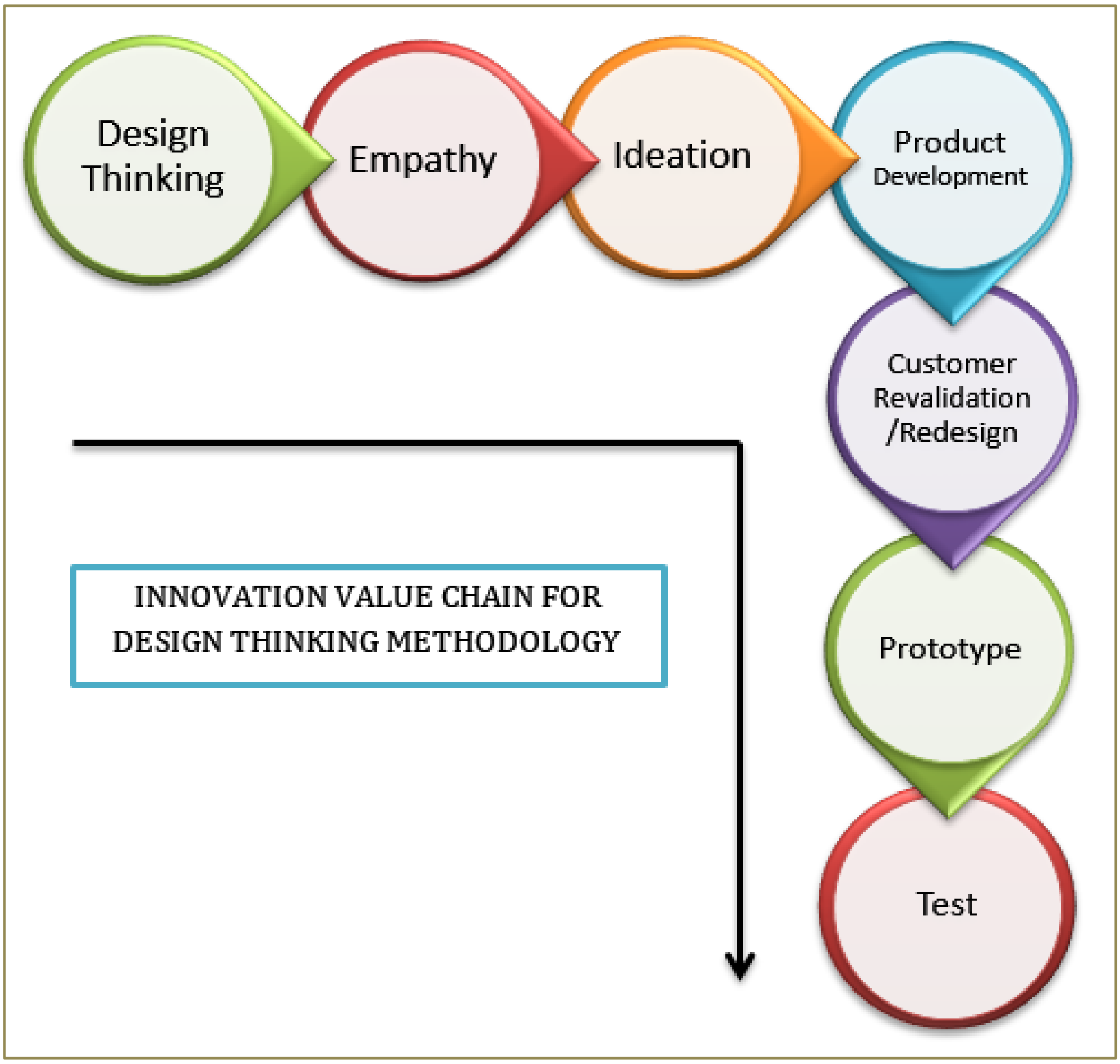
Design Engineering – 2A

General Guidelines and Syllabus_5th Semester

All students in 5th semester are to follow below guidelines for their DE-2A project work.

Students have learnt the detailed Design Thinking methodology in 2nd year and successfully gone through the process from Empathy mapping to rough prototypes of their concepts. Now in 5th and 6th semester all teams need to take their concept further in the development process of Innovation Value Chain to convert into final product/process. At this stage, it is essential to identify parameters and check for five basic design principles viz. 1) Technical, 2) Ergonomics, 3) Aesthetics, 4) Cost and 5) Environment in relevancy to the rough-prototypes as developed. Designing something new involves several iterations on different stages/ components/ aspects. Before investing further resources in terms of time/ money/ manpower it is important to strengthen these five principles to advance for novelty. It will include several rigorous iterative efforts to make final product/process.



OPEN DESIGN SCHOOL

Fundamental idea to introduce the subject is to make projects/ products human centric. Here is a brief comparision on conventional method and design thinking approach in developing a product.

	Design Thinking is appropriate if…	Conventional - Linear Analytic methods may be better if…
Is the problem human-centered?	Deep understanding of the actual people (users) is involved	There are a very few human beings involved in the problem or the solution
How clearly do you understand the problem itself?	We need to explore and get agreement	We understand the problem clearly and are sure we are solving the right one
What is the level of uncertainty?	There are many unknowns (large and small), and past data is unlikely to help us.	The past is a good predictor of the future
What data is already available to you?	There is very little relevent existing data to analyze	There are several clear resources of analogous data

(Source: Liedtka, J., Ogilvie, T., & Brozenske, R. (2014). The designing for growth field book: A step-by-step project guide. New York, NY: Columbia.)

All students' team need to work towards final prototype and then test it in real environment as per following guidelines. Case-to-case wisdom will be required to implement the same. It is advisable, for those who want to work on different concepts dissimilar than 2nd year, to choose any branch specific small artefacts/machine to be designed based on Design Thinking Methodology starting from very first phase i.e. Observation (field activity) and reach up to product development and then they will continue working towards final prototype as regular 5th semester work agenda.

In the 5th semester, student's team will develop their concept with reference to five aspects of product development process as mentioned earlier (Technological, Ergonomics, Aesthetics, Cost and Environment). Detailed design check list inclusive of maximum details on concept including material requirement, dimensions, sizes, shape, manufacturing process and allied requirements, parts – assembly, bill of material, quality, safety, performance, etc. shall be prepared. Following aspects should be taken into account while developing product.

1. Design for Performance, Safety and Reliability:

- ✓ *Design for performance:* The final product/process must perform for designed (projected in Product Development Canvas - PDC) features and functions as per the requirement of the user in actual working environment (revealed through rough-prototype validation).

- ✓ *Design for Safety:* Safety is the most important aspect of human centric product/process. Reasonable factor of safety should be taken into account considering all adverse and factual factors (Ideation canvas – location/context/situation may be referred back here) as there is human interaction with product/process in manifold circumstances.
- ✓ *Design for Reliability:* Reliability is the ability of a system or component to perform its required functions under stated conditions for a specified period of time[1]. Your final product/process should be reliable as required by the user and should perform its desired functions as required for desired time period.

2. Design for Ergonomics and Aesthetics

- ✓ *Ergonomics* is all about designing for human factors/comforts wherever they interact with product/process and surrounding environments. According to the **International Ergonomics Association** within the discipline of ergonomics there exist domains of specialization: (a) ***Physical Ergonomics*** – is concerned with the human anatomy, bio mechanical and physiological ability and its relevance to the product and surrounding systems; (b) ***Cognitive Ergonomics*** – is concerned with the mental ability such as perception, memory, reasoning and response power as they affect the interactions between humans and products/systems ; (c) ***Organizational Ergonomics*** – is concerned with the optimization of socio-technical systems including organizational structures, policies and processes.
- ✓ *Aesthetics* is all about designing for physical appearance (looks) of the product. In current time, customers are willing to buy the products which have stunning looks with respect to their competitive products. Design for Aesthetics includes appearance, style, colour, form/shape, visuals and so on.

3. Design for Manufacturability & Assembly (DFMA)

- ✓ DFMA stands for two terms; *DFM – Design for Manufacturability* which means for ease of manufacturing of parts/components of final product. *DFA – Design for Assembly* which means manufactured parts can be easily assembled to form a final product. DFMA approach helps to design and manufacture/construct the product easily and economically. Designer must design components/parts that can be easily manufactured with available resources at minimum cost of production and can be easily assembled by assembly personnel. The intentions behind implementing DFMA practice in product development is to minimize manufacturing and assembly cost, improve efficiency, eliminate waste of material and time. Iteration on involved raw materials may be performed to check available alternatives – as materials play a major role in production cost. Basic guidelines may be followed as below:

[1] Definition by IEEE.

- Check for alternative and compatible raw materials (Refer/ revise to LNM)
- Minimize the number of parts (Refer/ revise to PDC)
- Develop a modular design
- Design parts to be multi-functional
- Design parts for multiple-use
- Design for ease of fabrication/ production/ assemble
- Minimize assembly paths
- Avoid separate fasteners (i.e. monolithic units)
- Eliminate adjustments as possible (i.e. movement in parts addressing multiple use – it's a trade-off)
- Design for minimum handling
- Avoid use of additional tools when possible
- Minimize subassemblies (i.e. joining and removing some of the parts)
- Use standard parts when possible (refer/ revise to LNM)
- Simplify operations
- Design for efficient and adequate testing (refer/ revise to LNM)
- Use repeatable & understood processes
- Analyze failures
- Rigorously assess value (i.e. cost of production against minimizing cost of human efforts being done at present – Refer to AEIOU observation framework)

4. Design for Cost, Environment

- ✓ *Design for cost* means designing for lowest possible life cycle cost. It involves – assumed product design cost (manufacturing), delivery cost (to the end-user) as well as cost of operation and maintenance.
- ✓ *Design for environment* strategy describes best practices of designing a product/process to minimize health and environmental ill-impacts. Four main concepts of Design for Environment includes: (a) Design for Environmental aspects during Processing and Manufacturing; (b) Design for Environmental aspects in Packaging; (c) Design for Disposal or Reuse (i.e. after end of product/ process life-cycle as involved in one's case); (d) Design for Energy Efficiency (i.e. energy consumption during the product/ process usable life)

  Using the theories, methods, tools, software, mathematical tools, and standards etc. as listed in LNM prepared by the students during their studies of semester 4, students should complete the detail design (physical dimensioning/specifications) and production drawing/construction plan of the product/process during this semester so that fabrication of prototype/ sample live-working model can be undertaken during next semester. As the process is iterative students can also update the LNM based on the course work undertaken and experience gained so far.