SECTION 2

HOW DO ENGINEERS DESIGN?

Length of Lesson: 120 min

Desired Results

Technological Literacy Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Prerequisites:

- Read at sixth grade level or above
- Possess basic computer skills in word processing and searching the web

Tools, Materials, and Equipment Required:

- Computers that have access to internet
- LCD projector to present Power Point
- Area for students to have discussions

Supporting Resources

- http://www.technologystudent.com/

  This website is designed for introduce them children to design in life.

References:

Eide, A., Jenison, R., Mashaw, L., & Northup, L. (2001). Introduction to engineering design and problem solving. Boston: McGraw-Hill Science/Engineering/Math; 2 edition (August 8, 2001)

V. Ryan (2010). Technology Student. Retrieved May 29, 2010 from:

http://www.technologystudent.com/

Active Learning Plan

Preparation of teacher before lesson is taught (40 min)

- Review the ideas and objectives of the lesson.
- Review the reference book and learn the basic ideas of design.
- Review detailed instructions.

Presentation (80 min)

- Discuss how design effect our lives
- Explain the importance of design in engineering
- Discuss what are main steps in design
- Introduce Eide's design model

Application (40 min)

- Divide students into work groups (3 - 4 students per group), assign each group to keep a design journal to record data and design activities.

Teacher Reflection

- What happened during the lesson? How effective was the lesson plan?
- How the desired results were met? What are the next steps to improve student learning?

Detailed Instructions

Design as the core process of engineering, is open-ended and requires creativity of engineers. The definition of 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 science and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective".

Design steps in Eide's model:

1. Identification of a Need

   To address a need means what kind of problem we will resolve. We will use an example to demonstrate the process of design. Let's say we want to design a cup for students in kindergarten. That's a need.

2. Problem Definition

   This is often a temptation to construct quickly a mental picture of a gadget that if properly designed and manufactured will satisfy a need.

   In our example, the problem is design a cup which fulfills the requirements of parents and liked by children.

3. Search

   Sources of information :

   - Existing solutions
   - Internet

- Your library
- Trade journals
- Individuals whom you believe are experts in the field

In our example, we can use existing solutions, which are cups designed by other people for children, also we can go to the Internet to search for alternative solutions. If you know someone who is a cup designer, we can ask advice from that person.

4. Constraints

Constraints refer to limits we must considerate in design.

In our example, they refer to money and time we have to design the cup, materials we can select are limited, etc.

5. Criteria

Criteria are desirable characteristics of the solution which are established from experience, research, market studies, and customer preferences. In most instances the criteria are used to judge alternative solutions on a qualitative basis.

Typical design criteria:

- Cost: the money spent on the design (or any specific solution)—almost always a heavily weighted factor
- Weight: how heavy is the subject

- Safety features: is it safe enough for all the people who contact the subject?
- Effectiveness: can the subject make use of all the materials?
- Feasibility: how difficult do the subject be made?

Think about what is a good cup for kindergarten children?

Some criteria are :

- The material of the cup should be safe
- The cup should not be too heavy
- The cup should not be expensive
- The cup should have an appropriate size
- The cup should be attractive to kindergarten students

6. Alternative Solutions

We must produce a list of possible answers to the problem before selecting the best one.

In our example, we should list all possible design for the cup, such as :

Plastic cup, glass cup, ceramics cup, batman cup, Harry Potter cup, cups with lids, cups withour lids, etc.

7. Analysis

In order to find the best solution in light of available knowledge and criteria, we must analyze the alternative solutions to determine performance capability.

In our example, when we consider the safety of the materials, we should analyze which materials are safe and which are not. Glass is safe for adults but not safe for little students, so we need to delete glass from out list of materials. When we design the apprearance of the cup, we need to analyze what kind of factors can attract little students. We may want to print some anime characters on the cup but we need to decide which character we will use. These are factors we need to analysis in the process of design.

8. Decision

We can create a decision table to help us make the decision. Select the solution which get the highest points.

For example :

	Safety (1= not so safe, 2= fair, 3=safe)	Weight (1= heavy, 2=moderate, 3= light)	Price (1= expensive, 2= moderate, 3= cheap)	Size (1= large for students, 2=moderate, 3= children size)	Apprearance (1= not attractive, 2= moderate, 3= very attractive)	Total points
Design 1						
Design 2						
Design 3						
Design 4						
Design 5						
Design 6						

9. Specification

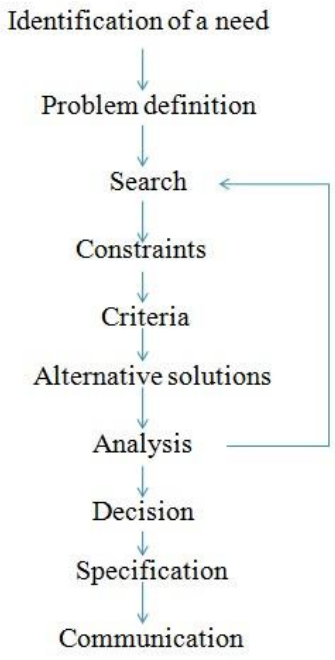
We need to keep a design journal in the process of design. In this journal, we should record what we have done in each step, materials, tools and equipment we have used.

For the design journal, students should record which step they complete and what they do in “activity”. In “product design reflection”, they should record what they think of the design step, are they satisfied with their design and why.

10. Communication

In the end of the design, we need to communicate with our clients or other designers. By communication, we can get feedback or other suggestions of our design and improve the design.

Flow Chart



Design Journal

Group Name: _____

Group Members: _____

Date: _____

Activity:

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Materials:

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Tools and equipment:

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Product Design Reflection:

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