



University of Engineering and
Technology, Peshawar

Engineering Economics

CSE-305

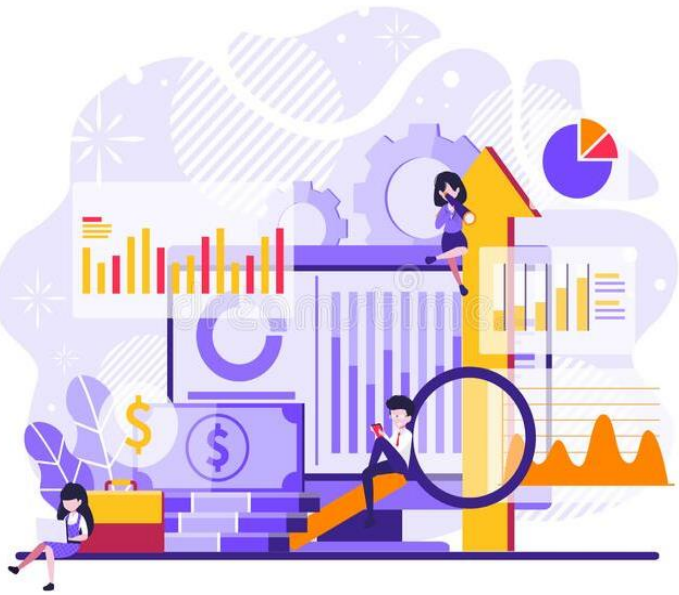
(Chapter 01)



Introduction to Engineering Economics

Dr. Durr-e-Nayab

Email: nayab.khan@uetpeshawar.edu.pk



Agenda

- **Motivation for this Course: Engineering Economics**
- **Applications and Major Domains**
- **Road Map for the Course**
- **Course Material and Distribution**
- **Evaluation Methods and Announcements**
- **Formal Introduction to Engineering Economics**



Goals and Objectives

➤ Goal:

To provide the basic knowledge about the basic concepts of **Engineering Economics** as a Decision-Making Tool to select the suitable alternatives for Engineering Projects.

➤ Instructional Objectives:

On successful completion of this course, the students will attain:

- **Understand** the role of **Engineering Economics Analysis** as a Decision-Making, Management and Planning Tool
- **Gain** knowledge and understanding of theoretical concepts and principles that form the basis of **Engineering Economics** such as Time Value of Money, Simple and Compound Interest, Cash Flows, Minimal Annual Return etc.
- **Identify** and **Apply** various alternative Evaluation Methods that are commonly used in Economic Decision-Making processes faced by Engineers.

Lecture Environment

In an effort to make this course enjoyable for everybody:

- Please **Be On Time!** This will only benefit YOU!
- If you have any queries, **Just Ask** me or write it down!
- **Class participation** is mandatory. Do not just sit to receive.
- Please **Turn Off** your pagers and cell-phones or on silent! If you have any important or expected one, attend it outside the class
- Bring your own book, table, notebook and calculator
- In your written works it is **Unacceptable To Use Someone Else's Work** without reference. Copied assignments, quizzes or other tasks will be tantamount to **cheating** and no grading will be done.
- Your work will **Never Be Re-Evaluated** for rejected/missed assignment.
- **Class Representatives** should collect and submit the assignments, quizzes and requests on behalf of their section in my office once and for all

Evaluations

In an ideal scenario:

- **Quizzes: 6 Quizzes** (3 Before Mid Term Exam and 3 Before Final Term Exam)
- **Assignments: 6 Assignments** based on quizzes (3 Before Mid Term Exam and 3 Before Final Term Exam)
- **Project: Mini project** in the application areas of Engineering Economics
- **Grading Criteria:**

Assignments	10%
Quizzes	20%
Mid Term	20%
Final Examination	50%
TOTAL	100%

Course Material

Text Book:

- **Engineering Economy** by William G. Sullivan, Elin M. Wicks, C. Patrick Koelling, 16th edition, Pearson/Prentice Hall, 2014.
- **Engineering Economy**, by E. Paul DeGarmo, William G. Sullivan, James, 9th edition, 1997.

Reference Books:

1. **Engineering Economics**, by R. Panneerselvam, PHL Learning Pvt. Ltd., Business and Economics, 2012.
2. **Engineering Economics**, by J. K. Yates, CRC Press Textbook, 2016 .
3. **Contemporary Engineering Economics**, by Chan S. Park, 6th Edition, 2016.

Course Outline:

- [Course Outline PDF File](#)

CLO to PLO Mapping:

- [CLO PLO PDF File](#)

Weekly Distribution:

- [Weekly Distribution PDF File](#)

Road Map for EE

Problem Solving

Equivalency, Cash Flows,
Interest Tables,
Investment, Deposit,
Single/Multi Payment(s)
Cash Flows



Implementations

Minimum Attractive Rate
of Return, Single Multiple
Compounding, Cost-
Benefit Ratio



Analyses

Beginning of Year, End of
Year Payments, Sinking
Funds, Capital Recovery,
Deferred Annuities,
Uniform and Gradient
Series



Theory of EE

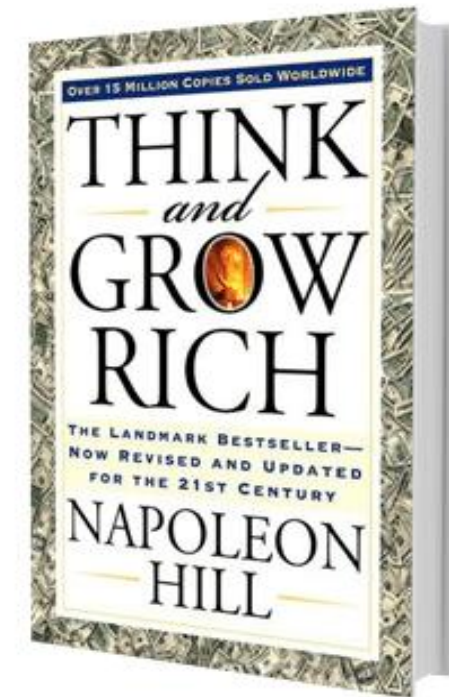
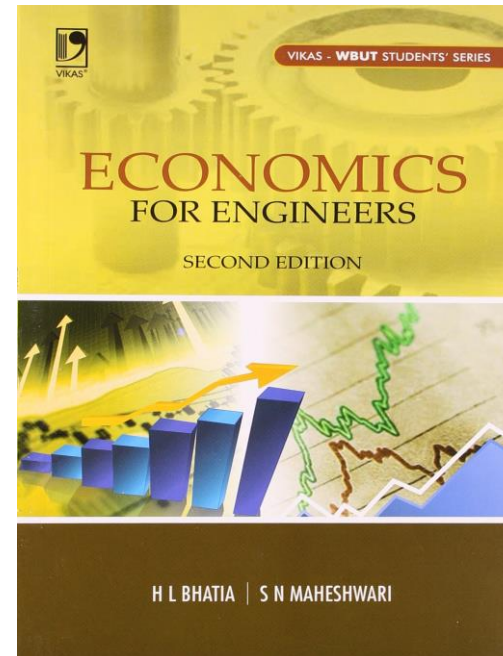
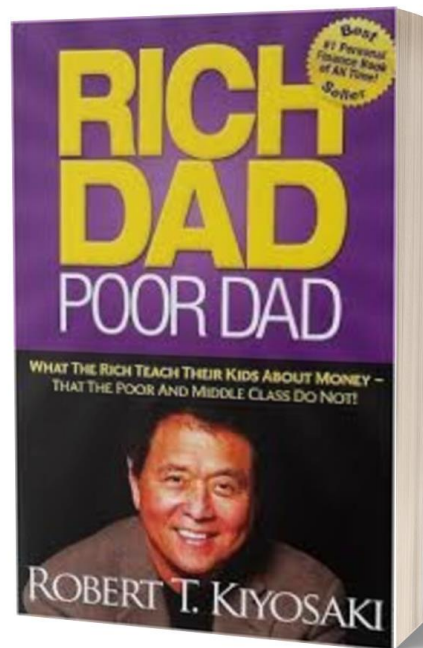
Cost, Volume, Breakeven
Point, Simple Interest,
Compound Interest,
Total Revenue
Function

Introduction

EE Basics, Basic
Terminologies, Cost
Terminologies, Price
Demand Relationship,
Time Money
Relationship



Reading Prescriptions



Introduction to Engineering Economics

- Introduction to Engineering Economics?
- Engineering Economic Decisions
- Engineering Projects & Decisions
- Role of Engineers in Engineering Economics
- Fundamental Principles of Economics
- Time Value of Money
- Cost Estimation



Engineering and Economics

Economics is a **Social Science** concerned with **Production, Distribution and Consumption of Goods and Services**.

Founder: Scottish Philosopher, Adam Smith “**An Enquiry into the Nature and Causes of Wealth in Nations**”, 1776.

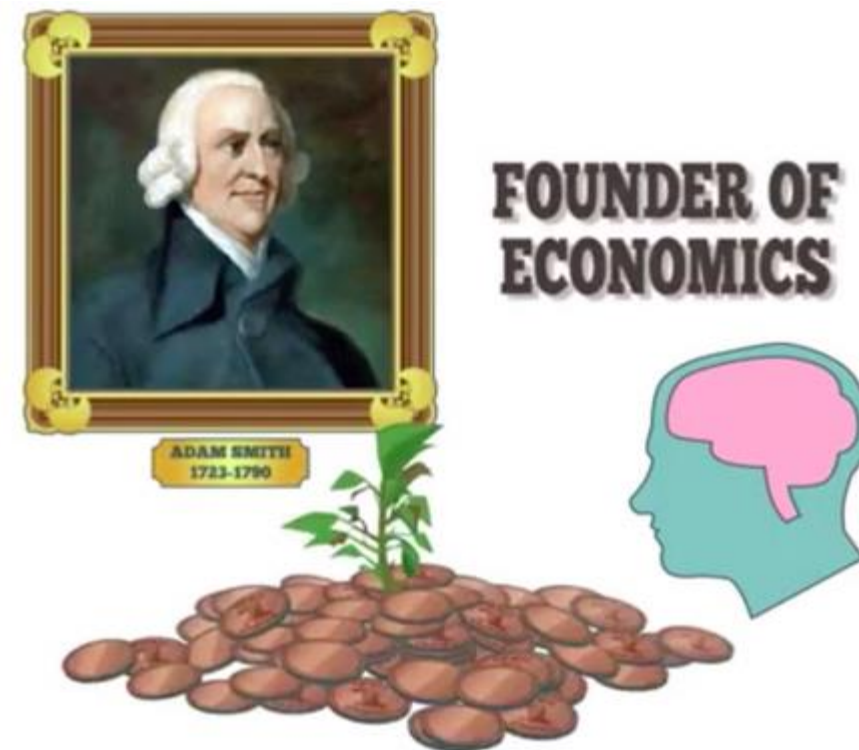
Types:

Micro Economics: Deals with **Individual Economic Units (IEU)**

Examples: Purchasing decisions by individuals, Price Demand Relationship (PDR), wages, utility, pricing etc.

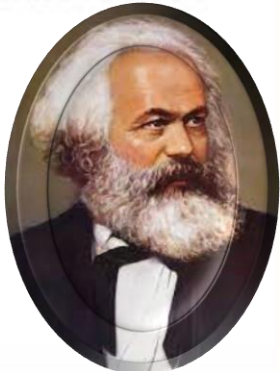


Macro Economics: Deals with **Aggregate Economic Quantities (AEQ)**

Examples: Gross Domestic Product (GDP), Inflation, Deflation, Foreign Trade, Interest Rates, Consumer Price Index etc.



Engineers being builders of the society have big deal with Economics

Types of Economics

COMMUNISM	CAPITALISM	SOCIALISM
No Private Ownership	Total Private Ownership	Limited Private Ownership
Central Government	Market Forces	Government and Private Entities
No Class Distinction	Class Distinction	Limited Class Distinction
Production for Basic Needs	Production for Profit	Production for Societal Needs
Karl Marx 	Adam Smith 	Charles Fourier 

Engineering and Economics

“Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, **Economically**, the materials and forces of nature for the benefits of mankind”

– **Accreditation Board for Engineering and Technology (ABET), USA**

Just being able to build/create things is not enough. Must be able to do it **Economically**

Engineering processes involve **decisions** and **tradeoffs**; each has a different cost, i.e. something you give up (**Opportunity Cost**)

Construct a building: Where and how to build it?

Design a product: What features? When to launch?



Engineering Economics

It involves the **Systematic Evaluation** of the economic merits of proposed solutions to **Engineering Problems**.

It is the **Dollars-and-Cents** side of the decisions that **Engineers** make or recommend as they work to position a firm to be profitable in a highly competitive marketplace.

Its mission is to balance these **Trade-Offs** in the most economical manner and make an **Engineer Economics-Aware** so that their products are **Economically Sound**



Engineering Economics: Problem Analysis

1. Problem definition

2. Problem formulation and evaluation

3. Synthesis of possible solutions (alternatives)

4. Analysis, optimization, and evaluation

5. Specification of preferred alternative

6. Communication via performance monitoring



Engineering Economics: Analysis Process

1

Problem Recognition, Definition, and Evaluation

What is the need? The more concrete the description, the better for further analysis

Evaluation of the problem typically includes refinement of needs and requirements

Information from the evaluation phase may change original problem formulation

2

Develop the Alternatives

What are the possible courses of actions? Screening alternatives to select a smaller group for further analysis



Engineering Economics: Analysis Process

3

Focus on the Differences

Only the differences in the alternatives are relevant to comparisons. If all options are equal, then taking any one of them will do.

4

Use a Consistent Viewpoint

Define and evaluate the alternatives and their outcomes from a fixed perspective, e.g., cost, time, effort.

5

Use a Common Unit of Measure

Make sure we are comparing options on an equal basis, .e.g., not comparing oranges with apples.



Engineering Economics: Analysis Process

6

Consider all Relevant Criteria and Develop Prospective Outcomes

What is the objective? Single or multiple objectives?
Typically measured by cash flow — Do I make money?

Non-monetary factors can also be important (e.g., reputation, customer/employee satisfaction, long-term sustainability, etc.)

However, these could be tricky to measure

7

Making Risk and Uncertainty Explicit

Can be philosophical, e.g., what is risk? Also, what kind of information about the uncertainty do we know? Scenarios? Probabilities?



Engineering Economics: Analysis Process

8

Revisit your Decisions

Things may not turn out as expected

Typically, decisions and outcomes are not in “one-shot”, i.e., they evolve dynamically over time

Factors affecting the outcome may change, and hence the decisions must adapt

Monitoring project performance during its operational phase improves the achievement of related goals

Reduces the variability in desired results



Case Study: Wrecked Your Car

You wreck your car! And you absolutely need one to get around

A wholesaler offers **\$2,000** for the wrecked car, and **\$4,500** if it is repaired

The car's standing mileage is **58,000 miles**

Your insurance company offers **\$1,000** to cover the cost of the accident

To repair the car costs **\$2,000**

A newer second-hand car costs **\$10,000** with a standing mileage of **28,000 miles**

A part-time technician can repair the car for **\$1,100**, but it takes a month. In the meantime, you need to rent a car, which costs **\$400 per month**.

Question: What should you do?



Case Study: Wrecked Your Car

No panic! Apply the Engineering Economic Analysis Procedure.

Step 1: Define the problem

In this case, it is simple — you need a car!

Step 2: Develop alternatives

You have several options.

- (A) Sell the wrecked car and buy the second-hand car. (Of course you would 'not just dispose the wrecked car.)
- (B) Repair the car and keep it.
- (C) Repair the car, sell it, and then buy the second-hand car.
- (D) Let the part-time technician repair the car and rent in the meantime. Afterwards, keep the car.
- (E) Let the part-time technician repair the car and rent in the meantime. Afterwards, sell the car and buy the second-hand car.



Case Study: Wrecked Your Car

No panic! Apply the Engineering Economic Analysis Procedure.

Step 3: Develop Prospective Outcomes via cash flows

(A) Sell the wrecked car and buy the second-hand car. $\$2,000 + \$1,000 - \$10,000 = -\$7,000$

(B) Repair the car and keep it. $\$1,000 - \$2,000 = -\$1,000$

(C) Repair the car, sell it, and then buy the second-hand car. $\$1,000 - \$2,000 + \$4,500 - \$10,000 = -\$6,500$

(D) Let the part-time technician repair the car and rent in the meantime.
Afterwards, keep the car. $\$1,000 - \$1,100 - \$400 = -\500

(E) Let the part-time technician repair the car and rent in the meantime.
Afterwards, sell the car and buy the second-hand car. $\$1,000 - \$1,100 - \$400 + \$4,500 - \$10,000 = -\$6,000$



Case Study: Wrecked Your Car

No panic! Apply the Engineering Economic Analysis Procedure.

Step 4: Use a consistent criterion

Let us just focus on your asset value immediately after the decision is made. (We are ignoring other things, such as higher future insurance costs, resell value of the second-hand car, etc.)

Step 5: Compare the alternatives

- (A) Sell the wrecked car & buy the 2nd-hand car. $\$10,000 - \$7,000 = \$3,000$
- (B) Repair the car and keep it. $\$4,500 - \$1,000 = \$3,500$
- (C) Repair the car, sell it, and then buy the second-hand car. $\$10,000 - \$6,500 = \$3,500$



Case Study: Wrecked Your Car

No panic! Apply the Engineering Economic Analysis Procedure.

(D) Let the part-time technician repair the car and rent in the meantime.

Afterwards, keep the car. $\$4,500 - \$500 = \$4,000$

(E) Let the part-time technician repair the car and rent in the meantime.

Afterwards, sell the car and buy the second-hand car. $\$10,000 - \$6,000 = \$4,000$

Step 6: Choose a preferred alternative after considering risk and uncertainties

From the asset value point-of-view, (D) and (E) are equally good. To differentiate them, we need other criteria. Say, if the repaired car has a higher risk of failing, then we would prefer (E).

Step 7: Revisit the decision

Road test the newer car and confirm your decision.



Engineering Economics Decisions

How crucial is **Decision-Making** in Engineering Economics Environment?

➤ Rational Decision-Making Process

➤ Economic Decisions

➤ Predicting the Future

➤ Role of Engineers in Business

➤ By 1999-2007 Black Berry had highest shares of Mobile Industry

➤ By 2007 it dropped down to 2% and below

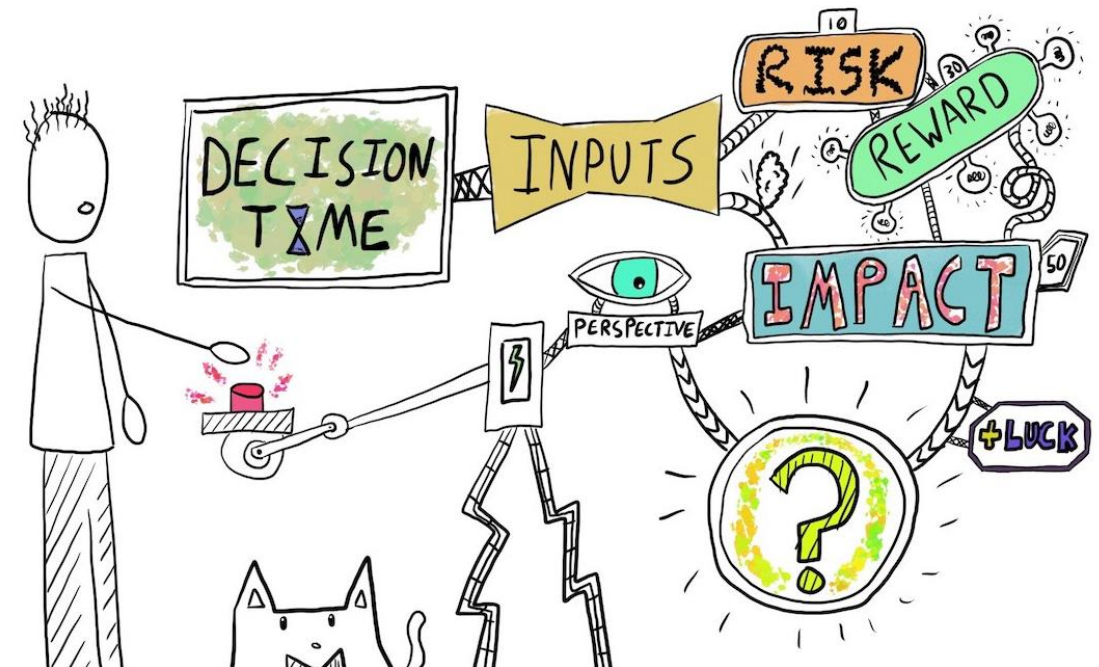
➤ What went wrong? What went wrong with Nokia?



Engineering Economics Decisions

Rational Decision-Making Process

- Recognize a **Decision Problem**
- Define the **Goals or Objectives**
- Collect all the **Relevant Information**
- Identify a set of **Feasible Decision Alternatives**
- Select the **Decision Criterion** to use
- Select the **Best Alternative**



Rational Decision Making: Case Study

Case Study: Which Car to Lease? Saturn vs. Honda

Recognize a Decision Problem



Need a car

Define the Goals or Objectives



Want Mechanical Security

**Collect all the Relevant
Information**



***Gather Technical as well as
Financial data***

**Identify a set of Feasible Decision
Alternatives**



***Choose between Saturn and
Honda***

**Select the Decision Criterion to use
Select the Best Alternative**



***Want minimum Total Cash Outlay
Select Honda***

Rational Decision Making: Case Study

Case Study: Which Car to Lease? Saturn vs. Honda

Decision Criteria: *Minimum Total Cash Outlay*

TABLE 1.1 Financial Data for Auto Leasing: Saturn versus Honda

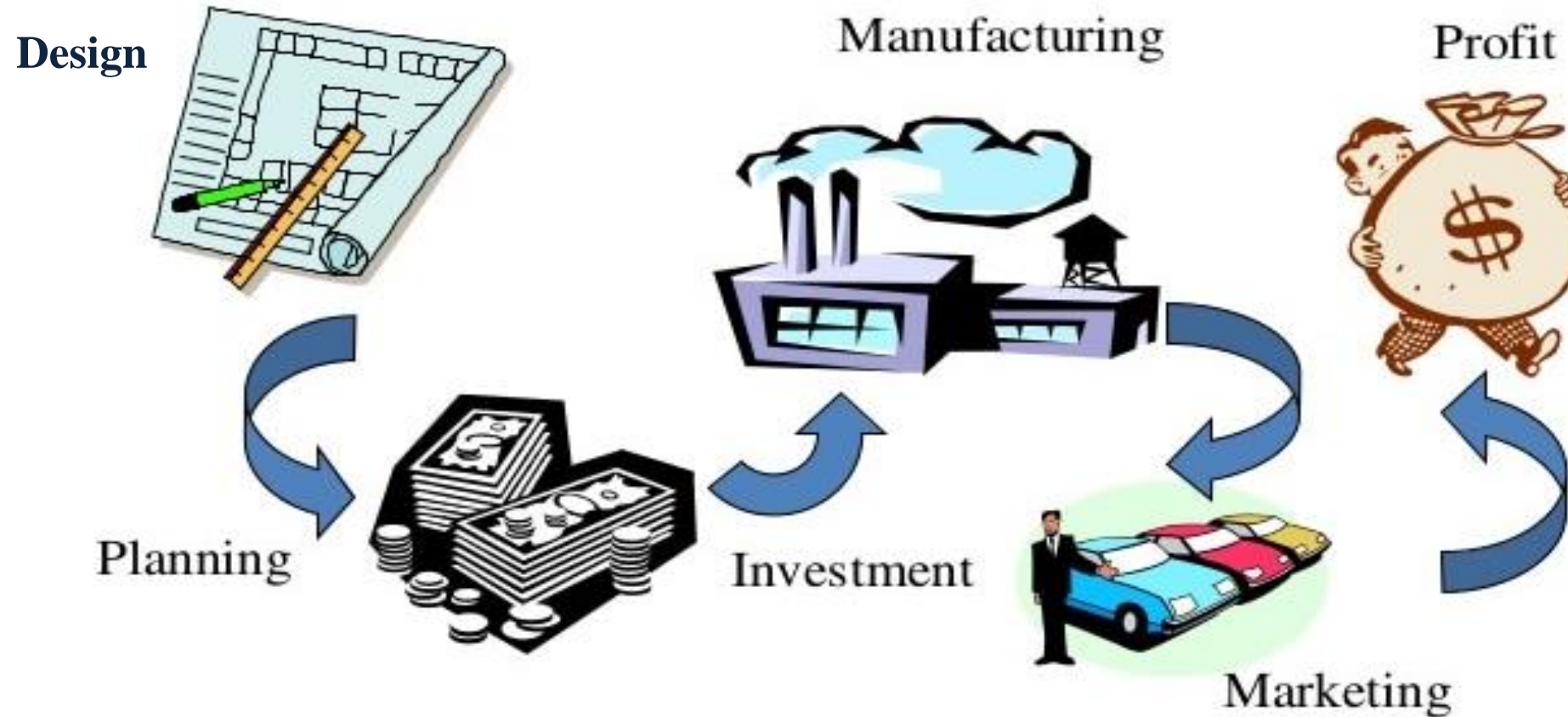
Auto Leasing	Saturn	Honda	Difference Saturn – Honda
1. Manufacturer's suggested retail price (MSRP)	\$15,573	\$15,810	– \$273
2. Lease length	48 months	48 months	
3. Allowed mileage	48,000 miles	48,000 miles	
4. Monthly lease payment	\$219	\$248	– \$29
5. Mileage surcharge over 36,000 miles	\$0.20 per mile	\$0.15 per mile	+\$0.05 per mile
6. Disposition fee at lease end	\$0	\$250	\$250
7. Total due at signing:			
• First month's lease payment	\$219	\$248	
• Down payment	\$1,100	\$800	
• Administrative fee	\$495	\$0	
• Refundable security deposit	<u>\$200</u>	<u>\$225</u>	
Total	\$2,014	\$1,273	+\$741

• Models compared: The 2003 Saturn ION3 with automatic transmission and A/C and the 2003 Honda Civic DX coupe with automatic transmission and A/C.

• Disposition fee: This is a paperwork charge for getting the vehicle ready for resale after the lease end.

Engineering Economics Decisions

Crucial Decision Making Phases



Engineering Economics VS Accounting

Evaluating Past Performance



Past

Evaluating and Predicting Future Events



Future

Present

Engineering Economics Decisions

Key factors in selecting good Engineering Economic Decisions

Objectives



Available Resources



Time



Uncertainty



Engineering Economics Projects

Large Scale Projects

Requires a large sum of investment

Can be very risky

Takes a long time to see the financial outcomes

Difficult to predict the revenue and cost streams

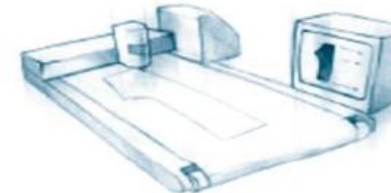
Self Improvement: How many more jeans would Levi need to sell to justify the cost of additional robotic tailors?



A sales clerk measures the customer using instructions from a computer as an aid.



The clerk enters the measurements and adjusts the data based on the customer's reaction to the samples.



The final measurements are relayed to a computerized fabric cutting machine at the factory.



Bar codes are attached to the clothing to track it as it is assembled, washed, and prepared for shipment.

FIGURE 1.6 "From Data to Denim": Making customized blue jeans for women, a new computerized system being installed at some Original Levi's Stores allows women to order customized blue jeans

Engineering Economics Projects

Large Scale Projects

Requires a large sum of investment

Can be very risky

Takes a long time to see the financial outcomes

Difficult to predict the revenue and cost streams

Logistics and Distribution: In Healthcare Delivery is the Traditional plan of visiting the service provider better than innovative plan of service provider visiting the patients?



Engineering Economics Projects

Large Scale Projects

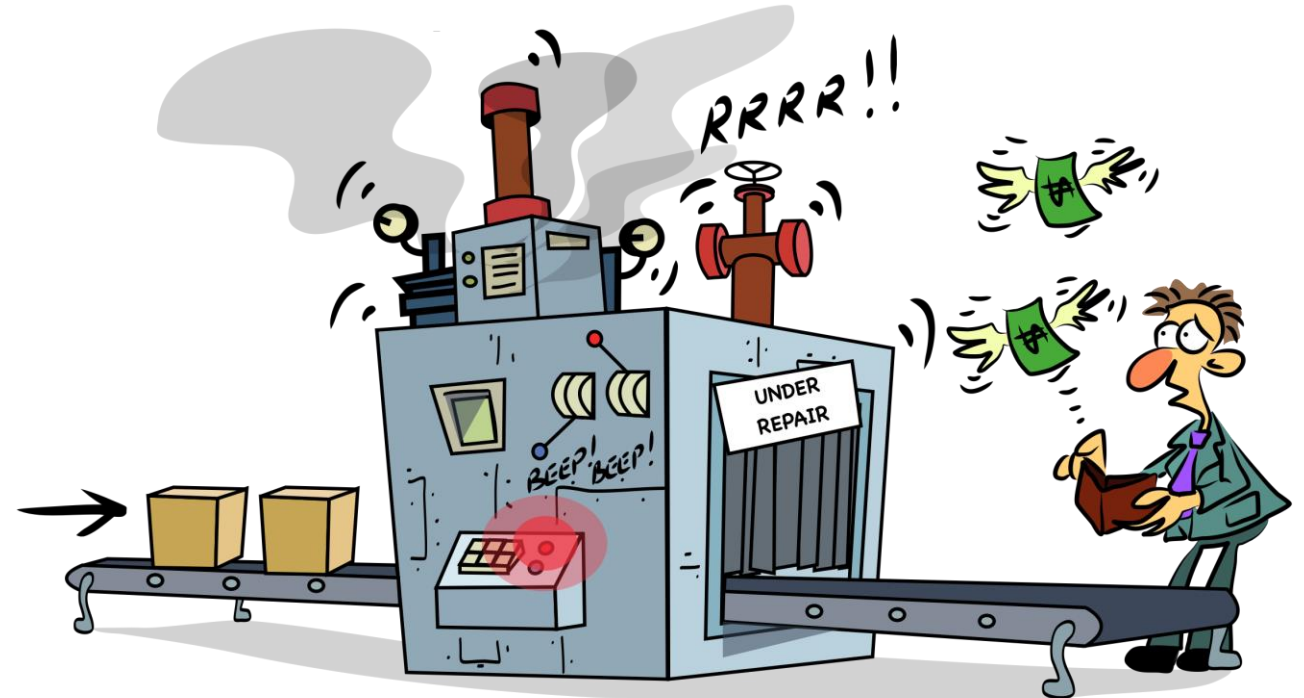
Requires a large sum of investment

Can be very risky

Takes a long time to see the financial outcomes

Difficult to predict the revenue and cost streams

Equipment Replacement and Process Selection: Now is the time to replace the old machine? If not, when is the right time to replace the old equipment?



Engineering Economics Projects

Large Scale Projects

Requires a large sum of investment

Can be very risky

Takes a long time to see the financial outcomes

Difficult to predict the revenue and cost streams

New Product or Product Expansion: Shall we build or acquire a new facility to meet the increased (increasing forecasted) demand? Is it worth spending money to market a new product?



Engineering Economics Projects

Large Scale Projects

Requires a large sum of investment

Can be very risky

Takes a long time to see the financial outcomes

Difficult to predict the revenue and cost streams

Cost Reduction: Should a company buy equipment to perform an operation now done manually? Should spend money now in order to save more money later? The answer obviously depends on a number of factors



Fundament Principles Engineering Economics

The Four Fundamental Principles of Engineering Economics:

Principle 1: An instant dollar is worth more than a distant dollar

Principle 2: Only the relative (pair-wise) difference among the considered alternatives counts

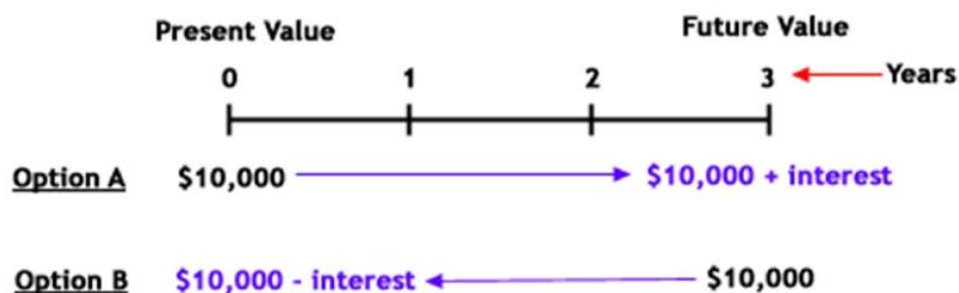
Principle 3: Marginal revenue must exceed marginal cost, in order to carry out a profitable increase of operations

Principle 4: Additional risk is not taken without an expected additional return of suitable magnitude



Principle 1: An Instant Dollar is worth More than a Distant Dollar

Time value of money



Inflation: Purchasing Capacity of Money



Interest: Earning Capacity of Money

Principle 2: Only the Relative (Pair-Wise) difference among the considered Alternatives counts

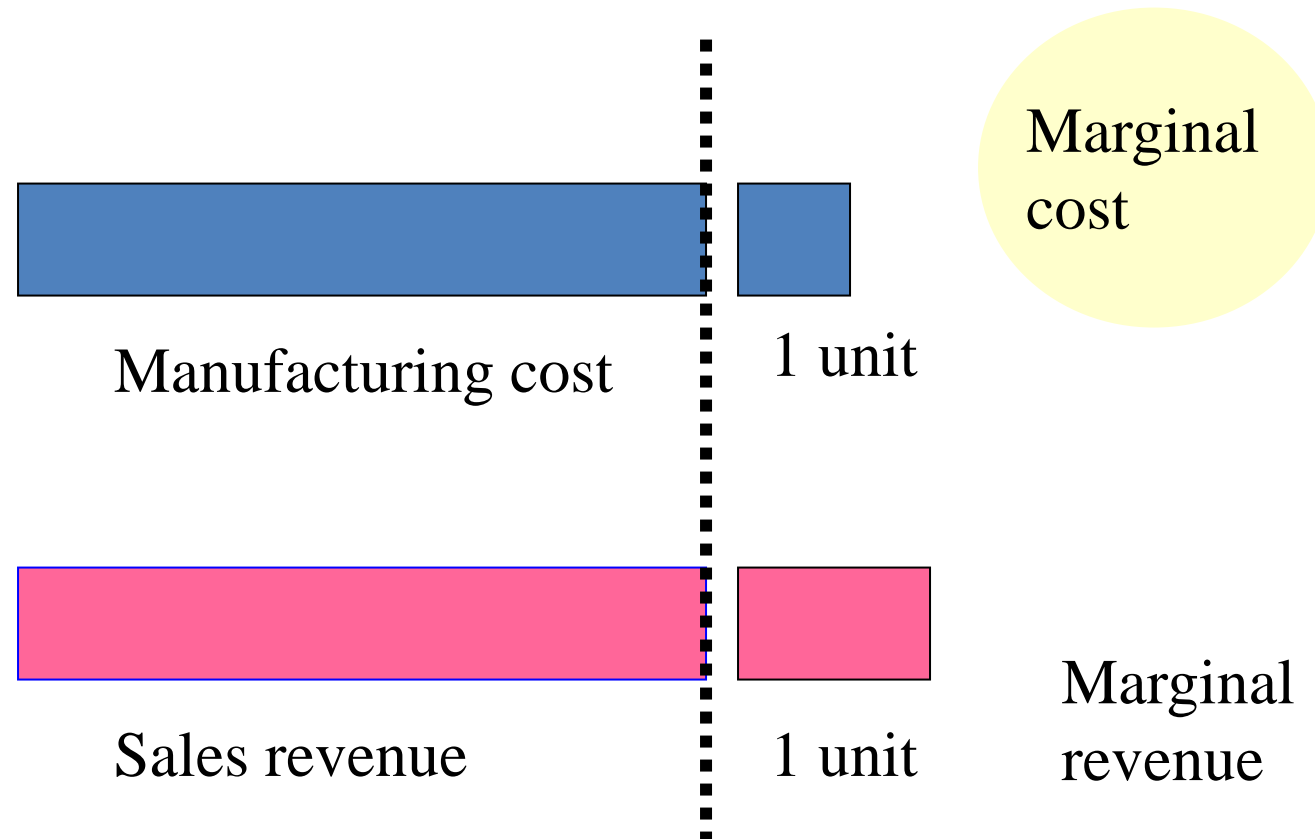
All it counts is the differences among alternatives

Option	Monthly Fuel Cost	Monthly Maintenance	Cash outlay at signing	Monthly payment	Salvage Value at end of year 3
Buy	\$960	\$550	\$6,500	\$350	\$9,000
Lease	\$960	\$550	\$2,400	\$550	0

Irrelevant items in Decision-Making

Principle 3: Marginal Revenue must exceed Marginal Cost

In order to carry out **Profitable** increase of operations



Principle 4: Additional Risk is not taken without the expected Additional Return

The magnitude of **Risk and Return** should be comparable

Investment Class	Potential Risk	Expected Return
Savings account (cash)	Low/None	1.5%
Bond (debt)	Moderate	4.8%
Stock (equity)	High	11.5%

Case Study: Decision Dilemma—Take a Lump Sum or Annual Installments

A couple won a lottery.

They had to choose between a single lump sum \$104 million, or \$198 million paid out over 25 years (or \$7.92 million per year). The winning couple opted for the lump sum.

Did they make the right choice?
What basis do we make such an economic comparison?



OptionA (LumpSum)	OptionB (Installment Plan)
\$104 million	\$7.92M \$7.92M \$7.92M \$7.92M \$7.92M

Which option is better and why?

Time Value of Money

Which option is better and why?

To make such comparisons (the lottery decision problem), we must be able to compare the value of money at different point in time

To do this, we need to develop a method for reducing a sequence of benefits and costs to a single point in time. Then, we will make our comparisons on that basis

Money has a time value because it can earn more money over time (**Earning Power**).

Money has a time value because its purchasing power changes over time (**Inflation**).

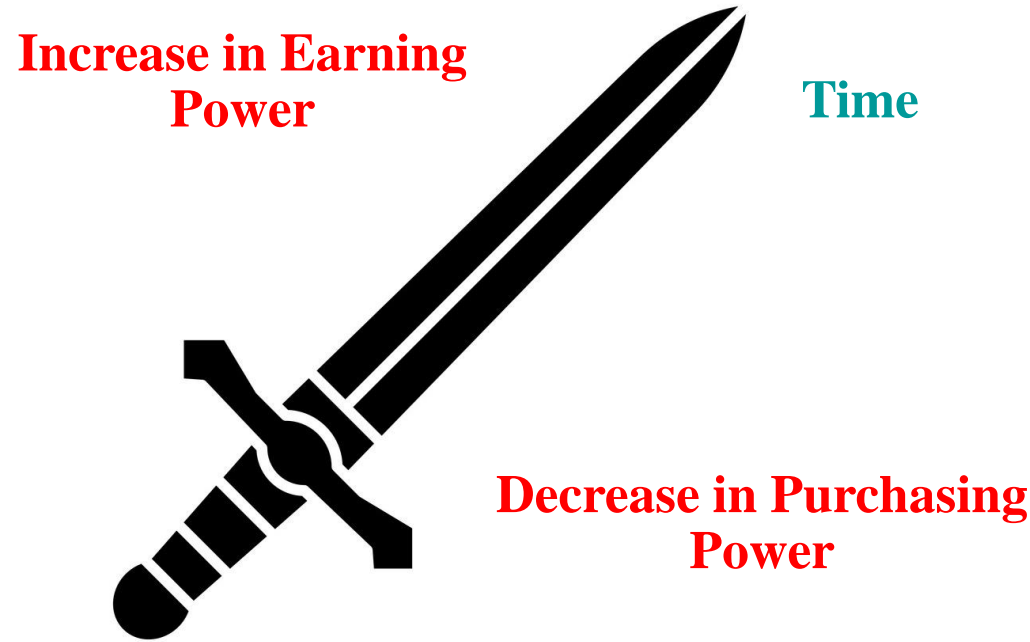
Time value of money is measured in terms of **Interest Rate**.



Interest is the cost of money - a **Cost** to the borrower and an **Earning** to the lender



Time Value of Money

This is a **two-edged sword** whereby earning grows, but purchasing power decreases (due to inflation), as time goes by



	Account Value	Cost of Refrigerator
		
Case 1: Inflation exceeds earning power	$N = 0 \quad \$100$ $N = 1 \quad \$106$ (earning rate = 6%)	$N = 0 \quad \$100$ $N = 1 \quad \$108$ (inflation rate = 8%)
Case 2: Earning power exceeds inflation	$N = 0 \quad \$100$ $N = 1 \quad \$106$ (earning rate = 6%)	$N = 0 \quad \$100$ $N = 1 \quad \$104$ (inflation rate = 4%)

Summary

- **Engineering Economics** deals with taking engineering decisions with economic perspective
- Engineering Economics design process involves (1) **Problem definition**, (2) **Problem formulation and evaluation**, (3) **Synthesis of possible solutions**, (4) **Compare the alternatives**, (5) **Select one alternative**, and (6) **Keep single unit for comparison**
- The term **Engineering Economic Decision** refers to all investment decisions relating to engineering projects
- The five main types of engineering economic decisions are (1) **Service Improvement**, (2) **Equipment and Process Selection**, (3) **Equipment Replacement**, (4) **New Product and Product Expansion**, and (5) **Cost Reduction**.
- The factors of **Time** and **Uncertainty** are the defining aspects of any investment project.