MEMORIAL UNIVERSITY

COURSE

ENGI -8700
CIVIL
Design Project

CAPSTONE

INSTRUCTOR

Dr. Steve Bruneau
EN.4013
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TOPIC

Lecture 1: Introduction, Design Method Summary, Design steps 1,2, logbook keeping

REFERENCES.

FILES

WEB

http://www.engr.mun.ca/~sbruneau/teaching/8700project

Engi. 8700 Senior Civil Design Project

Lecture Series Summary

As seen from above . . .

Purpose: To provide immediately practical guidance for the professional execution of the design project for 8700.

Method: One lecture per week with topics timed according to the approximate project phase. Total of 8 core lectures with 2 optional.

Topics:

1. Summary of the engineering design method, design steps 1 and 2, and record keeping - as required in 8700.
2. General project management . Teamwork, skills and tools.
3. MS Project guidelines for use in 8700.
4. Design steps 3 and 4 plus writing a project plan and project report .
5. Design steps 5 and 6 plus presenting and public speaking.
6. Life Cycle analysis and sustainability.
7. Probabilistic methods for cost estimating and load prediction.
8. Business, ethics, professional use of seal.

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Engi. 8700 Senior Civil Design Project - Lecture 1

Getting started . . .

Logbook:

An engineering logbook is a personal/professional reference about project learning and results.

To protect intellectual property in the workplace, it should be bound so that pages cannot be inserted/removed, written in ink (preferred but not required within context of this course), dated, and fill consecutive pages.

Logbook Rationale:

High performing individuals in all professions are similar to the extent that they monitor and control where they invest their time, they learn and apply the best practices of their profession, and they record value added activities that are likely to be reused/refined in the future.

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Logbook Procedures:

- Date each page. Start each day on a new page.
- Use descriptive headings; record in a table of contents (reserve 3-4 pages at start).
- Do not erase. Delete an entry by neatly drawing a single line through it.
- Do not remove pages, and do not skip pages.
- Avoid backfilling. If you realize later that you left something out, or just want to summarize something, go ahead and write it in, noting that it's after-the-fact.
- Use descriptive entry headings and dates in a standard page location.
- Record all personal communications related to project.
- Include and describe sketches, drawings, and photographs. Comment on these.
- Maintain list of weekly action items and check-off completion.
- Prominently display team contact information and roles.
- Keep a timeline of key project deliverables and due dates.
- Explain and analyze design ideas you are working on.
- Document methods and test procedures.
- Sign and witness often.

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Logbook procedures continued

Include *everything you contribute to … good, bad, and ugly.*

- Sketches/doodling
- Meeting notes
- Work-in-progress
- Sources of ideas
- Design process
- Customer needs/requirements
- Action Items
- Design alternatives
- Evaluation of data/results
- Rationale for decisions
- Class notes
- Half-baked Ideas
- Vendor notes
- Design reviews
- Project reflections
- Project objectives
- Calculations
- Research findings
- Decision criteria
- Professional development

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Engineering Design Method SUMMARY

In engineering a ***design*** is a description of a new or improved device or system.

A design is motivated by a ***client*** who has objectives, is procured for a ***user*** who has needs, and is carried out by a ***designer*** who specifies a solution; often in a situation or system that is poorly defined.

Design problems are often ***open-ended*** without any single “correct” solution and in some cases, no solution at all.

Design is often performed by a ***design team*** that works most effectively when the special capabilities of individuals are realized within a supportive and positive environment; made possible by adherence to the general principles of communication clarity, respect and agreement on common goals, rules and procedures.

The ***design process*** is defined, described and illustrated in countless ways, but the core activities are always the same:

1.Definition	re-frame problem, ID needs, objectives, constraints
2.Generation	designer generates or creates various design concepts
3.Selection	designer selects the optimal design solution
4.Evaluation	designer tests or models the chosen design
5.Refinement	designer creates detailed design for implementation
6.Communication	designer communicates final design to client/users

Engineering Design Summary

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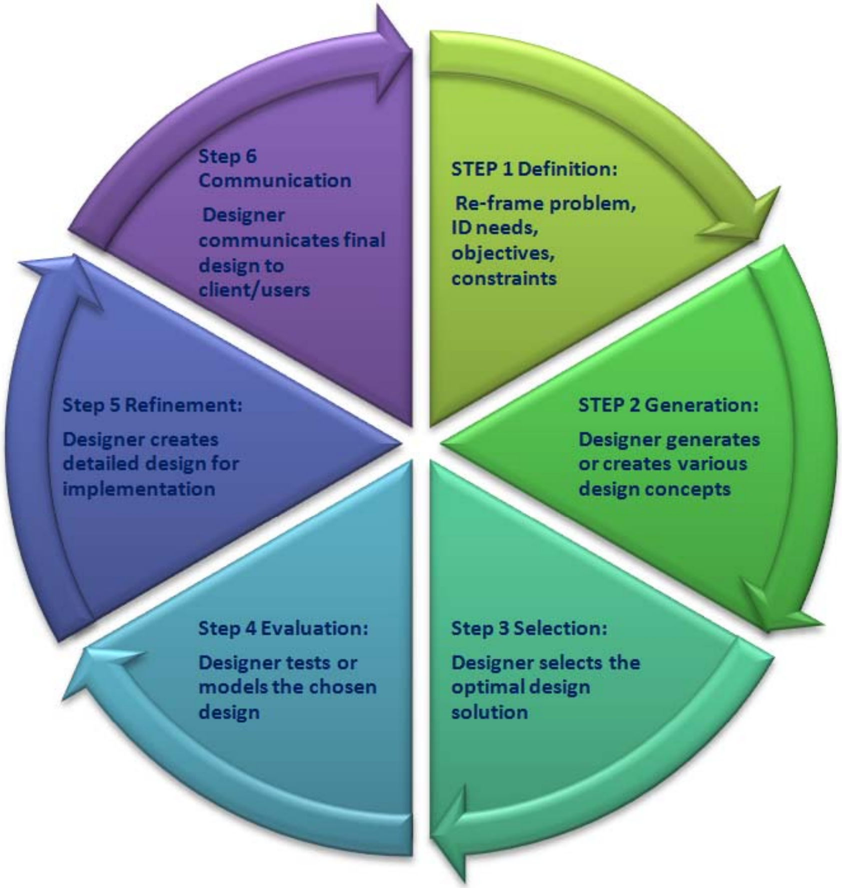

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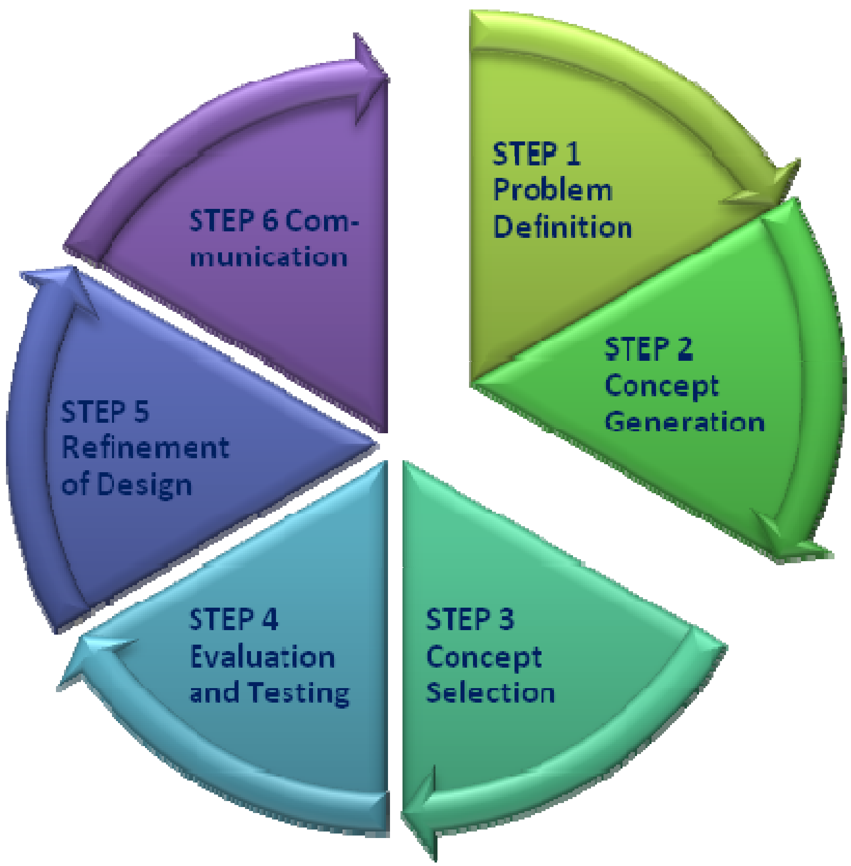
Engineering Design Method

In this lecture we will consider the first two slices of the design cycle pie as shown:

1. Definition — re-frame problem, ID needs, objectives, constraints
2. Generation — designer generates or creates various design concepts



Further explanation of each . . .

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Chapters 6, 7, 8, 11

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Problem Definition

The design process starts with the recognition of a need that can potentially be satisfied using technology. Thus a **NEEDS ASSESSMENT** is one of the first steps in understanding the problem at hand. Needs arise for a variety of reasons including:

- The necessity to make a product better or more profitable is a need
- The establishment of a new product line to satisfy customers is a need
- Protection of public health and safety is a need
- An invention that is unexpected and is to be commercialized
- An opportunity created by new technology, materials and scientific advances
- A change in rules and regulations.

The outcome of a needs assessment is a list of needs or requirements that then become a part of the problem definition.

Once needs are established a careful **PROBLEM STATEMENT** is written. The statement should not pre-suppose a solution – just tries to capture the following three components:

1 – an undesirable initial state

2 – a desired goal state

3 – obstacles that prevent going from the initial state to the final state

"Design a better lawn mower" - presupposes that the solution involves a lawn mower.
"Design an effective means of maintaining lawns" – leaves many more options open.

Leake and Borgerson, Wiley Press

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Problem Definition

Sprinkled throughout the Problem Definition Phase is **BACKGROUND RESEARCH**. This work is done to obtain a better understanding of the problem. Information is sought on *the target user, the operating environment, additional constraints, prior design solutions*, etc.

Common questions one tries to answer with research are:

- What must the design do,
- What has been written on the topic
- What features or attributes should the solution have,
- Is something already on the market that may solve the problem,
- What is right or wrong with how it is being done, who markets the current solution, how much does it cost, how can it be improved upon, will people pay for a better one if it costs more.

Research sources include existing solutions, the library, the internet, trade journals, government documents. Professional organizations, vendor catalogues, experts in the field.

Reverse Engineering is the process of physically disassembling an existing product to learn how each component contributes to the overall product performance (often used to gain insight into competitor's design solutions).

Leake and Borgerson, Wiley Press

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Problem Definition

n. pl. cri·te·ri·a (-tîr -) or cri·te·ri·ons. A standard, rule, or test on which a judgment or decision can be based.

Next step in the design process is to list the **DESIGN CRITERIA**. Design criteria are the desirable characteristics of the solution. Crieria are used at a later stage to judge alternative design solutions. Criteria applicable to virtually all design problems include: *cost, safety, environmental protection, public acceptance, reliability, performance, ease of operation, ease of maintenance, use of standard components, appearance, compatibility, durability*. Specific to certain design problems may be: weight, size, shape, power, noise level, physical requirements for use, reaction time for operation etc.

DESIGN CONSTRAINTS are quantitative boundaries associated with each design objective - they establish maximum, minimum or permissible ranges. A feasible design solution MUST satisfy all of the design constraints. Design constraints categories include:

1. Physical (space, weight, material)
2. Functional or operational
3. Environmental
4. Economic
5. Legal and regulatory
6. Ergonomic/human factors

Leake and Borgerson, Wiley Press

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Generation of Alternative Solutions

The next step is to systematically generate as many alternative product solutions as possible for subsequent analysis, evaluation and selection. **BRAINSTORMING** is the most common technique. The objective of brainstorming is develop as many ideas as possible in a limited amount of time. Emphasis is on quantity rather than quality. Free expression is essential, ideas can be evaluated later. Sometimes impractical ideas can inspire more viable ideas. To ensure a robust design, multiple concept alternatives need to be generated. **ASSUMPTION SMASHING** is also a means of generating ideas by challenging established assumptions and practices.

A morphological chart or **MORPH CHART** is a useful mechanism for expanding the number of concepts. It is a table that lists all the primary and secondary functional requirements versus the various means and alternative ways of achieving these functions – in no particular order. The stringing together of various combined functional options can result in a vast array of solution alternatives – many impractical but some enlightening.

Example: Mobile phone concepts

Function	Options				
Holding	Stopwatch style	Calculator style	Not held		
Storage	Pin badge	On sleeve	On belt	In pocket	Dispersed
Entering number	Keypad	Voice	Bar code		
Display	LED	LCD	None		
Power supply	Mains only	Battery	Solar	Mains	
Signal reception	Internal aerial	External aerial	Cable aerial		
Sound output	Speaker	Earphone			
Sound input	Internal microphone	External microphone			

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Next Lecture

General project management .
Teamwork, skills and tools.
MS Project guidelines for use in 8700.