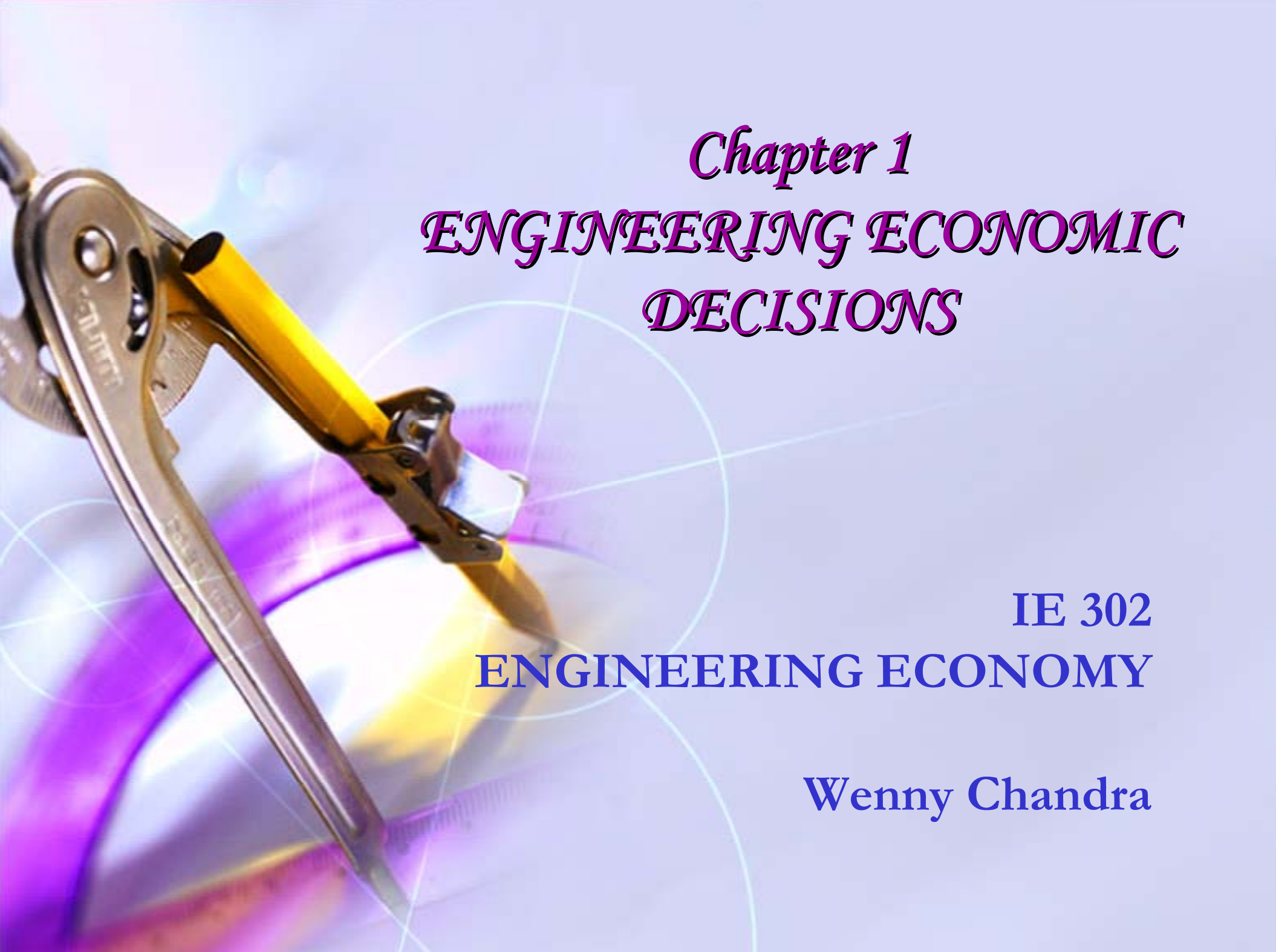


Chapter 1
ENGINEERING ECONOMIC DECISIONS

IE 302
ENGINEERING ECONOMY

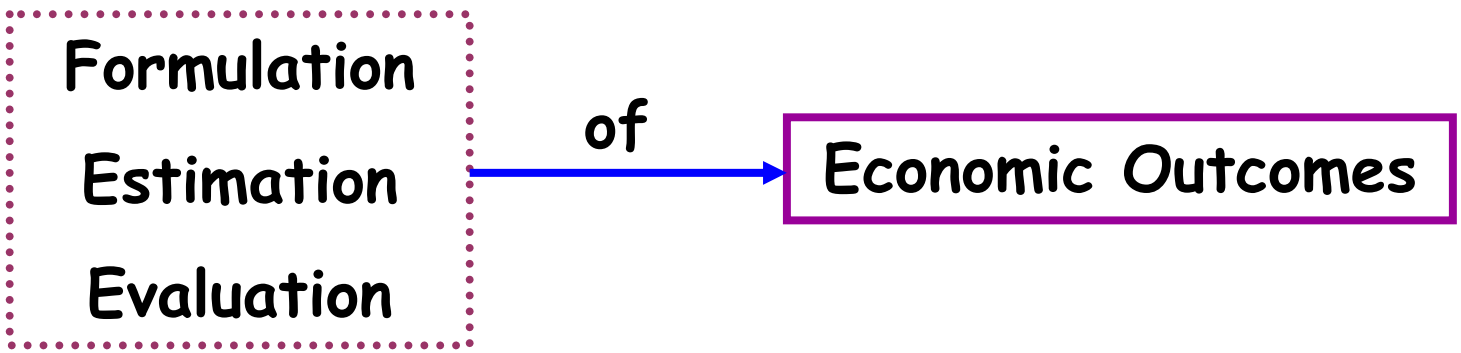
Wenny Chandra

Rational Decision-Making

- Everyone has to make decision
- Very often it involves several alternatives, with monetary consequences corresponding to each alternative
- **GOAL**: maximize the economic outcomes
- **DIFFICULTIES**: alternatives will happen or be implemented in the future → need **best estimates** of what is **expected to occur** and **rationally** decides which alternative is the best

Rational Decision-Making

- **ENGINEERING ECONOMY** provides a **RATIONAL** decision-making
- It involves:



- First, the purpose/goal must be defined and alternatives must be available

Types of Decision-Making

1. Personal Decisions
2. Engineering Activities
3. Public Sector Projects

1. Personal Decisions ~ Examples

- Buy or lease a car?
- Which graduate studies financially worth more over my professional career?
- Is it better to accelerate home mortgage payments, or utilize federal income tax deductions?
- Should I pay off my credit card balance with borrowed money?
- Exactly what rate of return did I make on my stock investment?

1. Personal Decisions ~ Logical Steps

- **Buy or lease a car?**

1) **Recognize a decision problem**
   - ➔ need a car
2) **Define the goals/objectives**
   - ➔ mechanical security and low cost
3) **Collect all relevant information**
   - ➔ technical and financial data
4) **Identify a set of feasible decision alternatives**
   - ➔ choose between Saturn and Honda
5) **Select the decision criterion to use**
   - ➔ minimum total cash outlay to satisfy driving needs
6) **Select the best alternative**

1. Personal Decisions ~ Logical Steps

- **Which graduate studies financially worth more over my professional career?**

1) Recognize a decision problem
   ➔
2) Define the goals/objectives
   ➔
3) Collect all relevant information
   ➔
4) Identify a set of feasible decision alternatives
   ➔
5) Select the decision criterion to use
   ➔
6) Select the best alternative

Types of Decision-Making

1. Personal Decisions
2. Engineering Activities
3. Public Sector Projects

2. Engineering Activities ~ Examples

- Should a new technique be incorporated into manufacture of a product?
- If a computer-vision system replaces the human inspector, will operating costs decrease over a period of 5 years?
- Is it economically wise to upgrade the composite material production center in order to reduce costs by 20%?
- Will the required rate of return achieved if the advanced medical laser manufacturing line is installed?
- Will a break-even be achieved (and in how many years) if this new product if marketed?

Types of Decision-Making

1. Personal Decisions
2. Engineering Activities
3. Public Sector Projects

3. Public Sector Projects ~ Examples

- How much new tax revenue does the city need to generate to pay for an upgrade to the electric distribution system?
- Do the benefits outweigh the costs of a bridge over the intracoastal waterway?
- Should a highway bypass be constructed around a city of 25,000 people, or should the current roadway through the city be expanded?
- Is it cost-effective for the state to cost-share with a contractor to construct a new toll road?
- Should the state university contract with a local community college to teach foundation-level undergraduate courses or have university faculty teach them?

Types of Decision-Making ~ Comparison

1. Personal Decisions
2. Engineering Activities
3. Public Sector Projects

From the various examples shown, it can be seen:

- Engineering activities & public sector projects often involves planning of (large sum) capital expenditure → large scale decision
- For companies, it will impact the financial statement → companies' worth = shares price
- For public sector projects, it's usually not about the earnings of the projects, but also involves quantifying the benefit of the projects to public welfares

Therefore, we need more **STRUCTURED** approach!

Problem-solving Approach

1. Understand the problem and define the objective
2. Collect relevant information
3. Define the feasible alternative solutions and make realistic estimates
4. Identify the criteria for decision making using one or more attributes
5. Evaluate each alternative, using sensitivity analysis to enhance the evaluation
6. Select the best alternative
7. Implement the solution
8. Monitor the results

Engineering Economy Study Approach

Problem identified; objective defined

E.g. Alt. 1: buy new equipment
vs Alt. 2: upgrade old equipment

Description & information

Financing strategies
Income & cost estimates
Tax laws

Cash flows over some time period

Time value of money
Interest rate

Analysis using an engineering economy model

Measure of worth

Choose best alternative

Engineering Economy ~ The Origin

- **Economic consideration as a primary concern and sound techniques to support it started to be developed in the 19th century**
- **1887: Arthur M. Wellington (a civil engineer) addressed the role of economic analysis in railroad building in the U.S.**
- **1930: Eugene L. Grant wrote the first textbook "Principles of Engineering Economy"**

Engineering Economy ~ The Origin

- **Engineering Economy involves systematic evaluation of the economic merits of proposed solutions to engineering problems.**
- **To be economically acceptable, solutions to engineering problems must demonstrate a positive balance of long term benefits over long-term costs**

Engineering Economy ~ The Principles

1. **Develop the alternatives**
2. **Focus on the differences**
3. **Use a consistent viewpoint**
4. **Use a common unit of measure**
5. **Consider all relevant criteria**
6. **Make uncertainty explicit**
7. **Revisit your decisions**

Engineering Economy ~ The Principles

1. Develop the alternatives

- A decision situation involves making a choice among two or more alternatives
- The quality of decision depends on the alternatives defined
- Creativity and innovation are essential to identifying alternatives
- BUT: not every alternatives is feasible
- Doing nothing (making no change to current situation) may be a feasible alternatives

2. Focus on the differences

- All that counts is the differences in the expected future outcomes among alternatives
- If all prospective outcomes of the feasible alternatives were exactly the same, we would be indifferent among the alternatives

3. Use a consistent viewpoint

- The prospective outcomes of the alternatives should be consistently developed from a defined viewpoint (perspective)
- Common viewpoint taken: owners of firm
- Whose viewpoint should be taken for:
  - Benefit packages for employees?
  - Public projects?

4. Use a common unit of measure

- It is desirable to use monetary unit ($) to enumerate the prospective outcomes so that they are commensurable (directly comparable)
- A nearby $ is worth more than a distant $ → time value of money

5. Consider all relevant criteria

- Although it's desirable to translate non-economic criteria into monetary terms, sometimes it's not straightforward
- E.g. loss of goodwill
- If monetary and non-monetary attributes are present, then multiple objective decision-making is necessary (IE 520 Multi-criteria Optimization)

6. Make uncertainty explicit

- The magnitude and the impact of future outcomes of any decision is uncertain
- E.g. inaccurate estimates of expense (production cost) or receipts (sales)
- The further away the future, the more likely the estimates will be off → increased uncertainty/risk
- Additional risk is not taken without the expected additional return

7. Revisit your decisions

- A bad decision-making process sometimes gives a good outcome = GOOD LUCK ☺
- BUT: A sound/rational decision might give a bad outcome ☹ because of wrong estimates
- The implemented decisions need to be routinely post-evaluated to improve future analysis and quality of decision making

Roadmap for this course

Topics covered:

- ✓ **Time Value of Money**
- ✓ **Money Management**
- ✓ **Present Worth Analysis**
- ✓ **Annual Worth Analysis**
- ✓ **Rate of Return Analysis**
- ✓ **Inflation**
- ✓ **Depreciation & Taxes**
- ✓ **Replacement Decisions**
- ✓ **Benefits-Cost Analysis of Public Projects**

References

- Park, Chan S., *Fundamentals of Engineering Economics*, Prentice Hall, 2004.
- Blank, Leland T. and Tarquin, Anthony J., *Engineering Economy*, 6th ed., Mc-Graw Hill, 2005.
- Sullivan, William G., Wicks, Elin M., and Luxhoj, James T., *Engineering Economy*, 12th ed., Prentice Hall, 2003.