ME 274: DESIGN PROJECT II

Lecture 1

Course Outline & Engineering Design Process

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Introduction

- This course, ME 274: SECOND YEAR DESIGN PROJECT is a second year course for BSc Mechanical Engineering.

COURSE OVERVIEW

- You will be taken through the following: **Principles of Mechanical Engineering Design**, **Design of Machine members under static**, **variable and impact loads.**

COURSE OBJECTIVES

On completion of the course it is expected that you will be able to:

- Study the **Engineering Design process** and apply it in **Design Projects**
- Study **Stress Analysis** to determine working stress
- Study **Failure Theories** and use it to Analyse Machine Elements

COURSE OUTLINE

The course is divided into five lectures

Lecture 1: Engineering Design Process

Lecture 2: Basic Stress Analysis for Machine Members

Lecture 3: Failure under Static Loading.

Lecture 4: Fatigue Failure under Variable Loading

Lecture 5: Failure under Impact Loading.

GRADING

- Continuous assessment: 30%
- End of semester examination: 70%

RESOURCES & REFERENCES/READING LIST/RECOMMENDED TEXTBOOKS

- You will need a good scientific calculator, as well as a previous knowledge in Mechanical Engineering in order to go through the course successfully.

1. Machine elements in mechanical design, robert l. Mott
2. Pugh, s, total design, addison-wesley, 1991
3. Shigley's mechanical engineering design, tenth edition, by Richard G. Budynas and J. Keith nisbett
4. Fundamentals of machine component design, f i f t h e d i t i o n by Robert C. Juvinall and kurt M. Marshek

Introduction

- There are many definitions of Design and various ways proposed for modeling or representing the process.

- There is no single way of defining design but, whatever the wording of a definition, design should be seen as encompassing the Total process which starts with **recognition and clarification** of '**a Need'** and continues until a satisfactory **result** is achieved.

- It is therefore **a broad and complex field**, involving many different types of activity, but is essentially concerned with projects. The notion of a project is central to the understanding design.

- In this section we shall study the Design process from the **Need recognition stage** to generation of **Conceptual designs**.

Learning Objectives:

After reading this unit you should be able to:

1. Draw and Explain the Engineering Design Flow Chart

2. List the Guidelines for writing a good Project Report.

3. Apply the Design Process Flow Chart to a Design task (Project)

Lecture Outline

The Engineering Design Process

- Recognition of Need
- Definition of Functional Requirements
- Planning the Design Project
- Definition of the Problem and Specification
- Conceptual Design
- Introduction to 'Total Design' Philosophy.

Evaluation and Selection of Design Alternatives

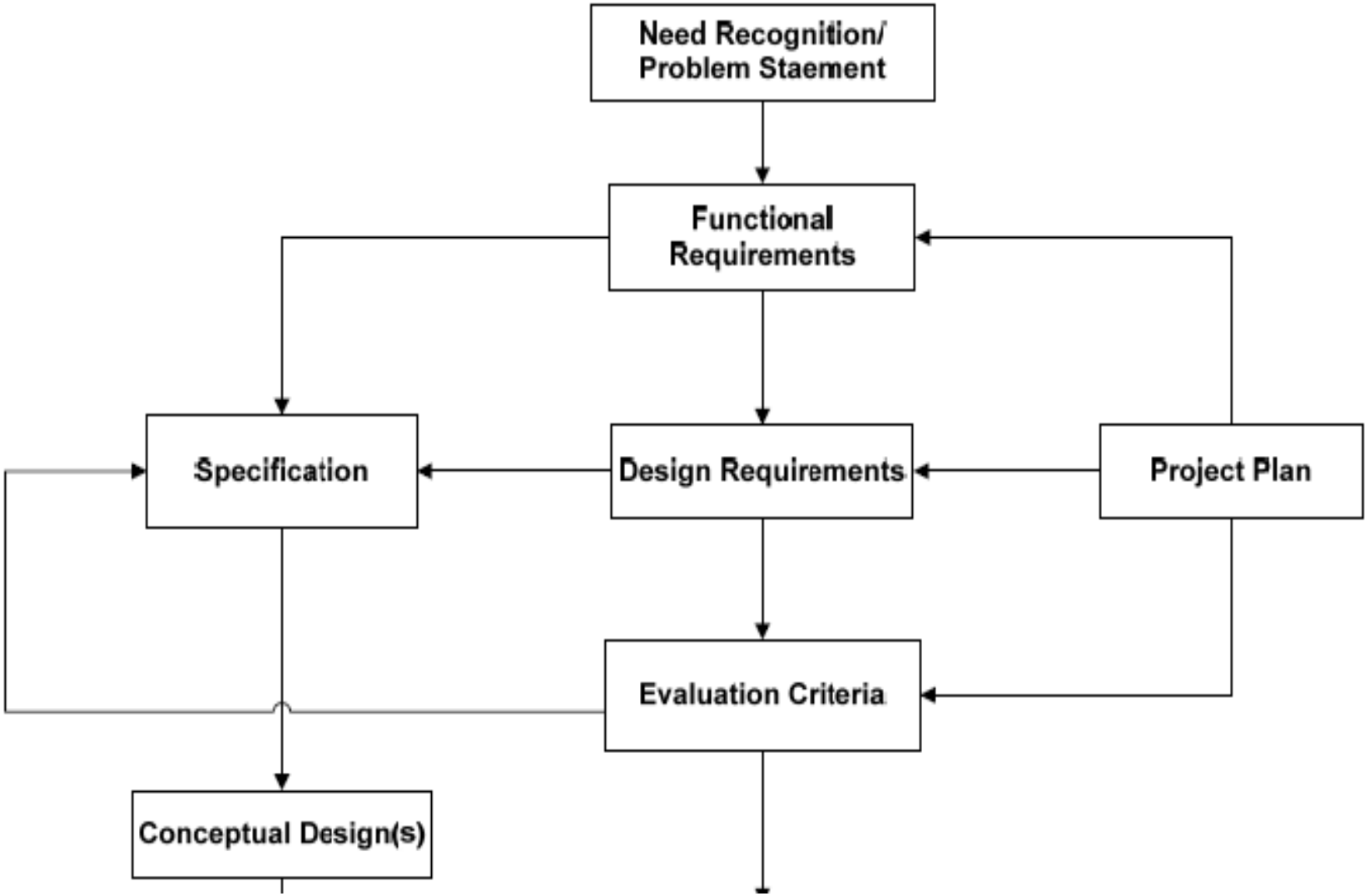
- Method A
- Method B
- Implementation of Design
- Desired Attributes of an Engineer

Design Process

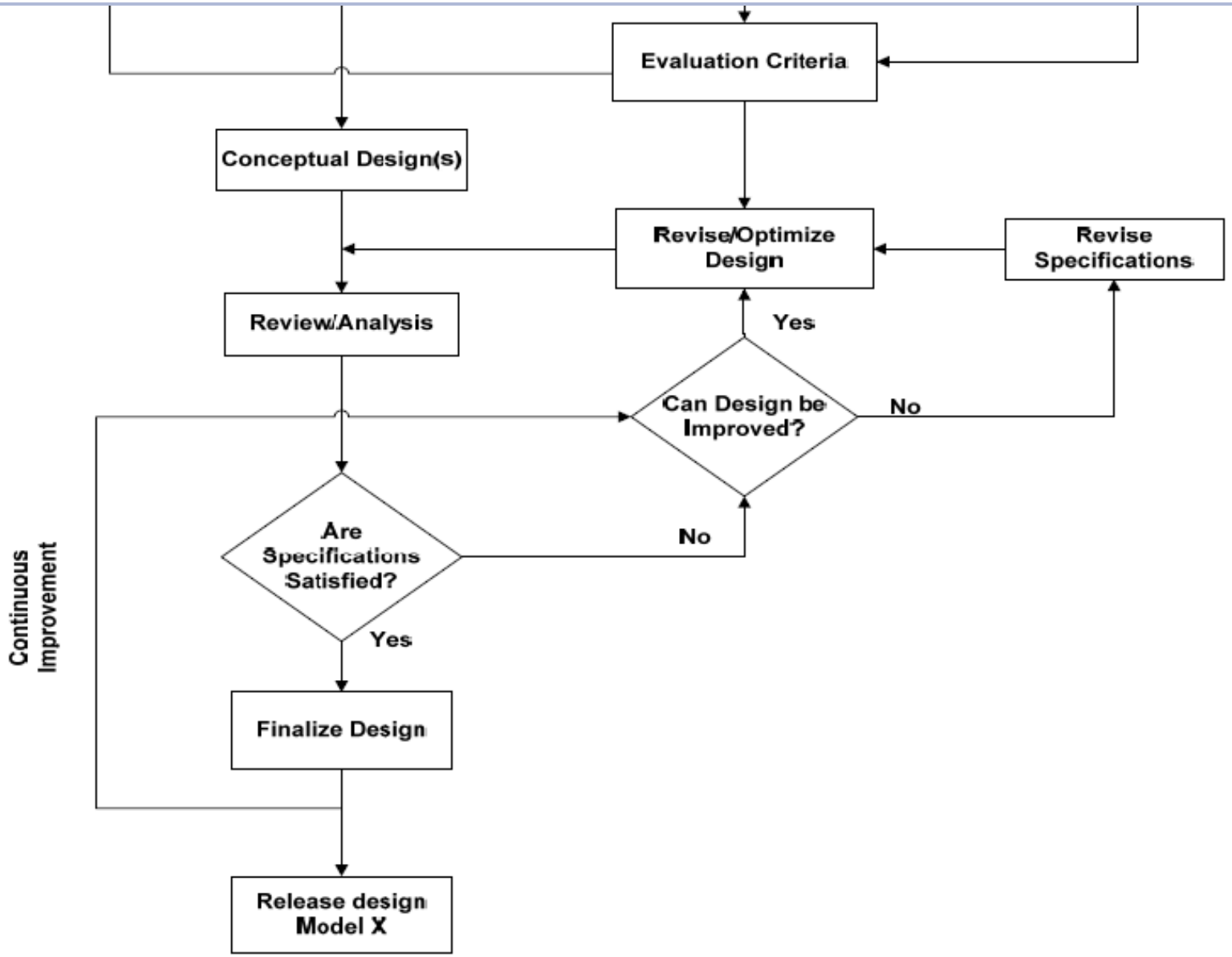
is the systematic activity necessary from the identification of the market/user need to the selling of the successful product to satisfy that need-

an activity that encompasses product, process, people and organisation.

Design Process Flow chart



Design Process Flow chart (Continue)



Recognition of Need

1. The human being is a wanting animal whose needs depend on what he already has.

2. The needs are arranged in a hierarchy of importance.

3. Once one need is satisfied, another emerges and demands satisfaction.

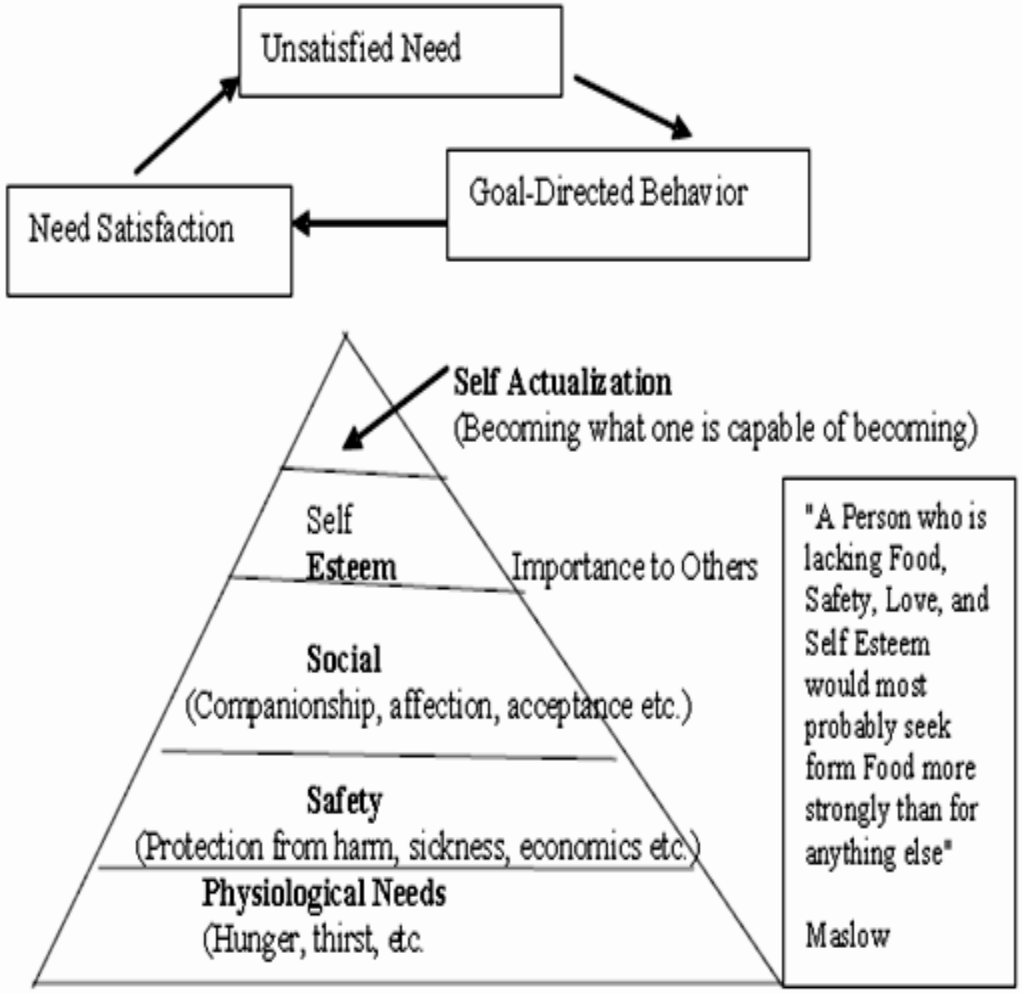


Figure 2:Maslow's Hierarchy of Need

Functional Requirements

- Statements which indicate "**what**" the device is supposed to do.
- They should always employ action phrases such as "**to lift**", "**to push**", "**to support**", "**to transmit**" etc.
- This is the ***Need Statement*** and should be as clear as possible to the intended customer.

Planning the Design Project

1. Identify tasks to be performed
2. Relate tasks to be performed
3. Apply time line to tasks
4. Develop a Gantt chart and/or Activity Path Network and Critical Path.
5. Apply responsibilities to tasks

Definition of Problem and Specification

1. **Design Requirements**:

   Detail statements indicating the expected specific and quantitative data with regard to the performance of the device.

   They indicate size, power, efficiency, speed, torque, etc.

2. **Evaluation Criteria**:

   Functionality, safety, reliability, usability, manufacturability, marketability, and competitiveness (initial cost, operating cost, maintenance cost, aesthetics, ecological and societal considerations).

   A sample of the criteria for the sterilizer is presented in the table below

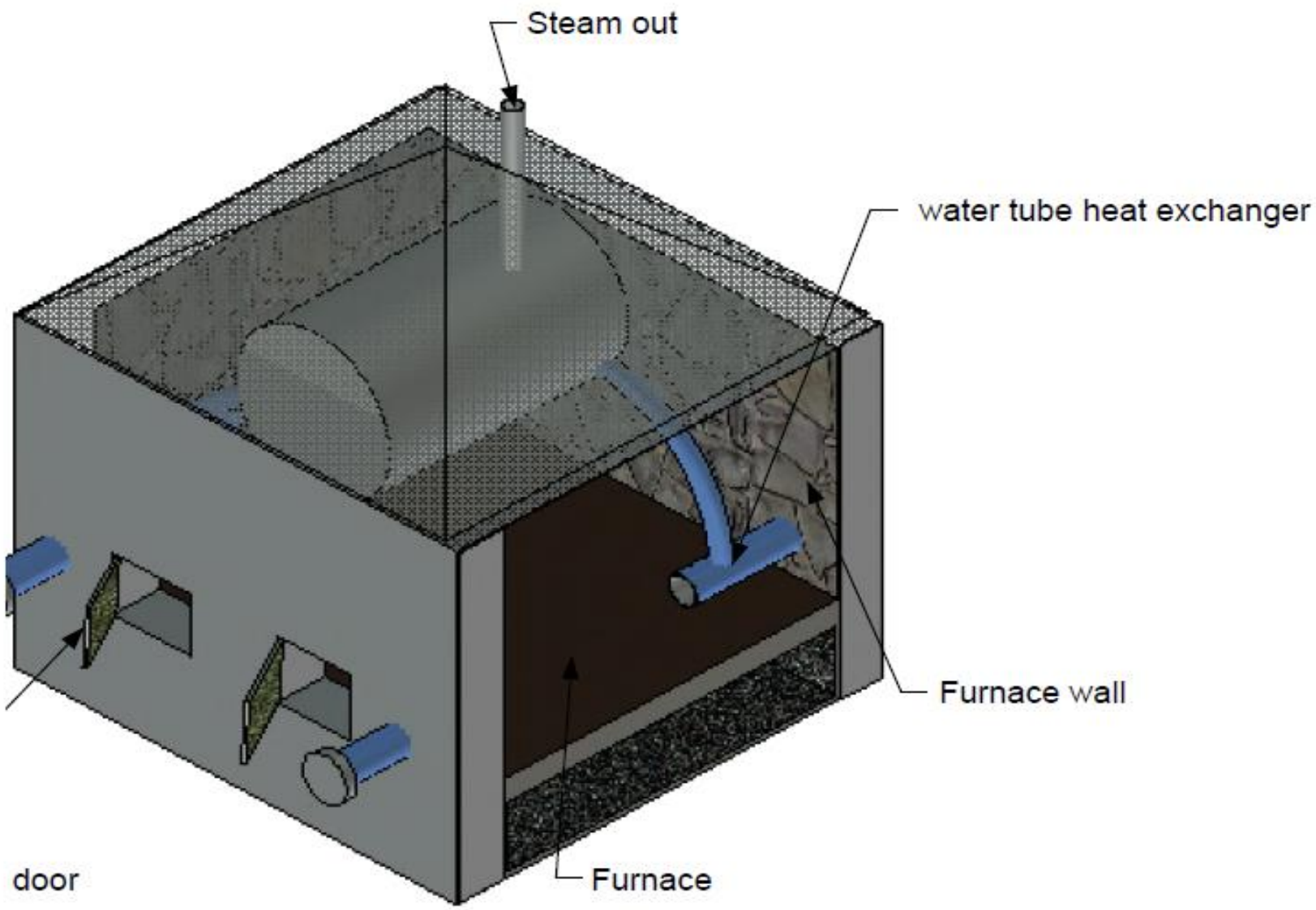
Evaluation Criteria Table

CRITERION	INITIAL COST		EASE OF MANUFACTURE		EASE OF MAITENANCE		ASSEMBLY	
WEIGHTING	0.25		0.25		0.25		0.25	
PARAMETERS	NUMBER OF PARTS		TYPES OF SHAPES		NUMBER OF FASTENERS		EASE OF ASSEMBLY	
	MAG.	Score	MAG.	Score	MAG.	Score	MAG.	Score
	Below 5	5	Very Easy	5	Below 5	5	Very Easy	5
	6 – 10	4	Easy	4	6 – 10	4	Easy	4
	11 – 15	3	Fairly easy	3	11 – 15	3	Fairly easy	3
	16 – 20	2	Difficult	2	16 – 20	2	Difficult	2
	Above 21	1	Very Difficult	1	Above 21	1	Very Difficult	1

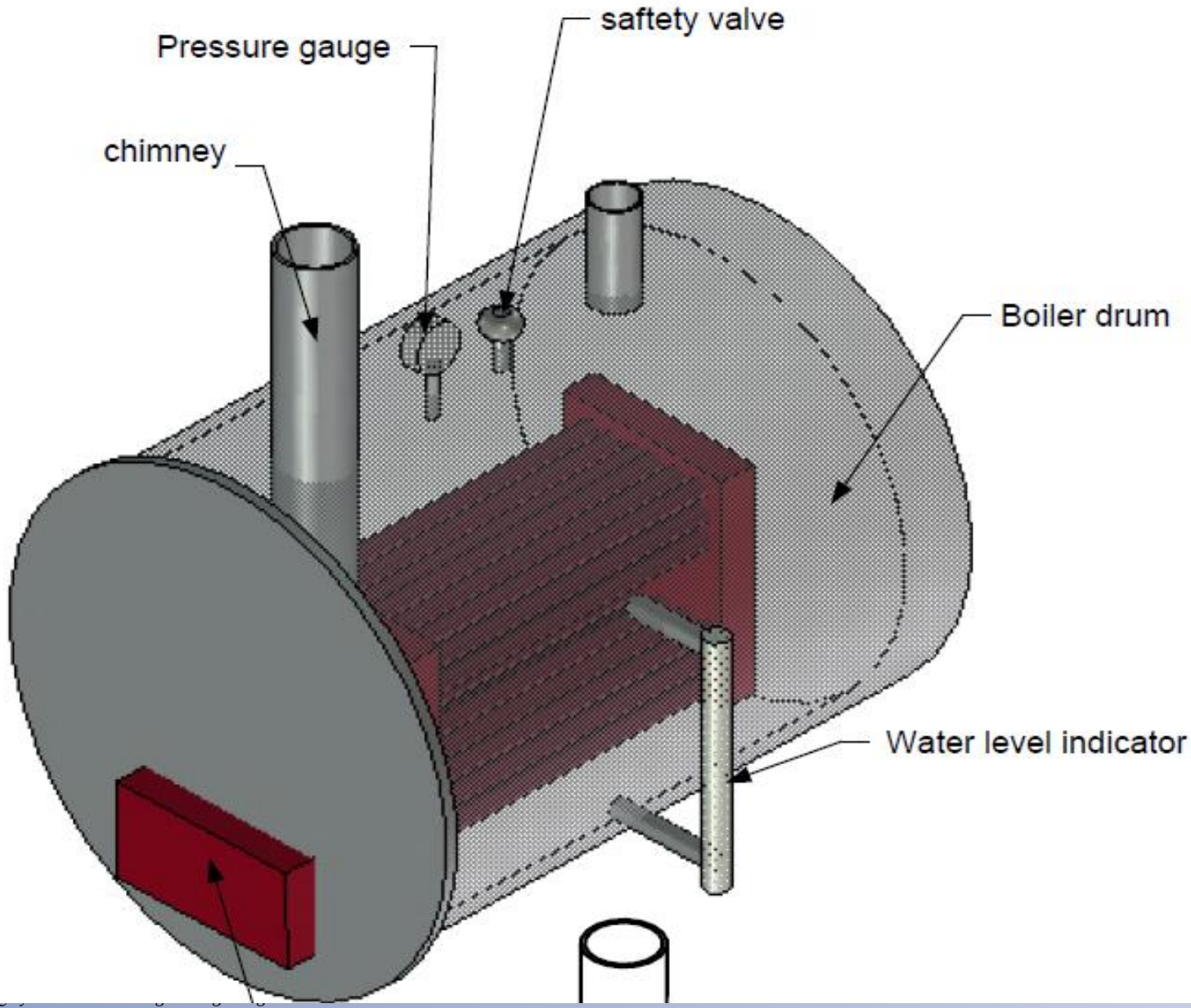
Conceptualize the Design

- Research - Gather information about past or similar designs.
- Develop conceptual approaches/techniques.
- Develop conceptual alternate designs
- Perform preliminary evaluation of alternative approaches.
- Select the best alternative.

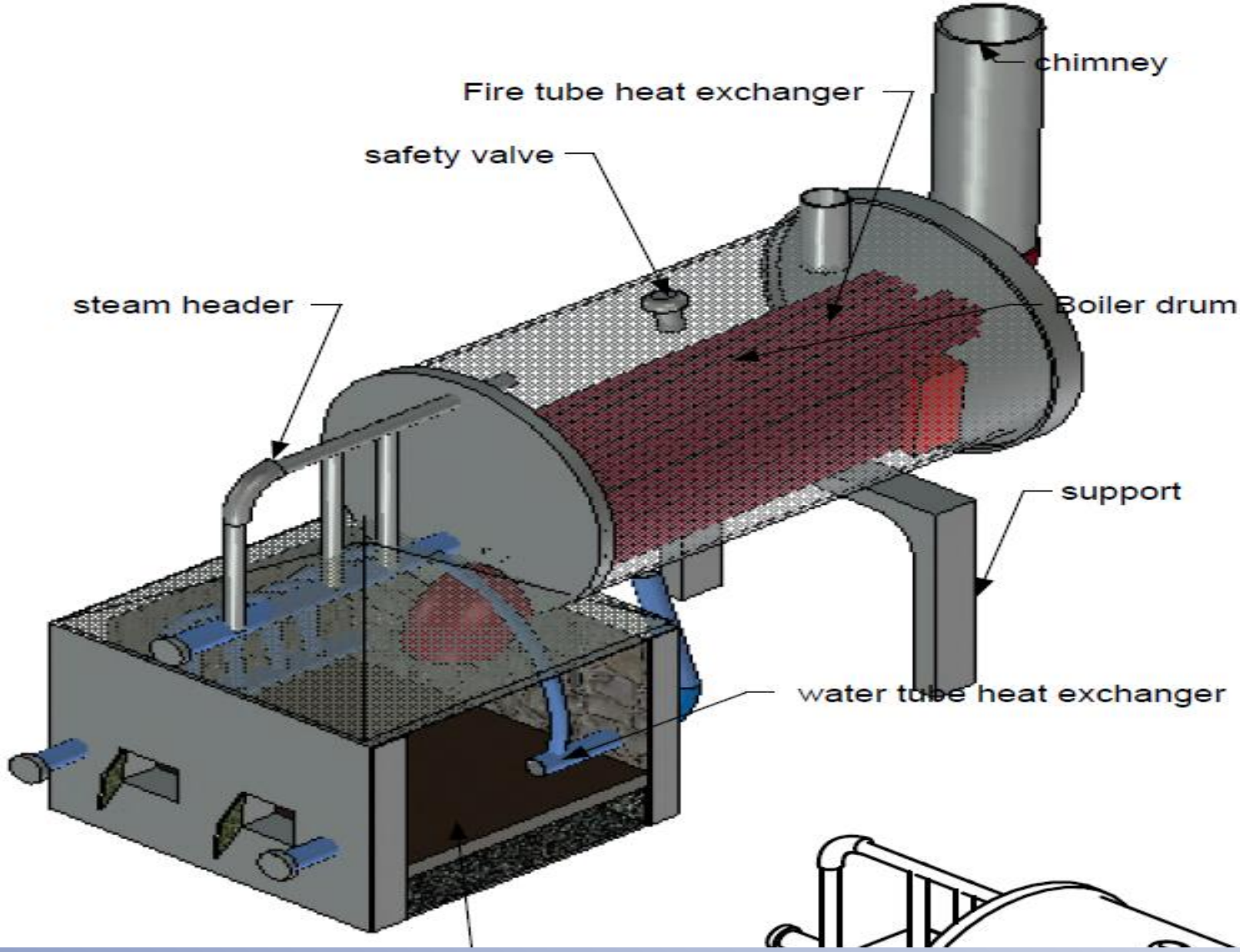
THE WATER TUBE DESIGN (CONCEPT 1)



THE FIRE TUBE DESIGN (CONCEPT 2)



COMBINATION DESIGN (CONCEPT 3)



Method A

1. If each criterion has the same weight as the others (equal weights):
2. Rank each design/process criterion from poor (1) to excellent (5)
3. Sum all rankings for each design/process ($C = \Sigma r_i$)
4. A higher score from step 2 indicates a favourable design/process

DECISION MATRIX TABLE FOR STERILIZER

CRITERION	INITIAL COST			EASE OF MANUFACTURE			EASE OF MAINTENANCE			EASE OF ASSEMBLY			TOTAL SCORE
WEIGHT	0.25			0.25			0.25			0.25			
PARAMETERS	NUMBER OF PARTS			TYPES OF SHAPES			NUMBER OF FASTENERS			EASE OF ASSEMBLY			
	MAG.	Score	Value	MAG.	Score	Value	MAG.	Score	Value	MAG.	Score	Value	
CONCEPT 1	**15**	**3.0**	**0.75**	**F. Easy**	**3.0**	**0.75**	**7**	**4.0**	**1.00**	**F. Easy**	**3.0**	**0.75**	**3.25**
CONCEPT 2	**15**	**3.0**	**0.75**	**Easy**	**4.0**	**1.00**	**6**	**4.0**	**1.00**	**Easy**	**4.0**	**1.00**	**3.75**
CONCEPT 3	**20**	**2.0**	**0.50**	**V. Easy**	**5.0**	**1.25**	**12**	**3.0**	**0.75**	**V. Easy**	**5.0**	**1.25**	**3.75**

METHOD B

1. If each criterion has a different weight (unequal weights)
2. Assign weights (w_i) to each criterion
3. Rank each design/process criterion from poor (1) to excellent (5)
4. Subtract the average ranking from each ranking (r_i-3)
5. Sum all weighted Score for each design/process, $C_{wi} = \Sigma w_i (r_i-3)$
6. A higher score from step "4" indicates a favorable design/process

DECISION MATRIX TABLE FOR STERILIZER

CRITERION	INITIAL COST			EASE OF MANUFACTURE			EASE OF MAINTENANCE			EASE OF ASSEMBLY			TOTAL SCORE
WEIGHT	**0.35**			**0.20**			**0.30**			**0.15**			
PARAMETERS	NUMBER OF PARTS			TYPES OF SHAPES			NUMBER OF FASTENERS			EASE OF ASSEMBLY			
	MAG.	Score	Value	MAG.	Score	Value	MAG.	Score	Value	MAG.	Score	Value	
CONCEPT 1	**15**	**3.0**	**1.05**	**F. Easy**	**3.0**	**0.60**	**7**	**4.0**	**1.20**	**F. Easy**	**3.0**	**0.45**	**3.30**
CONCEPT 2	**15**	**3.0**	**1.05**	**Easy**	**4.0**	**0.80**	**6**	**4.0**	**1.20**	**Easy**	**4.0**	**0.60**	**3.65**
CONCEPT 3	**20**	**2.0**	**0.70**	**V. Easy**	**5.0**	**1.00**	**12**	**3.0**	**1.05**	**V. Easy**	**5.0**	**0.75**	**3.50**

Implementation of Design

- Design Analysis (Stress/Sizing, deformation, deflection, manufacturability, etc.)
- Build Prototype (Modern Approach is to build a Computer Model and Simulation)
- Evaluation and Revision

Desired Attributes of an Engineer

- This is a list of basic, durable attributes into which can be mapped discipline specific skills reflecting the diversity of the overall environment in which the engineering profession is practiced.

- This list is a compilation of industry responses and roundtable discussions as distributed by The Boeing Company.

- A good understanding of engineering science, fundamentals Mathematics, Physical and life Science, and Information technology (far more than “Computer Literacy”).

- A good understanding of engineering design and manufacturing process; Engineering is about designing and making things people want.

Basic understanding of the context in which Engineering is Practiced

- Economics and business practices
- The Environment
- Customer and societal needs
- Government regulations

Good Communication Skills

- Written
- Verbal
- Graphic
- Listening

High Ethical Standards

1. Profession ethics

2. Business and workplace ethics

- Ability to think critically and creatively.
- Profound understanding of the importance of teamwork.
- Flexibility - An ability and self-confidence to adapt to rapid/major technological changes.
- Curiosity and a desire to learn for life.

Project Topics

1. **Health**
2. **Agriculture**
3. **Waste Management**
4. **Energy**