for $20,000. It is estimated that the useful life of the workstation is seven years, and its MV in seven years should be $2,000. Operating expenses are estimated to be $40 per eight-hour workday, and maintenance will be performed under contract for $8,000 per year. The MACRS property class is five years, and the effective income tax rate is 40%.

As an alternative, sufficient computer time can be leased from a service company at an annual cost of $20,000. If the after-tax MARR is 10% per year, how many workdays per year must the workstation be needed in order to justify *leasing* it? (Assume a maximum of 250 workdays per year!!)

# Extra Example 12-2

Solution