ENG 3PX3 - Engineering Economics

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Net Value Functions + Design Project Intro

Net Value

Net Value Function and Unit Conversion

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Engineering Economics and Net Value

→Applying economic concepts can help us to make rigorous and quantitative decisions

→Engineering economics aims to determine the ***Net Value*** of a project/design/decision

→Net value [of doing a project compared to not doing it] is:

$$Net\ Value = [Value\ of\ the\ Project's\ Benefits\ ] - [Cost\ of\ Producing\ the\ Project]$$

→In simple terms:

$$Net\ Value = Benefits - Costs$$

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Engineering Economics and Net Value

→**It's important to be clear:**

- What the net value is *relative to* (e.g., relative to another option, to doing nothing, etc.)
- *Whose* net value we're considering (e.g., from who's perspective?.):

→**Net value may be calculated differently depending on the perspective:**

$$Client's\ Net\ Value = (Benefits - Costs)_{Client} = Benefits_{Client} - Sale\ Price$$

$$Producer's\ Net\ Value = (Benefits - Costs)_{Producer} = Sale\ Price - Cost_{Producer}$$

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Engineering Economics and Net Value

→Both the producer and client are happy if:

$$Benefits_{client} > Sale\ Price > Cost_{producer}$$

→Therefore, there's the most room to be happy if the *system* net value is maximized:

$$System\ Net\ Value = Benefits_{client} - Cost_{producer}$$

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Accounting Example: Speedboats

→A company makes and sells speedboats. The company's profit function may look something like this, depending on who performed the analysis:

$$Profit = Revenues - Costs$$

$$Profit = Sales\ Revenue - Labour\ Costs - Materials\ Costs - Factory\ Production\ Costs$$

(Notice that this is a *profit* function as this is an *accounting* example, not quite Net Value)

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Accounting Example: Speedboats

→Based on the given information alone, we would choose alternative C as it has the maximum profit

→But what else should we consider?

- What if Option C is *riskier* than the other two?
- What if Option C has a greater *polluting impact* than A or B?
- What if Option C creates *social inequities*?

	Alterative A	Alterative B	Alterative C
Sales Revenue	$1,000,000	$2,000,000	$5,000,000
Labour Costs	$500,000	$1,200,000	$3,000,000
Materials Costs	$200,000	$400,000	$1,000,000
Factory Prod. Costs	$100,000	$300,000	$500,000
Profit	**$200,000**	**$100,000**	**$500,000**

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Accounting Example: Speedboats

→This table is *accounting*; Revenue in, costs out.

→*Economics* has broader scope and incorporates values of non-financial aspects

→Economics gives you tools to make *quantitative* comparisons between alternatives that consider these additional factors

Net Value Functions

→**We combine all factors into a single expression called a *Net Value Function* (*NVF*)**

→**For example:**

$$NVF = Benefit\ of\ solution - Cost\ of\ space - Cost\ of\ time - Cost\ of\ labour - \ldots$$

→**Throughout this course, we will learn how to integrate factors into a NVF to fully encapsulate the given scenario. This includes concepts such as:**

- Cost of Space
- Cost of Time
- Environmental Impacts
- Ethical Considerations
- Time Value of Money

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Net Value Functions

→**When developing a net value function, you will need information such as:**

- Estimates & assumptions (more used in 3PX3)
- Answers from the client & research (more used in reality)
- Engineering technical analysis (e.g., determining how heat transfer relates to flow rate).

→**Example: Client: "I hate cleaning my blender after blending tomatoes. Can you engineer me a solution to that?"**

- Need more info!
- How long does it take you?
- How much do you hate it compared spending money and/or time doing "neutral" things?
- What's the cost to you of having someone else there? …

Unit Matching and Unit Conversion

→**When developing a net value function, every item may not be in the same unit**

- E.g. time vs money, “intangible” benefits, comfort, entertainment value, convenience etc.

→**We need to “match” or “convert” these units to a common unit so that we can compare each item**

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Unit Matching and Unit Conversion

→**Example: Someone offers you 5 apples for 3 oranges, should you take the 5 apples?**

$$Net\ Value = Benefits - Costs = 5\ \text{apples} - 3\ \text{oranges} = ???$$

→**Converting apples and oranges to the same unit ($)**

- Price of apples = $3.89/kg. Mass of apples = 100 g each → $0.389/apple
- Price of oranges = $1.75/lb. Weight or orange = 8 oz each → $0.875/orange

$$Net\ Value = Benefits - Costs = 5\ \text{apples} - 3\ \text{oranges} = \$1.945 - \$2.625 = -\$0.68$$

NO!

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Unit Matching and Unit Conversion

→But is that the whole story? Not really

1. The benefits to you are not necessarily equal to the price
2. We are omitting the cost of time in our net value (i.e., time out of your day to go shopping)
3. Quantity-dependent value - you may find less benefit in increasing the number of apples you have from 98 to 99 than when you increased it from 0 to 1 (i.e., the "**marginal value**" you get from your 99^{th} apple is less than from your 1^{st} apple).

→We will explore this concept as well as net value functions and their applications further in the next lecture!

Design Project

Course Project - Winter Semester, 2024

Design Project in 3PX3

→Throughout this semester, you will be working in a team to assess the economic viability of a hypothetical engineering project that you develop

→Unlike previous Design Projects, you will consider large scale economic impacts and ways to optimize your design choices to improve feasibility

→In your Design Studio groups, you will apply the engineering economics tools from lectures in this simulated engineering design project

Project Management Expectations in 3PX3

→You'll need project management skills and techniques for the entire design project

→As a team you are required to:

- Track your progress (on the course) with a Gantt chart
- Organize and document all meetings, including design choices and assumptions
- Split roles and responsibilities equally amongst team members

→For your [hypothetical] design, you are required to:

- Create a WBS for the tasks needed to bring the product/service to market
- Detail design lifecycles and required resources

Design Project in 3PX3

→Group of 4 (with a minimum of 2 different engineering streams) will choose a specific problem to address through a designed solution and economic analysis

→Mark breakdown:

Design Project Component	Weight
Progress Check-Ins/Participation	**9%**
Simple Report	**18%**
Draft	4%
Final	10%
Interview	4%
Complex Report	**28%**
Draft	5%
Final	15%
Interview	8%
Design Project Self-Reflections	**5%**
Inter-Group Discussions	2%
Self-Reflection	3%

Design Project in 3PX3 – Important Dates

Week	Submission	Date
2	Enroll in groups	Night of DS
3	Progress Check-In	During DS
4	Progress Check-In	During DS
5	Progress Check-In, Draft of Simple Report due	Night of DS
6	Inter-group Discussions	During DS
7	Reading week	
8	Progress Check-In, Simple Report due	During DS, Night of DS
9	Team interviews	During DS
10	Progress Check-In, Draft of Complex Report due	During DS, Night of DS
11	Inter-group Discussions	During DS
12	Progress Check-In, Complex Report due, Self-Reflection Due	During DS, night of DS, one day after DS
13	Team final interviews	During DS

Lecture 1 – Participation Quiz

Lecture Participation Quizzes

Participation Quizzes Instructions

→**The template for all in-class participations quizzes is on Avenue → Content → 4-Resources → 3PX3 Quiz Template**

→**Each quiz consists of the following sections:**

1. In-class
2. (Optional) Before the next class
3. Reflection
4. Score

→**The template contains detailed instructions. Submit the quiz during the In-class time to the Lecture Participation Quizzes dropbox under Assignments. If you do not finish all required sections during lecture, include these sections in your *next* quiz submission.**

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