INTRODUCTION TO ENGINEERING DESIGN

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ENGINEERING DESIGN OBJECTIVES and PREREQUISITE SKILLS

OBJECTIVES

After module, students should be able to:

1. **Describe the design process**
2. **Develop time schedules**
3. **Perform preliminary design steps**

PREREQUISITE SKILLS
TEAMING

REASONS FOR TEACHING DESIGN

- **Develop the intellectual abilities of students**
- **Develop design skills of individual students**
- **Satisfy the needs of employers**
- **Meet accreditation requirements**

REASONS FOR TEACHING DESIGN

- **Design is a skill that can be learned.**
- **All that is required is practice.**

ABET DEFINITION ENGINEERING DESIGN

Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective.

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (c)

ABET DEFINITION ENGINEERING DESIGN

Among the fundamental elements of the design process are the

- **establishment of objectives and criteria,**
- **synthesis,**
- **analysis,**
- **construction,**
- **testing,**
- **and evaluation.**

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (c)

ABET DEFINITION ENGINEERING DESIGN

The engineering design component of a curriculum must include most of the following features:

- **development of student creativity,**
- **use of open-ended problems,**
- **development and use of modern design theory and methodology,**
- **formulation of design problem statements and specifications,**
- **consideration of alternative solutions,**

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (c)

ABET DEFINITION ENGINEERING DESIGN

The engineering design component of a curriculum must include most of the following features(continued):

- **feasibility considerations,**
- **production processes,**
- **concurrent engineering**
- **design,**
- **and detailed system descriptions.**

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering topics (c)

ABET DEFINITION ENGINEERING DESIGN

Further, it is essential to include a variety of realistic constraints, such as

- **economic factors,**
- **safety,**
- **reliability,**
- **aesthetics,**
- **ethics,**
- **and social impact.**

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering topics (c)

ABET DEFINITION ENGINEERING DESIGN

- **Each educational program must include a meaningful, major engineering design experience that builds upon the fundamental concepts of**
  - » **mathematics,**
  - » **basic sciences,**
  - » **the humanities and social sciences,**
  - » **engineering topics,**
  - » **and communication skills.**

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (d)

ABET DEFINITION ENGINEERING DESIGN

- **The scope of the design experience within a program should match the requirements of practice within that discipline.**

- **The major design experience should be taught in section sizes that are small enough to allow interaction between teacher and student.**

- **This does not imply that all design work must be done in isolation by individual students; team efforts are encouraged where appropriate.**

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (d)

ABET DEFINITION ENGINEERING DESIGN

- **Design cannot be taught in one course; it is an experience that must grow with the student's development.**

- **A meaningful, major design experience means that, at some point when the student's academic development is nearly complete, there should be a design experience that both focuses the student's attention on professional practice and is drawn from past course work.**

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (d)

ABET DEFINITION ENGINEERING DESIGN

- Inevitably, this means a course, or a project, or a thesis that focuses upon design.

- "Meaningful" implies that the design experience is significant within the student's major and that it draws upon previous course work, but not necessarily upon every course taken by the student.

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (d)

ABET DEFINITION ENGINEERING DESIGN

- The public, from catalog statements and other advising documents,
- ABET, from the self-study questionnaire,
- should be able to discern
  - » the goals of a program and
  - » the logic of the selection of the engineering topics in the program.

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (e)

ABET DEFINITION ENGINEERING DESIGN

In particular, the institution

- must describe how the design experience is
  - » developed and
  - » integrated throughout the curriculum,
- show that it is consistent with the objectives of the program and
- identify the major, meaningful design experiences in the curriculum.

from EC 2000-2001 Criteria for Accrediting Engineering Programs, Section I.C.3.d.(3) Engineering Topics (e)

ENGINEERING DESIGN

Take five minutes and divide up into teams of two or three

ENGINEERING DESIGN IN CLASS ACTIVITY

- In your teams
- Take 10 minutes
- Write a 10 step design strategy
- Be prepared to give your results to the class

10 STEP DESIGN STRATEGY

1. Identify need
2. Define problem
3. Search
4. Constraints
5. Criteria
6. Alternatives
7. Analysis
8. Decision
9. Specifications
10. Communication

from *Introduction to Engineering Design*

DESIGN EXERCISE
ACTIVITY TIME SCHEDULE
(ASSIGNMENT ONE)

- **PROBLEM**
  - » **Develop a "sample" activity time schedule**
- **EXERCISE**
  - » **Work with team to develop a schedule**
    - –**How would you attack this problem ?**
    - –**Limits must be placed on the time for each step**
  - » **Prepare one transparency with your schedule**
  - » **Be prepared to present to class at next meeting**

ENGINEERING DESIGN

END CLASS ONE

ENGINEERING DESIGN

START CLASS TWO

ENGINEERING DESIGN
CLASS 2

STUDENT SOLUTIONS

TO

ASSIGNMENT ONE

DESIGN EXERCISE
"SAMPLE" ACTIVITY TIME SCHEDULE

	Percentage of total time
Design steps	10 20 30 40 50 60 70 80 90 100
1. Identify need	x
2. Define problem	xx
3. Search	xxxxxxxxxxxxxxxxxxxxxxxxxx
4. Constraints	xxxx
5. Criteria	xxxx
6. Alternatives	xxxxxxxx
7. Analysis	xxxx
8. Decision	xxx
9. Specifications	xxxxxxxx
10. Communication	xxxxx

from *Introduction to Engineering Design*

ENGINEERING DESIGN

CLASS TWO

HAND IN ASSIGNMENT ONE

ENGINEERING DESIGN
CLASS 2
QUIZ 1

WRITE:

2 STEPS IN A DESIGN PROCESS

DESIGN STRATEGY
ANSWERS TO
QUIZ 1

1. Identify need
2. Define problem
3. Search
4. Constraints
5. Criteria
6. Alternatives
7. Analysis
8. Decision
9. Specifications
10. Communication

from *Introduction to Engineering Design*

DESIGN STRATEGY

1. Identify need
- » Before the design process can even begin a "need" must be defined
- » In a commercial or economic sense, the consumers are ultimately the judges of whether there is truly a need

2. Define problem
- » This step consists of refining and expanding incomplete statements
- » We must be careful not to solve the wrong problem with our design

from *Introduction to Engineering Design*

DESIGN STRATEGY

3. Search
- » Begin your search for information on your problem
- » This activity will continue for life of the project
- » It will occur concurrently with steps 4 through 9

4. Constraints
- » It is now time to commit to paper the real numbers that will limit or box-in your design
- » we must insure that the stated constraints are not "artificial" (or over restrictive)

from *Introduction to Engineering Design*

DESIGN STRATEGY

5. Criteria
This is a list of the desirable characteristics, often with their importance as % of the total

For example:

1. Cost	40%
2. Safety	20%
3. Durability	15%
4. Use of standard parts	15%
5. Ease of operation	10%
	100%

from *Introduction to Engineering Design*

ENGINEERING DESIGN
PROJECTS(1/4)

- Mechanical pencil
- Safety razors from three vendors; include one disposable razor
- Flashlight
- Battery-powered slide viewer
- A beverage holder for a card table
- Headlights that follow the wheels' direction
- A protective "garage" that can be stored in the car's trunk
- A device to prevent theft of helmets left on motorcycles
- A conversion kit for winter operation of motorcycles
- An improved rack for carrying packages or books on a motorcycle or bicycle

from *Introduction to Engineering Design*

ENGINEERING DESIGN PROJECTS(2/4)

- A child's seat for a motorcycle or bicycle
- A tray for eating, writing, and playing games in the back seat of a car
- A system for improving traction on ice without studs or chains
- An inexpensive built-in jack for raising a car
- An auto-engine warmer
- A better way of informing motorists of speed limits, road conditions, hazards, etc.
- Theft- and vibration-proof wheel covers
- A better way to check the engine oil level
- A device to permit easier draining of the oil pan by weekend mechanics

from *Introduction to Engineering Design*

ENGINEERING DESIGN PROJECTS(3/4)

- A heated steering wheel for cold weather
- A less expensive replacement for auto air-cleaner elements
- An overdrive system for a trail bike
- A sun shield for an automobile
- A well-engineered, efficient automobile instrument panel
- An SOS sign for cars stalled on freeways
- A remote car-starting system for warm-up
- A car-door positioner for windy days
- A bicycle trailer
- Automatic rate-sensitive windshield wipers
- A corn detasseler
- An improved wall outlet

from *Introduction to Engineering Design*

ENGINEERING DESIGN PROJECTS(4/4)

- A better rural mailbox
- A home safe
- An Improved bicycle for recreation
- A transit system for campus
- Improved pedestrian crossing at busy intersections
- Improved campus parking facilities
- A simple but effective device for cleaning clogged drains
- A device to attach to a paint can for pouring
- An improved soap dispenser
- A better method of locking weights to a barbell shaft
- A shoestring fastener to replace the knot
- A better jar opener

from *Introduction to Engineering Design*

ENGINEERING DESIGN EXERCISE DESIGN PROJECT (ASSIGNMENT TWO)

- Select project from the list
- Or make one up with approval of instructor
- Prepare an activity time schedule
- Complete first two steps of design process
  - »1. Identify need
  - »2. Define problem
- Prepare one transparency with
  - »activity time schedule
  - »"need"
  - »problem definition
- Be prepared to present to class at next meeting

ENGINEERING DESIGN

END CLASS TWO

ENGINEERING DESIGN

START CLASS THREE

ENGINEERING DESIGN

STUDENT SOLUTIONS

TO

ASSIGNMENT TWO

ENGINEERING DESIGN

CLASS THREE

HAND IN ASSIGNMENT TWO

ENGINEERING DESIGN
CLASS 3
QUIZ 2

WRITE:

Four criteria for your project,

with their importance

ENGINEERING DESIGN
CLASS 3
QUIZ 2

STUDENT SOLUTIONS

TO

QUIZ 2

DESIGN STRATEGY

6. Alternatives

Brain storm to develop a list of ideas, or solutions, to your problem

7. Analysis

From the list of solutions you must narrow the list to those that best fit the criteria developed in step 5

from *Introduction to Engineering Design*

DESIGN STRATEGY

8. Decision

Choose the solution from the short list in step 7

9. Specifications

Complete the detailed engineering specification

10. Communication

All your good work is for naught if you do not effectively communicate your results

from *Introduction to Engineering Design*

ENGINEERING DESIGN

Literature Cited

A. R. Eide, R. D. Jenison, L. H. Mashaw, L. L. Northup, Introduction to Engineering Design, Mc-Graw Hill, Boston, 1998.

Criteria for Accrediting Engineering Programs, Revised 3/18/2000, Accreditation Board for engineering and Technology, Inc., Baltimore, MD.

ENGINEERING DESIGN

END CLASS THREE