# Flexibility week reading and exercise material

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# Objective

The purpose of this material is to develop and illustrate the principles and methodology required to answer the basic economic question of any investment decision: Does its benefits exceed its costs?

# Introduction

- Decision analysis in engineering context:
- Involves the systematic evaluation of the economic merits of proposed solutions to an engineering problem.

# Solutions to engineering problems must

- Permit identification and scrutiny of their estimated outcomes, and
- Translate profitability to the "bottom line" through a valid and acceptable measure of merit.

# Why Engineering Decisions Need Economic Thinking

Engineers don’t just solve technical problems — they must also ensure solutions are **economically viable**.
“Can we afford it?” and “Is it worth it?” are just as important as “Can we build it?”
Common questions engineers face:
•Should we build in-house or outsource?
•Do we automate or hire more people?
•Is the environmental impact worth the added cost?
•Which option gives us the best return over time?

# Engineering economic analysis can play a role in many types of situations

- Choosing the best design for a high-efficiency gas furnace.
- Selecting the most suitable robot for a welding operation on an automotive assembly line.
- Making a recommendation about whether jet airplanes for an overnight delivery service should be purchased or leased.
- Determining the optimal staffing plan for a computer help desk.

# There are seven fundamental principles of engineering economy

- Develop the alternatives
- Focus on the differences
- Use a consistent viewpoint
- Use a common unit of measure
- Consider all relevant criteria
- Make uncertainty explicit
- Revisit your decisions

# Engineering economic analysis procedure

- Problem definition
- Development of alternatives
- Development of prospective outcomes
- Selection of a decision criterion
- Analysis and comparison of alternatives.
- Selection of the preferred alternative.
- Performance monitoring and post evaluation of results.

# Electronic spreadsheets are a powerful addition to the analysis arsenal

- Most engineering economy problems can be formulated and solved using a spreadsheet.
- Large problems can be quickly solved.
- Proper formulation allows key parameters to be changed.
- Graphical output is easily generated.

# Should Jim Sell his Gas-Guzzler?

Jim's 1998 minivan is quite functional, but it only averages 20 miles per gallon (mpg). He has found a somewhat newer vehicle (roughly the same functionality) that averages 26 mpg. He can sell his current minivan for $2800 and purchase the newer vehicle for $4,000. Assume a cost of gasoline $4.00 per gallon How many miles per year must Jim drive if he wants to recover his investment in three years? Assume an interest rate of 6%, zero salvage value for either vehicle after three years, and identical maintenance cost.

# Learning activity

- Try to find solution for the presented problem. It might take 10-25 minutes.

# Gas-Guzzler Solution

Current minivan

$$PW_1 = \$2{,}800 + \left(\frac{x}{20}\right)(\$4.00)(P/A, 6\%, 3)$$

New vehicle

$$PW_2 = \$4{,}000 + \left(\frac{x}{26}\right)(\$4.00)(P/A, 6\%, 3)$$

Equating these, and solving for x, we find

$$x = 9{,}729\ miles / year$$

# What Happens to an investment Profitability When the Estimated Value of Study Factors are Changed

- What if expenses are 10% higher than expected—is the project profitable?
- What if sales revenue is 15% lower than expected?
- What change in either expenses or revenues will cause the project to be unprofitable (decision reversal)?

# Reconsidering Jim's Gas-Guzzler

Considering that Jim drives about 10,000 miles per year, our previous analysis would indicate that he should purchase the vehicle that gets better mileage. However, what if gas prices drop by 10%? Should Jim still sell his gas-guzzling minivan?

$$PW_2 = \$4{,}000 + \left(\frac{x}{26}\right)(\$3.60)(P/A, 6\%, 3)$$

$$PW_2 = \$4{,}000 + \left(\frac{x}{26}\right)(\$3.60)(P/A, 6\%, 3)$$

$$x = 10{,}806\ miles/year$$

So, if gas prices drop by 10%, Jim should keep his minivan.