

ECE 101 Exploring Electrical Engineering

■ *Design*

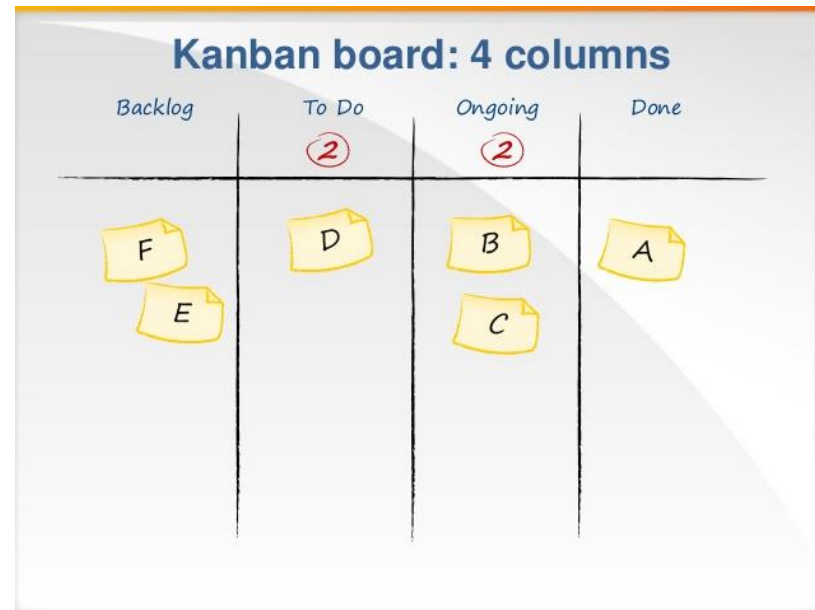
- Intro
- 10-steps
- Videos:
 - <https://www.youtube.com/watch?v=M66ZU2PClcM> (short)
 - <https://www.youtube.com/watch?v=2Dtrkrz0yoU> (long)
 - <https://www.youtube.com/watch?v=16p9YRF0l-g> (TED)

What is engineering design?

- “to create, fashion, execute, or construct according to plan”
- “Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process ...”
- How do you teach / learn design?
- Some “specs” on this:
 - Build upon math, sciences, social science, comm. etc concepts
 - Make it reflect actual practice
 - Team effort
 - Develop across curriculum (→ capstone)
 - Draw on previously acquired knowledge and skills

What is engineering design?

- Consider the project of designing a **shopping cart**
- Take this example & work in your assigned groups
- Can you state the problems this project is attempting to solve?
- Suppose that you were not given any specs and requirements
- Describe stages this project would go through
- Label them on sticky notes
- Put them in proper order (top-down) on a board (Kanban)
- State a major outcome for each (what will be produced? How will you know you were successful?)
- Draw a Kanban board on whiteboard and label columns with stage names
- Translate this into a board on trello.com



Design process

- There is more than one way to approach eng. design
- Depends on circumstances, environment and project
- 10-stage design process:
 1. Identify the problem/product innovation
 2. Define the working criteria/goals
 3. Research and gather data
 4. Brainstorm/generate creative ideas
 5. Analyze potential solutions
 6. Develop and test models
 7. Make the decision
 8. Communicate and specify
 9. Implement and commercialize
 10. Post-implementation review and assessment
 11. How many can you identify in Ideo video (short or long)?

1. Identify the problem

- Companies may have departments devoted to this
- Entrepreneur may start from an idea and perceived need
- Establishing **clearly** what the actual problem is critical
- Identify sources of information that can help clarify the scope and nature of the problem
- Who provides input? Typically, many sources.
- Very important to understand customer needs (or perceived needs)
- What is competition up to?
- Is this improvement on existing design or completely new design?

2. Define the working criteria and goals

- How do we know which solution is better than others?
- Need to establish criteria or standards to be used in all 10 stages to evaluate (measure) possible solutions
- In this stage – establish preliminary goals which will act as the focal point of the team throughout the process
- It is possible to change criteria as design develops
- For your shopping cart problem: what working criteria would you suggest? Work as a group and propose at least three, preferably more.

2. Define the working criteria and goals

■ Textbook suggestions:

- ☐ Cost
- ☐ Production difficulty
- ☐ Size, weight, strength
- ☐ Look
- ☐ Ease of use
- ☐ Safe to use?
- ☐ Legal problems
- ☐ Reliability & durability
- ☐ Recycle?
- ☐ Will anyone want it / purchase it
- ☐ How different is it from competition?

■ Define overall goal for the process

3. Research and gather data

- What type of information will be needed? What are the best sources of information?

Type of information:

- What info has been published
- Is there a solution already
- Who is providing it
- What are pro/cons of it
- Cost of that solution
- Is cost significant issue
- Ratio of time spent vs. overall costs
- Legal issues
- Environmental concerns

Sources:

- Libraries
- What else? Give at least three
- Professional associations
- Trade journals and publications
- Newspapers and magazines
- Market surveys
- Government publications
- Patents
- Sales people
- Experts

Re-evaluate preliminary working criteria / standards

4. Generate creative ideas

- Create as many potential solutions to the problem as possible
- Organize a group of people with different backgrounds
- One technique: brainstorming
- Focus is on creating as many ideas without any judgments
- Time permitting – have an exercise in brainstorming
 - How many ways to use a piece of string and a Styrofoam drinking cup?
 - What could be created from a trash bag that contains old magazines, tape and ruler
 - Pick a facilitator; define the problem; select a group; explain the process; record ideas; involve everyone; no evaluating; eliminate duplicates; pick three
- No elimination is done at this stage

5. Analyze potential solutions

■ Narrow the list:

- ☐ Eliminate duplicates
- ☐ Allow the group to ask clarifying questions
- ☐ Ask the group to evaluate the ideas and vote for top three

■ Analysis:

- ☐ Common sense (could be dangerous / difficult)
- ☐ Economic analysis
- ☐ Using basic engineering principles and laws
- ☐ Estimation
- ☐ Compatibility with working criteria
- ☐ Computer-aided analysis
- ☐ Conservative assumptions

6. Develop and test models

- Specific models for the top choices are developed
- Types of models:
 - Mathematical models
 - Computer models (CAD)
 - Scale models
 - Diagrams or graphs
- Testing with working criteria in mind

Durability	Ease of assembly
Reliability	Strength
Environment	Quality consistency
Safety	What about EE tests?

7. Make the decision

- Once testing is done, how do we pick the best solution?
- Decision matrix / table: working criteria in one column, 2nd column is for weighted available point total for each criteria and 3rd column(s) is for performance scores for each solution

Working criteria	Points available	#1	#2	#3
Cost	20	10	15	18
Difficulty	15	8	12	14
Size	5	5	4	4
Appearance	10	7	6	8
...				
Total	100	63	72	84

8. Communicate and specify

- Prepare and organize all materials that will help make the final decision (approval) of the project and help with implementation.
- Could include: written reports, technical presentations, memos, e-mails, diagrams, drawings, sketches, printouts, graphs, charts etc.
- Team “sells” the product to the rest of the organization – communication is critical in all stages but especially in this one
- Some additional materials, e.g. training materials, operating manuals, programs etc may be developed at this stage

9. Implement and commercialize

- Final chance to terminate or go ahead
- Costs now escalate so all serious issues must be resolved
- Others get involved:
 - Management and key supervisory personnel (decision making)
 - Technical representatives – responsible to get the product out the door
 - Business representatives:
 - Human resource personnel
 - Financial people
 - Purchasing personnel
 - Marketing and advertising staff
 - Sales people
 - Attorneys and legal support staff

10. Post-implementation

- Final project review and assessment
- Terminate the project team
- Review product's performance (production efficiency, quality control reports, sales, revenues, costs, expenditures, profits)
- Report detailing product's strengths and weaknesses, lessons learned, ways to improve design process in the future