

# ELE 491

## Senior Design Project Proposal

These slides are loosely based on the book Design for Electrical and Computer Engineers by Ford and Coulston. I have used the sources referenced in the book freely and without re-attribution. Please see the book for full source attribution



# ELE 491

## Senior Design Project Proposal

Class 6 – Concept Generation

# Concept Generation

## Overview

- Project Flow
  - Identify problems
  - Create requirements
  - **Generate/evaluate conceptual solutions**
  - Decomposition
  - Modeling and Design
  - Validation
  - Delivery

# Concept Generation

## Overview

- **Top Ten Attributes of a Great Engineer \***
  - **Possesses a Strong Analytical Aptitude:** A great engineer has excellent analytical skills and is continually examining things and thinking of ways to help things work better. They are naturally inquisitive.
  - **Shows an Attention to Detail:** A great engineer pays meticulous attention to detail. The slightest error can cause an entire structure to fail, so every detail must be reviewed thoroughly during the course of completing a project.
  - **Has Excellent Communication Skills:** A great engineer has great communication skills. They can translate complex technical lingo into plain English and also communicate verbally with clients and other engineers working together on a project.
  - **Takes Part in Continuing Education:** A great engineer stays on top of developments in the industry. Changes in technology happen rapidly, and the most successful engineers keep abreast of new research and ideas.
  - **Is Creative:** A great engineer is creative and can think of new and innovative ways to develop new systems and make existing things work more efficiently.

\* src: engineeringschools.com

# Concept Generation

## Overview

- **Top Ten Attributes of a Great Engineer – cont'd**
  - **Shows an Ability to Think Logically:** A great engineer has top-notch logical skills. They are able to make sense of complex systems and understand how things work and how problems arise.
  - **Is Mathematically Inclined:** A great engineer has excellent math skills. Engineering is an intricate science that involves complex calculations of varying difficulty.
  - **Has Good Problem Solving Skills:** A great engineer has sharp problem solving skills. An engineer is frequently called upon solely to address problems, and they must be able to figure out where the problem stems from and quickly develop a solution.
  - **Is a Team Player:** A great engineer understands that they are part of a larger team working together to make one project come together successfully, and therefore, must work well as part of that team.
  - **Has Excellent Technical Knowledge:** A great engineer has a vast amount of technical knowledge. They understand a variety of computer programs and other systems that are commonly used during an engineering project.

# Concept Generation

## Overview

- The Conflict
  - **Is Creative:** A great engineer is creative and can think of new and innovative ways to develop new systems and make existing things work more efficiently.
  - **Shows an Ability to Think Logically:** A great engineer has top-notch logical skills. They are able to make sense of complex systems and understand how things work and how problems arise.
  - **Must be able to suspend logical/critical thinking in order to free up the creative thinking**

# Concept Generation

## Creativity

- Definitions
  - The ability to transcend traditional ideas, rules, patterns, relationships, or the like, and to create meaningful new ideas, forms, methods, interpretations, etc.
  - Characterized by sophisticated bending of the rules or conventions.
- Synonyms:
  - cleverness, creativeness, imagination, imaginativeness, ingeniousness, ingenuity, innovativeness, invention, inventiveness, originality

# Concept Generation

## Creativity

- Creativity Activities
  - Src: <http://creativitygames.net/>
  - Team up
  - Create a plausible company or store that would use the following logo
  - Create a slogan for your company/store
  - 5 min





# Concept Generation

## Creativity

- Barriers to Creativity
  - Perceptual blocks
  - Emotional blocks
  - Cultural and environmental blocks
  - Intellectual and expressive blocks

# Concept Generation

## Creativity

- Barriers to Creativity
  - Perceptual blocks
    - Limit the space
      - Add constraints that don't exist
    - Stereotyping
      - Prior history colors current thinking
      - Always did it with an opamp – need an opamp now
    - Problem Identification
      - *Who, when, how, why* all impact what you define as the *what*

# Concept Generation

## Creativity

- Barriers to Creativity
  - Emotional blocks
    - Fear of failure
      - \$\$\$ riding on your decisions
      - Your career
      - Others careers
      - Peoples safety
    - Lack of control
      - Chaotic
      - No clear process or path
      - No “Aha!” moment yet
    - Rush to judgment
      - Shoot down ideas instead of build them up

# Concept Generation

## Creativity

- Barriers to Creativity
  - Environmental blocks
    - Poor teamwork
      - Wrong mix
      - Too judgmental
      - Lack of open mind
    - TIME
  - Cultural blocks
    - Engineers believe there is A right solution
    - Creativity generally runs against what you are taught

# Concept Generation

## Creativity

- Barriers to Creativity
  - Intellectual and expressive
    - Lack the required basic knowledge to create new solutions
      - No understanding of digital design → no non-analog solutions
    - Lack the ability to articulate your ideas
  - Vertical vs lateral thinking
    - Vertical – follow the path to a solution
    - Lateral – explore the space to see what “might be”
    - Lateral required for concept generation
    - Vertical required for design

# Concept Generation

## Perception

- On the next few slides – take note of the **FIRST** thing you see

# Concept Generation

## Creativity

- Enhancing Creativity
  - Have a questioning attitude
    - Why? Why? Why?
  - Practice
    - Puzzles, Problem of the day
  - Suspend judgment
    - Consider all ideas as viable
    - Even when discarded – keep the idea for another use
  - Allow time
    - End time is often fixed – start early – allow ideas to percolate
  - Think like a beginner

# Concept Generation

## Creativity

- Enhancing Creativity
  - A semi-formalized process – SCAMPER
    - Substitute
    - Combine
    - Adapt
    - Modify
    - Put to other use
    - Eliminate
    - Rearrange or reverse



# Concept Generation

## Concepts

- Generating Concepts
  - Background research
    - Literature searches
    - Patent searches
    - Benchmarking
    - Stakeholder interviews
  - Brainstorming
    - Individually or in groups
    - All ideas will be considered
    - No criticism or judgment
    - Quantity
    - Build on ideas – do this intentionally

# Concept Generation

## Concepts

- Evaluating Concepts
  - Creative stage should yield  $>10x$  number of concepts to pursue
  - Preliminary evaluation
    - Reduce number of concepts to 2-3x number to be pursued
  - Final evaluation
    - Reduce the number of concepts to the number to be pursued
    - Typically 1
    - Sometimes carry more than 1 for a period of time when several look promising
      - Requires extra resources or time

# Concept Generation

## Concepts

- Evaluating Concepts
  - Preliminary evaluation
    - Reduce number of concepts to 2-3x number to be pursued
    - Limited technical analysis
      - Technical viability
      - Access to components, equipment, expertise
      - Cost, schedule
      - RISK
    - Informal AHP process
      - Identify a path to meet all key requirements

# Concept Generation

## Concepts

- Evaluating Concepts
  - Final evaluation
    - Reduce number of concepts to number to be pursued
    - Deeper technical analysis
      - Technical viability
      - Access to components, equipment, expertise
      - Cost, schedule
      - RISK
    - Semi-formal AHP process
      - Score all key requirements

## In Class Activity