Engineering Design

What is it?

EECE401 Senior Design I

Dr. Charles Kim

“Senior Design” – brief definition ?

Engineering Design in 3 phases

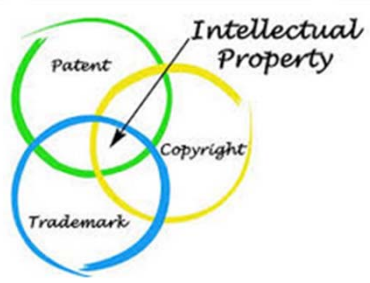
- **1. Problem Formulation**
  - Recognition of a set of ( )
  - **Formulation of a comprehensive problem statement**
  - Determine the **requirements** of the project
- **2. Problem Solving**
  - Know the current ( ) of the product relevant to the project
  - Generate ideas to ( ) the requirements
  - **Generate alternative ideas**
  - **Analyzes all the ideas**
  - **Makes Decision** on which idea (Top Design) will be implemented
- **3. Solution Implementation**
  - Creates an implementation and test **plan**
  - Follows the plan to **build** the design
  - **Evaluates** against the requirements from problem formulation

Characteristics of Design

- Design is:
  - A ( ) through the 3 phases of
    ( ),
    ( ),
    and ( ).
  - ( ), not trial-and-error
  - ( ), not a recipe (nor a cookbook)
  - ( ), not an event or product
  - ( ), back to earlier phases
  - ( ), to faithfully execute planned activities

Characteristics of Design

- Design <u>should</u>:
  - ( ) with regulation, codes, rules, standards, etc
  - Work under multiple (and sometimes contradictory) ( ):
    - Money, time, socio-cultural, ethical, etc.
  - **Perform with ( ) behavior** and responsible action
  - Understand and exercise ( ) **Rights**

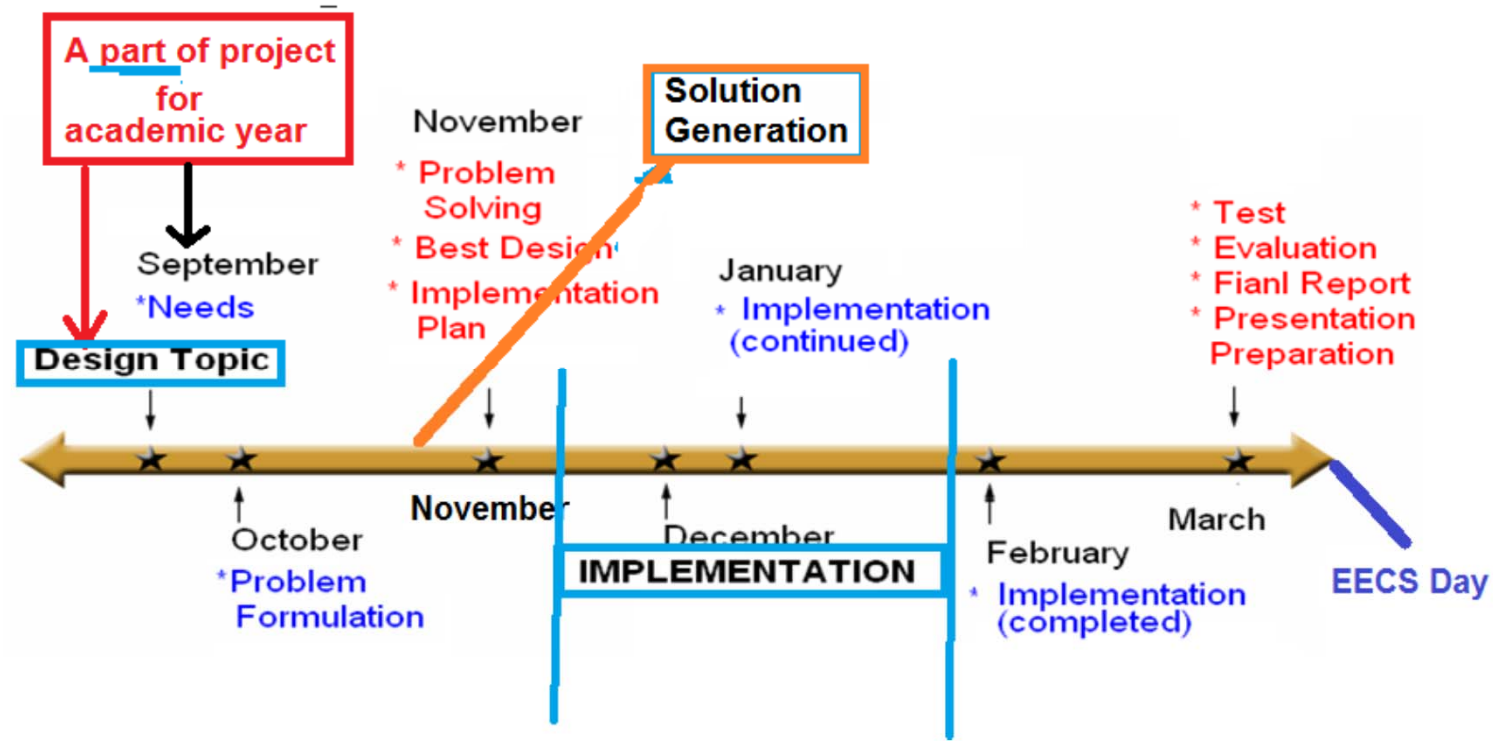


Elements of *Unsuccessful* Design Projects: Lessons from Past Design Teams

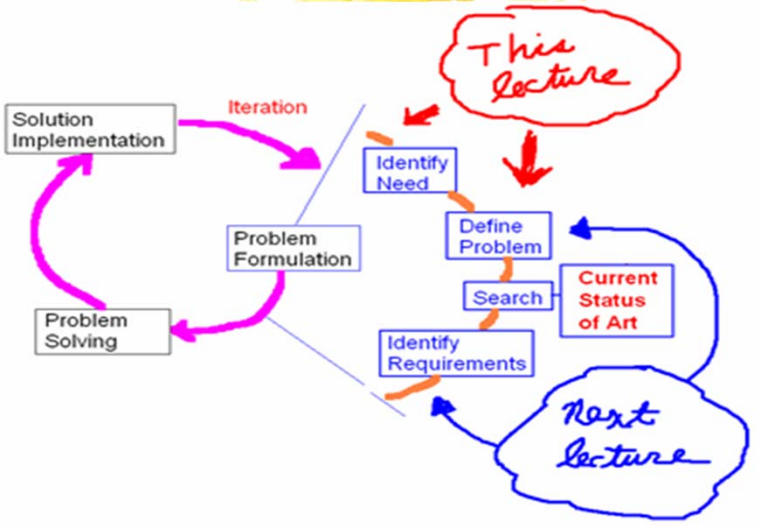
- Skill sets of team members
  - Only EE or CpE students in a team
  - No Hardware and System Integration Experience
  - Slow in learning new skills
  - Did not overcome technical difficulties
- Weak Team Dynamics
  - Unbalanced Task and Relationship
  - Leadership Problem
  - Lack of commitment
- Frequent Changes in Design
  - Sought easier path for implementation
  - Focused only on each component - Did not consider the entire system
  - Frequent design/component change

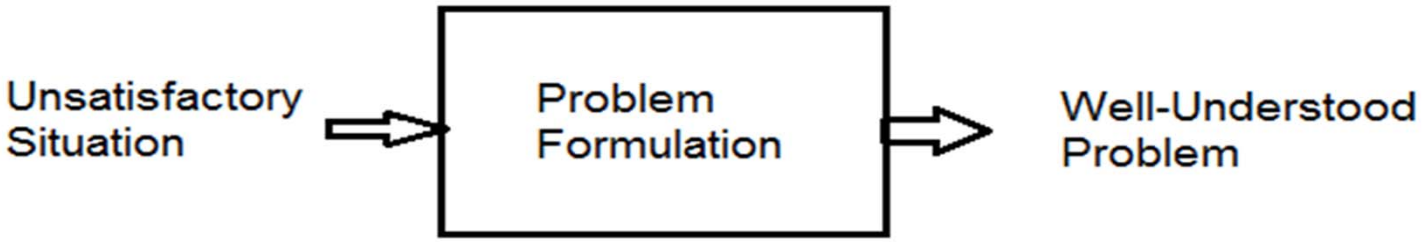
Timeline and Milestones

- **Understanding Design Processes**: August - September



Design Phase 1 - Problem Formulation





Problem Formulation: What is this ?

- "The process of converting a dissatisfied situation into a ( )"
  - Understanding the problem ("Needs"), Not finding solution ("Approach") to the problem
  - Einstein: "*The mere formulation of a problem is far more essential than its solution, which may be merely a matter of mathematical or experimental skill.*"
  - Why do we do this?
    - **Need Identification** and **Problem Definition**
    - Clear set of **Requirements** that can guide the design process through to its completion

Identifying Needs and Defining Problem

- **Identify Needs**
  - Dissatisfied situation --- problem or research topic of the team
  - Need exists – Research purpose
  - Ask your project advisor what he/she **needs** for the team for the academic year
  - Ask what **specific problem** you're asked to solve
  - Ask what is the final product to deliver
  - Don't consider Solution yet --- this will limit your solution ideas !!!
- **No Rush to get a solution ("Approach")** after Needs Identified:
  - A wrong problem may be solved!
  - A symptom may be solved!
  - **A part** of the problem may be solved!
  - Or a partial solution is obtained

Blind Men and the Elephant

- Pillar? Rope? Tree branch? Hand fan? Wall? Pipe?
- Lesson
  - Parts vs. Whole
  - Symptoms vs. Root Cause
  - Project Title (long-term goal) vs. Required Elements (academic year goal) for the entire system

Checkout Line Complaints: Problem Identification

Situation: Customer Complaint: Cashiers talk each other while serving customer.

Store Manager's Response:

Process of Defining Problem

- **Process** of **Defining Problem**
  - Outline why the present situation is so dissatisfying
    - What is the major problem
    - What is urgently needed
    - Understand the background and the situation
  - Comparing it to other situations that are familiar or where experience already exists
  - Gaining and understanding what caused it.
    - What is the breakthrough for the project success
  - Then concisely describe the **complete set of customer needs** (i.e., project's goal, deliverables)
- **And make your problem statement (Need)**
  - **Specific, Quantitative, and Illustrative**

Problem Formulation in the Context of Value Proposition

- **"Value Proposition"**
  - **Why I am the best person for the position/project**
  - **Why my proposal solves your problem best**

- **Contents: "N-A-B"**
  - Customer's **N**eed
  - My **A**pproach -→ We deal this later
  - **B**enefits to the Customer
  - *Source: "Practice of Innovation" by C. R. Carlson

Example of Value Proposition

- It is the value proposition presented to a cable company executive for a video-on-demand system.
- "I understand that you are looking to expand your business. I think we might be able to help.
- **(Need)** **(Problem)**
  - Movie rentals represent a $5 billion business opportunity that you currently cannot access.
  - The only parts of rentals that people really dislike are the obligation to return the tapes plus the late fees.
  - Customers find that it is inconvenient and wastes time.

  - *Source: "Practice of Innovation" by C. R. Carlson

Example of Value Proposition

- (**Approach**) -- This will be covered in the next phase
  - We have developed a system that allows you to provide videos on demand to your customers using your cable system, with access to all the movies of Blockbuster.
  - Our approach makes use of one of your currently unused channels, with no changes to your system. In addition, you do not need to invest any capital. Each movie costs your customers $6.99, the same cost as a rental at a video store.
- **Benefits**
  - You will receive $5 of new revenue per movie rented, with a margin of 20 percent after paying for the movie costs.
  - Your customers will have all the pause and fast forward functions of a VCR when watching the movie, and they do not have to return the movie when done. Late fees are gone.
  - We estimate you could capture a market share of 20 percent.

  - *Source: “Practice of Innovation” by C. R. Carlson

The last step – combine to 1 sentence statemnt

- (**Need**) (**Problem)**
  - Movie rentals represent a $5 billion business opportunity that you currently cannot access.
  - The only parts of rentals that people really dislike are the obligation to return the tapes plus the late fees.
  - Customers find that it is inconvenient and wastes time.
- **Benefits**
  - You will receive $5 of new revenue per movie rented, with a margin of 20 percent after paying for the movie costs.
  - Your customers will have all the pause and fast forward functions of a VCR when watching the movie, and they do not have to return the movie when done. Late fees are gone.
  - We estimate you could capture a market share of 20 percent.
- **Final 1-sentence "Problem Statement" –** combination of the essence of the Need and the Benefit
  - "The need of your company in the movie rental business in the current situation of customers' inconvenience and time-waste of tape/cd return is to quickly provide a means to eliminate the tape return requirement so that it may capture at least 20 percent market share."

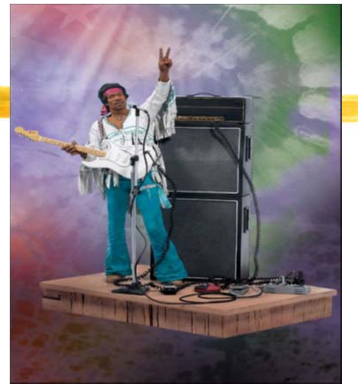
Problem Definition Exercise 1

- **Your customer**
  - **Crowded dorm room**

- Team Exercise:
  - 1) Write a Need(i. e., problem or undesired situation) (or bullet items)
  - 2)Write a Benefit (or bullet items) following the Value Proposition Examples
  - 3)Combine the Need and the Benefit into an 1-sentence statement
  - **Submission** required

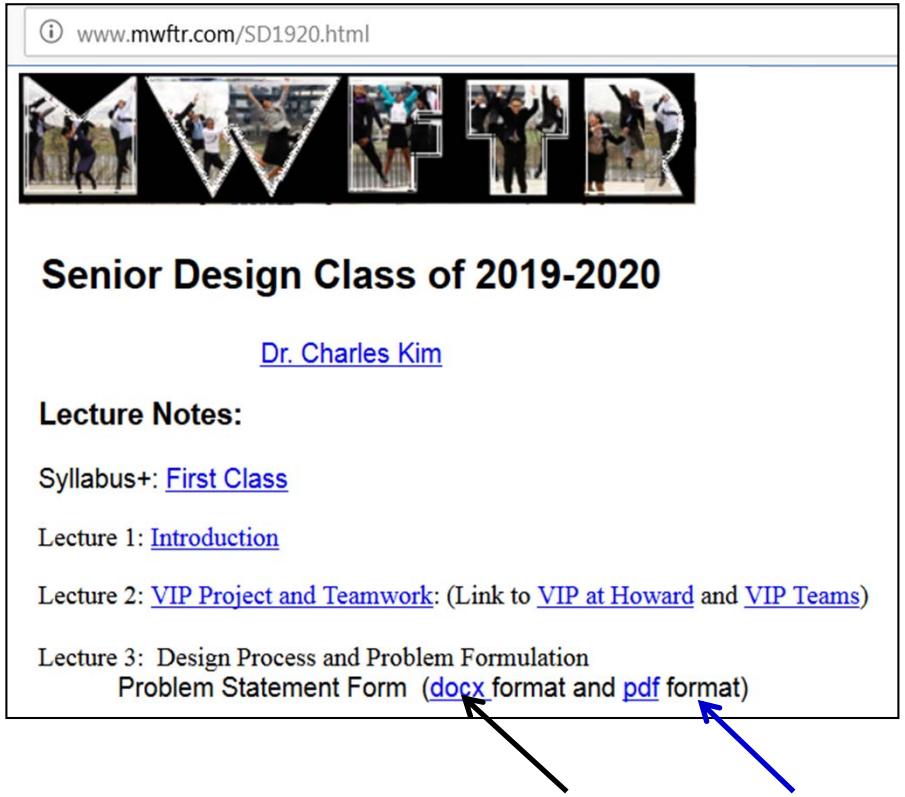
Problem Formulation Exercise - 2

- You (and your company) propose to Jimmy Hendrix and Eric Clapton a wireless guitar amp.
- Exercise Focus: (a) You write a need (Problem - Presently Undesired Situation) statement and a benefit statement, and (b) Combine them into an 1-sentence problem statement
  - Specific, Quantitative, and Illustrative
- Submission required



What is your team's Problem Statement?

- **Discuss in your team's next weekly meeting**
- **Complete the activity for identifying the proble**
- **Submit the Problem Statement**
- **Word and PDF format**



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Problem Statement Form

for VIP and Design Class

Date:_____

Team Name		
Team Project Title		
Team Faculty Advisor		
Team Graduate Assistant		
Team Members	Senior Design Class Students	
	Other Students	
Team Project's Long Term Goal		
Team Project's Academic Year Goal		
Problem Statement	Needs/Problems (i.e., Presently undesired situations)	Itemize:
	Benefits	Itemize:
	1-Sentence Problem Statement	A complete sentence:

Weekly Meeting Agenda: What is your team's Problem?

Team Activity Assignment

- Submit the Problem Statement which includes all 6 items listed below

1. **Team Name/Team Project Title:**
2. **Team Members:**
3. **Team Members of Senior Design Class:**
4. **Project's Long-Term Goal:**
5. **Project's 2019-2020 Academic Year Goal:**
6. **Problem statement**
    1. Needs/(problem - presently undesired situation) – list them all specifically
    2. Benefits – list them quantitatively
    3. Combine the above to a concise 1-sentence problem statement
7. **Submission – Monday 9/30/2019**