

UoG / UESTC Joint School of Engineering

Engineering Project Management & Finance

Engineering Economics: Capex,
Opex, and Total Cost of Ownership
(TCO)

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- Simple company accounts
 - Balance Sheet, P&L (Income) Statement, Cash Flow
- Relevant costs
 - Holiday to Florida
 - Exitel Semiconductor
- ‘Make or Buy’ decisions
 - Comparing internal supplier (insource) with external supplier (outsource)

- Build on these to understand:
 - The differences between Capex and Opex
 - Understanding the Total Cost of Ownership (TCO) of equipment
 - Calculating the TCO for an asset
- This will complete the Engineering Economics Section

There is a key cost not factored into this analysis?

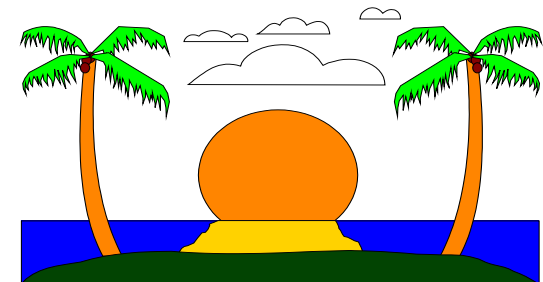
Florida Spring Break Drive/Fly Analysis

Cost	Drive	Fly
Motel	\$ 640	\$ 640
Eating out costs	160	160
Kennel cost	40	40
Car insurance	100	100
Gasoline	200	-
Airfare/rental car	-	500

8 days @ \$80

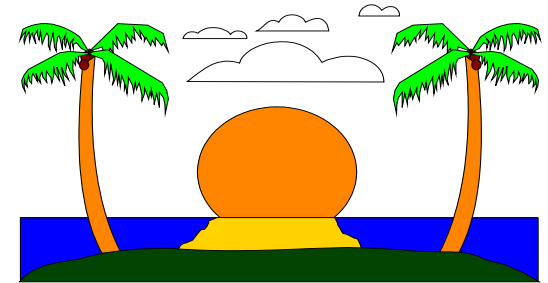
8 days @ \$20

8 days @ \$5



Capital (CapEx) and Operational (Opex) Expenditure

Cost	Drive	Fly
Motel	\$ 640	\$ 640
Eating out costs	160	160
Kennel cost	40	40
Car insurance	100	100
Gasoline	200	-



Car Purchase (\$10,000)		
Monthly Repayments	\$278	\$278

Both these costs
are not relevant
(to fly/drive decision)
But do exist

How do we / should we account for the cost of the car?

Capital Cost: Buying a car

	Year 0	Year 1	Year 2	Year 3	Year 4
Purchase a Car with a bank loan	\$10,000				
Repayments to Bank		\$2500	\$2500	\$2500	\$2500
Balanced owed	\$10000	\$7500	\$5000	\$2500	\$0
Value of car (Depreciation)	\$10000	\$8000	\$6000	\$4000	\$2000
Your net 'wealth' [Value of Asset – the money still owed]	\$0	\$500	\$1000	\$1500	\$2000

So after 4 years you will own a car now worth \$2000 but you will also have had the benefit of using the car.

Note: example does not show interest on the loan. If interest over 4 years was \$2000 your 'Net Wealth' = 0 but you have still had the benefit of the car

How does this apply to a company?

- Remember: a P&L (income) statement shows the business activity over a defined period (month, quarter or year)
- The business records must show a 'True and Fair' view of the company
- Question: *How does a company buy an expensive piece of equipment without show a large loss when it is bought?*
- Answer: The costs of large items are spread over the lifetime of the equipment; e.g. 5 years
 - This type of expense is called 'Capital Expenditure (CapEx)'
 - Every year, the P&L will show 20% of the capital cost

- Capital Expenditures
 - Land and Buildings
 - Vehicles
 - Factory machinery and production equipment
 - Store equipment and furnishings
 - Laboratory equipment
 - Large IT systems (Hardware and/or Software)
 - Buildings
 - Office Furniture and Office Equipment.
- General Rule: Items which have a lifetime of many years are CapEx

Definition

- OpEx (Operational expenditure) refers to expenses incurred in the course of ordinary business, such as sales, general and administrative expenses (BUT excluding Cost of Goods Sold (CoGS), taxes, depreciation and interest).

In other words..

- This is the day-to-day costs of running the business and producing products (power, heat, light, rent, insurance etc) summed up over the period. These are Fixed Costs (i.e you cannot easily allocate them to production units).

Note: Cost of Goods Sold has its own line in the P&L (Income) Statement
[Sales – CoGS = Gross Profit (Margin)]

Where do CapEx and OpEx show in the (Income) Statement ?

National Semiconductor Corporation

TWO-YEAR SELECTED FINANCIAL DATA

(In Millions, Except Per Share Amounts and Employee Figures)



	Years Ended	May 29, 2011	May 30, 2010
OPERATING RESULTS			
Net sales	\$	1,520.4	1,419.4
Cost of sales		482.0	484.2
Gross margin		1,038.4	935.2
Operating expenses		586.8	609.4
Operating income		451.6	325.8
Interest (expense) income, net		(52.5)	(58.5)
Other non-operating (expense) income, net		3.9	1.3
Income before income taxes		403.0	268.6
Income tax expense		104.2	59.4
Net income	\$	298.8	209.2

Includes Insurance

Includes depreciation
and interest on loans
for capital equipment

- CapEx:
 - Purchases of major equipment with a lifetime of more than 1 year. It requires a loan of capital (money) from a 'bank' (either internal or external) to purchase
 - The cost of the capital equipment is spread over the useful life of the equipment (could be 3, 5, 10 years) according to what it is
 - Every year, the P&L will record the depreciation of the equipment as a 'charge' deducted from Earnings / Gross profits
- OpEx:
 - The day-to-day / month-month / year - year running costs of the business making products or delivering services
 - Items essential for the running of the business are OpEx

Question: Do you think Aircraft tyres are CapEx or OpEx?

- A common question in engineering, especially for expensive pieces of capital equipment is:
- *What is the total cost of ownership of that piece of equipment?*
 - Over a period of time (often 1 year)
 - Over the machine's lifetime
- *Reason for this question is:*
 - To understand the cost components of a process*
 - As a pre-cursor to performing a make-or-buy analysis*

- The Obvious Costs:

- Purchase Cost
- Installation Cost
- Labour costs
- Utility Cost (Power etc)
- Consumables Cost (chemicals etc)
- Maintenance
- Calibration Costs
- Repair

- The Less Obvious:

- Pre-Purchase Analysis
- Tendering Process
- Facility preparation
- Building/Floor space
- Training costs
- Process Modification
- Decommission costs
- Removal Costs
- Re-instatement costs
- Disposal costs

What appears to be a simple challenge can be very complex. When using TCO Analysis it must be clearly defined what is required

A Simple TCO Analysis

- Usually TCOs are performed on a critical and/or expensive piece of capital equipment
- To further complicate a TCO calculation, the future costs have to be adjusted for inflation

Example: If we consider a piece of equipment which has a maintenance cost of \$1M per year, How much will maintenance cost over 5 years (without inflation)?

Year 1	Year 2	Year 3	Year 4	Year 5	Total
\$1M	\$1M	\$1M	\$1M	\$1M	\$5M

BUT....

- If there is inflation of 10% in the economy, how do we do our TCO calculations? The value of \$1M in one year's time will be different than it is today...

Answer:

- *We adjust all our figures to be at today's* prices (when you are calculating the TCO)*
- *This is known as calculating the Present Value(PV) of something. [also known as the Present Discounted Value]*

How to calculate Present Value

- Inflation is the ‘erosion’ of money; the money you have to day is worth less in 1 year’s time
- i.e. if you had \$100 today, and inflation is 10%, in one year it would only buy \$90 of goods compared with today (although the price tag would still say \$100)
- Similarly, if a piece of equipment has a maintenance cost of £1M for the next 5 years the cost of future maintenance is lower than today...
- The present value of the maintenance
 - in 1 year is $\$1\text{M}/(1+0.1) = \0.91M
 - In 2 years is $\$1\text{M}/(1+0.1)^2 = \0.83M
 - In 3 years is $\$1\text{M}/(1+0.1)^3 = \$0.75\text{M} \dots$ etc

Calculating a TCO for a new machine

- Calculate the Total cost of ownership over 5 years for a machine. Purchase price is \$10M, maintenance and calibration is \$1M per year, power is \$500K, resale value is \$0M. The life of the machine is 5 years. All costs are fixed, inflation is 10% and should be applied to power only.

A simple TCO Analysis

\$(M) Actuals	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Purchase Price	10						10.0
M & C		1.0	1.0	1.0	1.0	1.0	5.0
Resale						0.0	0.0
Power	0.0	0.50	0.55	0.61	0.67	0.73	3.06
						Total	18.06

Calculating PV at 10% inflation

TCO Analysis	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Purchase Price	10						10
M & C (PV)		0.91	0.84	0.75	0.68	0.62	3.8
Resale(PV)						0.0	0.0
Power	0.0	0.5	0.5	0.5	0.5	0.5	2.5
				Present	Value	Total	16.30

There are many TCO calculators available; they all are based on PV

- This completes our look at Engineering Economics

We have looked at:-

- basic company accounts
- (Balance Sheet, P&L, and Cash flow)
- simple make or buy analysis
- Relevant costs
- short term financial benefit by leasing
- The difference between CapEx and OpEx
- Finally a simple Total Cost of Ownership

You are now the scariest thing to a finance department

.... An engineer who understands (a little) about finance!!