Guidelines to Coop Student and Technical Report Writing

Engineering Design Steps (ABET)

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The COOP student needs to act as a Computer Engineer under the supervision of the Company by addressing each of his COOP tasks as follows:

Whenever possible, break-down each of your COOP tasks into the following steps:

1. **Identifying a need** (one of my COOP tasks is assigned because there is a need for it, what is this need!)
2. **Defining the problem** (a given COOP task will be completed if I solve a specific problem, What is this problem)
3. **Conducting research** (How and where to search the library, ebooks, datasheets, manufacturer web, etc to find relevant material to solve the problem!)
4. **Narrowing the research** (knowing the problem to be solved I need to filter Software/Hardware components that may help in building a solution)
5. **Analysing set criteria** (knowing the problem (specifications) and relevant components found I need to find out whether some components meets the problem specifications or not!)
6. **Finding alternative solutions** (determine a few possible solutions using found components for the above problem, I need to identify each of these possible solutions!),
7. **Analysing possible solutions** (knowing the problem (specifications) and possible solutions I need to find out whether some solutions meets the problem specifications or not!)
8. **Making a decision** (given two or more possible solutions I need to select one feasible and economical solution)
9. **Presenting the product** (I need to describe my solution in writing using whatever needed as graphics, drawing, etc.)
10. **Communicating** (prepare a written report in which each task will be broken down into: Identifying a need, Defining the problem, Conducting research, Narrowing the research, Analysing set criteria, Finding alternative solutions, Analysing possible solutions, and a Making a decision.)

It is clear that some COOP tasks are service-oriented which cannot be described as Engineering Design. However, you are required to have at least one or more of your COOP tasks to be Engineering Tasks and be described as above.

By following up the above Engineering Design steps you gain: (1) act as real computer engineers, (2) maximize your grades in COOP presentation and COOP report evaluation by the COE faculty.

Engineering Design Definition (Web Samples)

- ✓ The systematic and creative application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.
- – www.doe.mass.edu

- ✓ Is the creative, iterative and often open-ended process of conceiving and developing components, systems and processes. Design requires the integration of engineering, basic and mathematical sciences. A designer works under constraints, taking into account economic, health and safety, social and environmental factors, codes of practice and applicable laws.
- – www.ee.wits.ac.za/~ecsa/gen/g-04.htm

Engineering Design Definition (ABET)

ABET is Accreditation Board for Engineering and Technology

- ✓ 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
- ✓ Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing and evaluation

ABET Design Component Features

- ✓ 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 specification
  - ❖ Consideration of alternative solutions
  - ❖ Feasibility considerations
  - ❖ Production processes
  - ❖ Concurrent engineering design, and
  - ❖ Detailed system description
- ✓ Further it is essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics and social impact

Engineering Design Steps (ABET)

- ✓ This process can be divided up into a ten-step process, which includes:
  1. Identifying a need
  2. Defining the problem
  3. Conducting research
  4. Narrowing the research
  5. Analyzing set criteria
  6. Finding alternative solutions

7. Analyzing possible solutions
8. Making a decision
9. Presenting the product
10. Communicating and selling the product

Identifying a Need

- ✓ The first step of this process is the identification of a need
- ✓ Engineers themselves often do not do this step of the process, but rather society discovers a need and then presents that need to the engineering firm/community
- ✓ The term "need" is fairly vague, but often refers to desire or shortage of a good
- ✓ This "need" can sometimes be considered a necessity to some people but a luxury for others

Identifying a Need -- Examples

- ✓ Dealing with _____ is almost impossible. I wish there was a _____ to help.
- ✓ I need a _____ to get _____ done.

What is the scope of "*need*"?

- ❖ Personal
- ❖ Local
- ❖ Global

Defining the Problem

- ✓ The second step of the engineering design process is defining the problem
- ✓ Engineers must appropriately define the problem first in order to find an acceptable solution to it or improve it
- ✓ Question
  - What is the first step in "*defining a problem*"?
- ✓ Identify client (or customer)
- ✓ Confer extensively with the client concerning the problem
  - Put yourself in the client's shoes; try to learn as much as you can about the business, process, people, … whatever it is that is experiencing the problem
  - This will help you to fully define the problem
- ✓ **The key to this step is to listen. You may know more about technology than the client, but he or she knows much more about his/her problem**
- ✓ **Don't be afraid to go back and ask the client questions**
  - The better you understand the problem, the better your solution will be
  - When you think you fully understand the problem, write a statement describing the client's problem in detail and get him or her to review the statement and agree

Conducting Research

- ✓ The third step in the design process is research
- ✓ Most of a productive engineer's time will be spent locating, applying, and transferring information
- ✓ In order for an engineer to solve a problem, they first must be well acquainted with as much information possible, which in turn produce a better solution
- ✓ First we have to look at the types of information available
- ✓ **Here the engineer asks him or herself many questions, such as:**
    - ⇒ What has been written about it?
    - ⇒ Is something already on the market that may solve the problem?
    - ⇒ What is wrong with the way it is being done?
    - ⇒ What is right with the way it is being done?
    - ⇒ Who manufactures the current 'solution'?
    - ⇒ How much does it cost?
    - ⇒ Will people pay for a better one if it cost more?
    - ⇒ How much will they pay (or how bad is the problem)?"
- ✓ **All these questions help us get a better grasp on the problem at hand**
- ✓ Another major part of this research step is determining the source of information
- ✓ It is the engineers' job to sift through all of the gathered research and decide what is relevant
- ✓ One source available is an already existing solution
- ✓ Reverse engineering is an effective learning technique if other "solutions" are available on the market
    - o **Is this ethical?**
- ✓ Effective sources of information include the Internet, local libraries, available government documents, personal organizations, trade journals, vendor catalogs and individual experts available
- ✓ It is very important to record these findings in a bibliography so that it is easy to find the information at a later date.

Narrowing the Research

- ✓ The next step, step four, is to put limitations or constraints on the research
- ✓ Up until now, the problem research and definition has been kept broad to allow for a large amount of possible solutions
- ✓ Constraints are necessary because they eliminate any extreme solutions that would be inefficient, costly, and physically impossible to create

Analysing Set Criteria

- ✓ Step five is to analyze the criteria, or "characteristics of the solution that are established from experience, research, market studies, and customer preferences" that are desired by the consumer
- ✓ In this step, solutions are compared on a qualitative basis such as appearance, durability and cost
- ✓ The importance of each characteristic must be agreed upon the team of engineers in order to find the top reasonable solutions to the problem

Finding alternative solutions

- ✓ In the next step, step six, we examine various (alternative) solutions to the problem
- ✓ In this step, a list of the **possible solutions** is made
    - The pros and cons of each solution are considered
- ✓ May create a checklist of characteristics of the possible solutions and decide what could be changed to better the final result
- ✓ "Brainstorming" is a great way to decide what is good about the solution and what could be changed to better the solution

Analysing possible solutions

- ✓ At step seven, we analyze the possible solutions
- ✓ To find the best solution, analyze all possible alternative solutions to determine their potential
    - Condense the possible solutions
    - Analyze the potential performance of the solution to determine if the solution is physically possible

Making a decision

- ✓ For step eight, it is time to make a decision
- ✓ Some decisions are easily made through analyzing and constraining from the previous steps, but at other times the decision on which solution to choice can be close to impossible
    - What makes decision making so tough is the trade offs of choosing one solution over the other
    - Often engineers can come up with impeccable solutions, detailing the strengths and weaknesses of all solutions, but in the end cannot make the decision of which is better on their own
        - Attempt/desire to "over engineer" a solution
- ✓ One tool that can be helpful in the decision making process is to be organized

- Having as much information possible about all the alternative solutions will make it easier to evaluate the product efficiently

✓ Another crucial tool is to have the objective for the problem and important criteria clear in mind

- Frequently when working on a problem, you may find yourself side tracked, so it's important to remember the purpose of the solution

Presenting the product

✓ Step nine in the design process is clearly to specify the product to others

- Here it is important clearly to define exactly what the solution is

✓ Details about the product can be given visually through sketches

- It's important to have accurate sketches in order to describe your ideas to technicians and drafters

✓ **Successful engineers have to communicate accurately through written, spoken and graphical languages in order to develop and interpret specifications**

Communicating

✓ Communication and selling the product is step ten

- In the end, the engineer is going to have to sell the design of his or her product
- Have to sell and explain the product in a persuading manner

✓ Selling the product takes place all along the design process

✓ Another form of communication is the written report

- May be read by both management and clients

✓ These written reports can vary in formality, but usually contain:

- an appropriate cover page, abstract, table of contents, body, conclusion and recommendations, and appropriate appendices

✓ Another common way of communicating the new product is through an oral presentation which presents the information convincingly to the listener

✓ The key to a good oral presentation is:

- be prepared, have good posture, good eye contact and project your voice load and clearly

✓ It's important that the oral presentation gives enough information to get the idea across to the desired audience but not too much information to become overwhelming, and confusing

- Technical presentations
- Executive presentations