Design Process – Define Requirements & Requirement Review

General Description (Framework):

- **Scope** – *As a group*, you are expected to present a *Requirement Review* for each one of your three selected problems. As part of the discussion one of the problems will become your group capstone project.
- **Presentations** - Timetable (45 min total per group)
  - **Problem 1** – 10 min
  - **Problem 2** – 10 min
  - **Problem 3** – 10 min
  - **Discussion** - 15 min
- **Review –** Review the following material as you prepare for the presentations
  - **Slide Note No.** 5 – Requirement Definition
  - **Chapters 6,7,8,9, -** Nigel Cross, Engineering Design Methods, Wiley **Note:** These book chapters provide many examples for each one of the analysis
  - **YouTube Videos**
    - Quality Function Deployment (QFD) and House of Quality

Detailed Description:

- **Prepare a PowerPoint including two parts:**
  - Part 1: Explicate the Problem – Part 1 will be a repetition of the initial presentations such that each subject is addressed in detail
  - Part 2: Requirements Definition
- **Part 1: Explicate the Problem**
  - **Formulate the Problem Precisely** - Describe the problem in a precise but also concise, easily understandable manner.
  - **Position and Justify the Problem** –
    - **Context** - Clarify in which practice the problem appears. Explain why the problem is important and to whom.
    - **Ensure the Problem Is of General Interest** - Make clear that the problem is of interest not only to a local practice.
    - **Ensure the Problem Is Solvable** - Define and analyze the problem so that it becomes small enough to be solved.
  - **Find the Rood Cause** – Perform a root cause analysis using the fish bone diagram using the 5Ms
  - **Define Resources**
    - **Specify the Sources of the Problem** - Describe the literature and the stakeholders that have previously identified, studied, and experienced the problem.

- **Define Strategy & Methods**
  - **Describe How the Problem Has Been Explicated** - Explain what has been done to explicate the problem, in particular, how the stakeholders have been involved and how the research literature has been reviewed.
  - **Research Methods** - Among the 10 research methods, select one or more and use them for the purpose of defining the problem. For example look for similar products in the market, search for scientific papers related to the topic, study the market via statistical information or a dialogue with stakeholders.

- **Part 2: Requirements Definition**
  - **Element Definition -** Identify the artifact context and anatomy and clearly describe them
    - Intended Practice / Other practice
    - Artifact
    - Problem
    - Uses
    - Perception
    - Addresses
    - Environment
    - Function
    - Behavior
    - Structure
    - Intended Effects
    - Side Effects
  - **Analysis -** Use all the following four methods and perform the analysis on the problem (See Appendix for the steps). Describe each step in each method and the end result of each method. Since you may not have an opportunity to interact with real customers use the other group members as your customers.
    - Objective Tree Method
    - Function Analysis Method
    - Performance Specification Method
    - Quality Function Deployment Methods

Appendix

Method No. 1: Objective Tree Method – Summary

Aim - The aim of the objectives tree method is to clarify design objectives and sub objectives, and the relationships between them.

1. Prepare a list of design objectives. These are taken from the design brief, from questions to the client and from discussion in the design team.

2. Order the list into sets of higher-level and lower-level objectives. The expanded list of objectives and sub objectives is grouped roughly into hierarchical levels.

3. Draw a diagrammatic tree of objectives, showing hierarchical relationships and interconnections. The branches (or roots) in the tree represent relationships which suggest means of achieving objectives.

End Result: Objective Tree

Method No. 2: Functional Analysis Method – Summary

Aim - The aim of the function analysis method is to establish the functions required, and the system boundary, of a new design.

1. Express the overall function for the design in terms of the conversion of inputs into outputs. The overall 'black box‘ function should be broad - widening the system boundary.

2. Break down the overall function into a set of essential sub functions. The sub functions comprise all the tasks that have to be performed inside the black box.

3. Draw a block diagram showing the interactions between sub functions. The black box is made 'transparent', so that the sub functions and their interconnections are clarified.

4. Draw the system boundary. The system boundary defines the functional limits for the product or device to be designed.

5. Search for appropriate components for performing the sub functions and their interactions. Many alternative components may be capable of performing the identified functions.

End Result: Block Diagram

Method No. 3: Performance Specification Method – Summary

Aim – Make an accurate specification of the performance required of a design solution.

1. Consider the different levels of generality of solution which migh be applicable. There might be a choice between

- Product alternatives
- Product types
- Product features

2. Determine the level of generality at which to operate. This decision is usually made by the client. The higher the level of generality, the more freedom the designer has.

3. Identify the required performance attributes. Attributes should be stated in terms which are independent of any particular solution.

4. State succinct and precise performance requirements for each attribute. Wherever possible, specifications should be in quantified terms, and identify ranges between limits.

End Result: Specification List (quantitative values or ranges)

Method No. 4: Quality Function Deployment Method– Summary

Aim - Set targets to be achieved for the engineering characteristics of a product, such that they satisfy customer requirements.

The procedure is as follows:

1. Identify customer requirements in terms of product attributes. It is important that 'the voice of the customer' is recognized, and that customer requirements are not subject to 'reinterpretation' by the design team.
2. Determine the relative importance of the attributes. Techniques of rank-ordering or points-allocation can be used to help determine the relative weights that should be attached to the various attributes. Percentage weights are normally used.
3. Evaluate the attributes of competing products. Performance scores for competing products and the design team's own product (if a version of it already exists) should be listed against the set of customer requirements.
4. Draw a matrix of product attributes against engineering characteristics. Include all the engineering characteristics that influence any of the product attributes and ensure that they are expressed in measurable units.
5. Identify the relationships between engineering characteristics and product attributes. The strength of the relationships can be indicated either by symbols or

numbers; using numbers has some advantages, but can introduce a spurious accuracy.

6. Identify any relevant interactions between engineering characteristics. The 'roof' matrix of the 'house of quality' provides this check, but may be dependent upon changes in the design concept.
7. Set target figures to be achieved for the engineering characteristics. Use information from competitor products or from trials with customers.

End Result: House of Quality and Roof Diagram