GUJARAT TECHNOLOGICAL UNIVERSITY

General Guidelines for

DESIGN ENGINEERING

Course Initiated by:

Centre for Industrial Design

(OPEN DESIGN SCHOOL)

For any query, please write us at: design@gtu.edu.in

Contents:

Concept Note for DE

Gujarat Technological University, Ahmedabad, India - is always striving for shaping a better future for its students by putting astonishing efforts to make its education system excellent enough so students and ultimately whole society would benefit. In the light of above context, GTU has established a ***Centre for Industrial Design (OPEN DESIGN SCHOOL)*** to lead and manage the design-oriented pedagogies at all its Colleges. The Centre also collaborates with the industries to improve its design processes and it may accept consultancy assignments for design and innovation. While the Consultancy projects may help the industry, the objectives during the initial years would be to build and improve capacities among the faculty members. Secondly such projects would provide opportunities to the students to work on real-life projects.

On 2nd February, 2012 (The first cohort of 4-year degree engineering students graduated out in May 2012.), GTU started the process of updating its syllabi. Being the most Innovative and one of the largest University of India, GTU always tries to cope up with all latest trends in Innovation, Entrepreneurship and Technological advancement. In this regard, GTU has introduced a creative and interactive practical approach in its syllabi named "Design Engineering" in AY 2014-15. Design Engineering is very unique and pioneering initiation of GTU based on globally accepted and implemented techniques by designers and engineers called ***"Design Thinking"***. One of the key objectives of this initiation is to infuse the Design Thinking mind-set into engineers of future with pervading the methodology into core subjects also. It is a first of its kind initiation in the Indian Education System by affiliating type University. Four modules, in Design Spine, have been introduced from 3rd to 6th semester in every branch of the engineering curriculum of its all affiliating colleges across the Gujarat State.

To move a step forward in this direction, GTU's Centre for Industrial Design (OPEN DESIGN SCHOOL) has conducted a series of Faculty Development Programs (FDPs) to sensitize the Design Driven Innovation for faculty members of various colleges and created different frameworks/Canvases so that students can better learn the subject. So far, 51 FDPs have been organized centrally at GTU till date at various learning level, in which more than 4000 faculty members have been trained for Design Thinking methodology from around 125 engineering colleges across the states from more than 15 branches. Further one International conference and one National Symposium have been organized by GTU to map the progress of the initiation as well as to know the ground reality at the colleges by inviting academia, industry and policy makers on common platform, the very basic idea of these two events was to strengthen the course by applying global practices in Design Thinking to achieve "Make in India" & "Start- up India" initiatives of Honourable Prime Minister, Mr. Narendra Modi.

Design Engineering Process

Design Engineering is based on methodology that is globally accepted and practiced by designers and engineers called ***"Design Thinking"***. Design thinking process may be divided into six simple yet iterative phases as shown below. At every semester students need to follow this whole process for their projects.

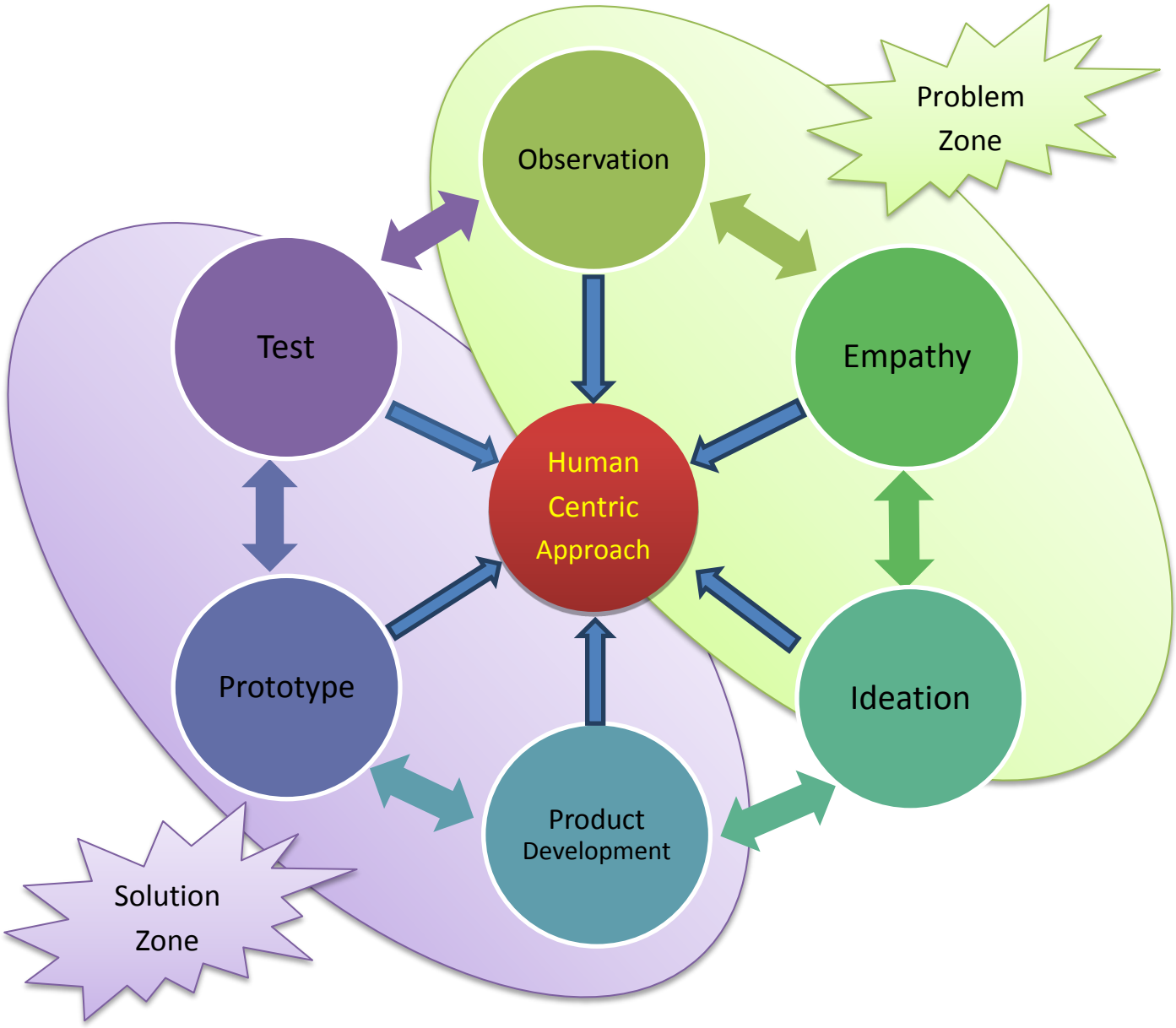
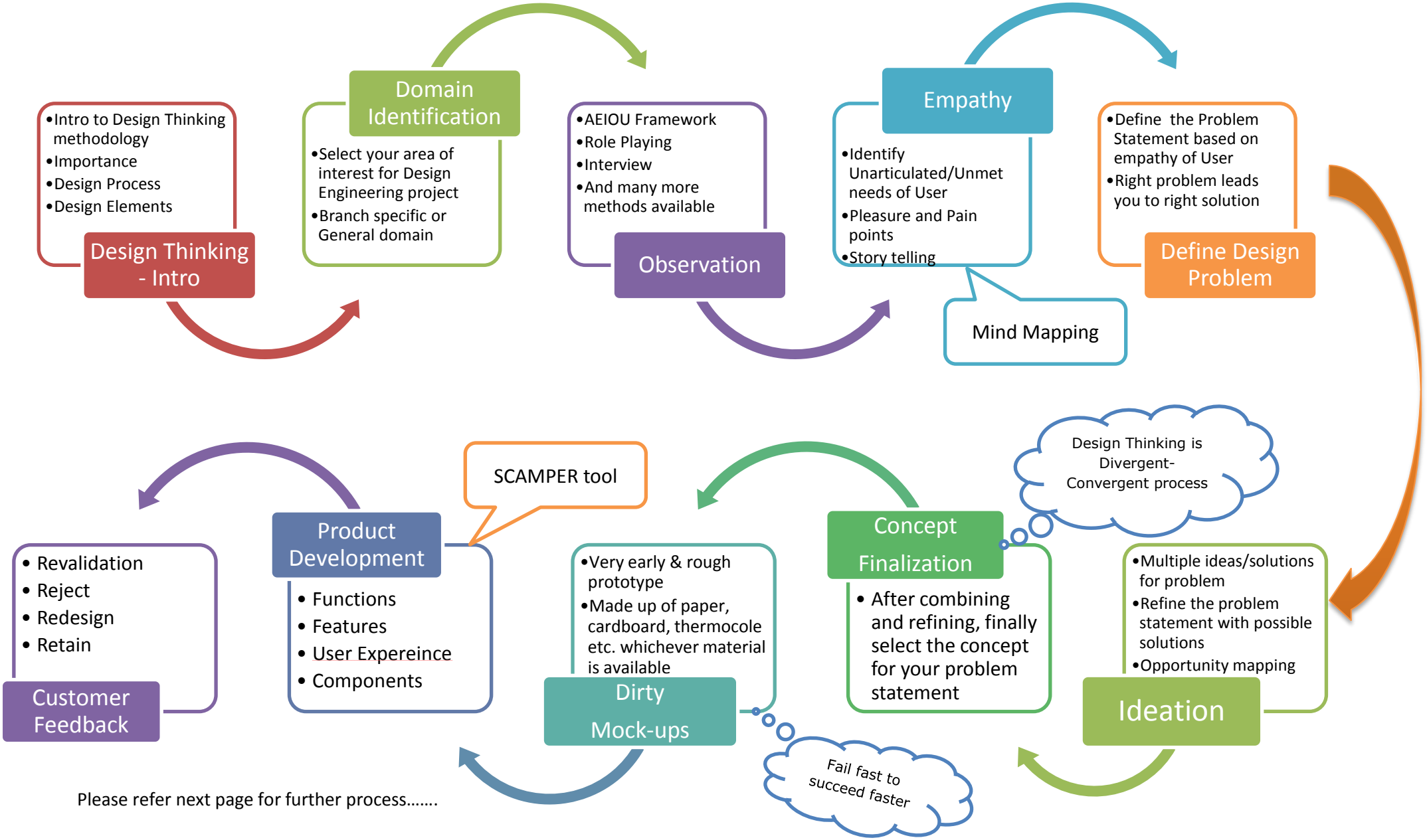


Figure 1: Design Thinking Process

Design Thinking Process – Details with Tools & Techniques



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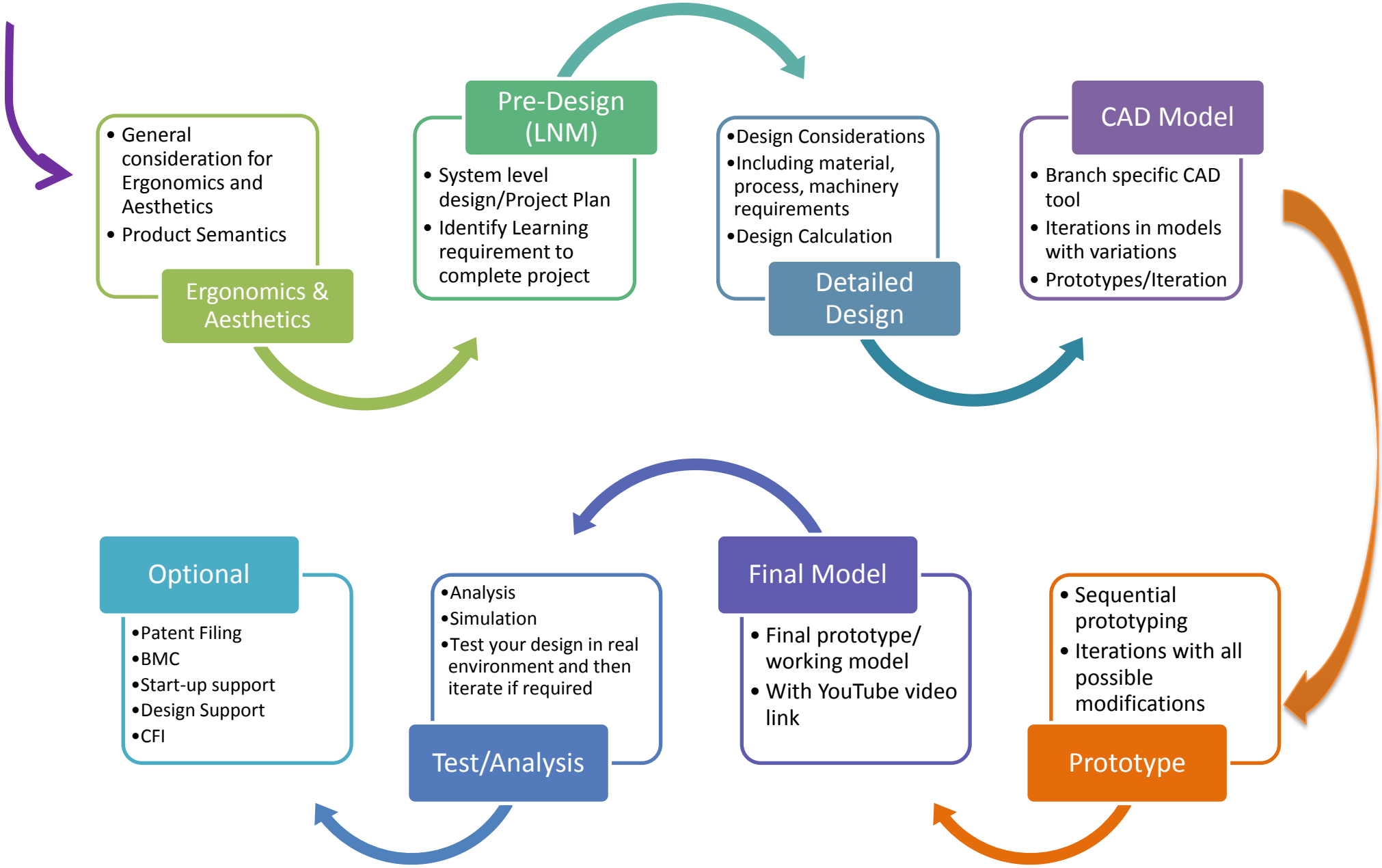
Ergonomics & Aesthetics
• General consideration for Ergonomics and Aesthetics
• Product Semantics
Pre-Design (LNM)
• System level design/Project Plan
• Identify Learning requirement to complete project
Detailed Design
•Design Considerations
•Including material, process, machinery requirements
•Design Calculation
CAD Model
• Branch specific CAD tool
• Iterations in models with variations
• Prototypes/Iteration
Prototype
• Sequential prototyping
• Iterations with all possible modifications
Final Model
• Final prototype/ working model
• With YouTube video link
Test/Analysis
•Analysis
•Simulation
•Test your design in real environment and then iterate if required
Optional
•Patent Filing
•BMC
•Start-up support
•Design Support
•CFI

Very Important Information:

As shown above, Design Thinking process is step by step process but iterative in nature. Based on type/nature of projects, it may slightly vary with the sequence. Design Engineering subject at GTU is based on below mentioned four modules from 3rd to 6th semester *(in final year for IDP/UDP, students will use their learning from these four modules of DE to complete their projects)*. These modules include Design Thinking Process, Design Elements, Design Methods and various learning tools for better understanding. In each module at every semester, student will use above shown Design Thinking process (whole cycle) to complete their projects, starting from Observation to prototype but with different learning objectives in every semester as described in each module further. *Students, faculty members and institutes are encouraged to work on multi-disciplinary/stream project.*

The objective of using whole Design Thinking process in every semester and repeating it again and again is to master the process so that irrespective of the problem and domain, after graduation, in their professional carrier students would solve the problems easily irrespective of domain as they would have mastered the process. By saying this, University wants that the students will learn the process properly and focus on details of every stage. The final outcome of the project is one of the important and desired evaluation criteria, but one should also celebrate the failure. So we suggest the students that you should only focus on the process of Design Thinking and do not worry about the final outcome, you can always iterate and modify your concept at every stage. If one would follow the process accurately then outcome would be definitely precise.

During their Bachelor of Engineering, students are learning the various principles and aspects of engineering, through this Design Engineering course, university wants to inculcate Design Mind-set and Attitude in the students so that students can integrate their engineering/technical knowledge to create better solutions. Students and faculty members need to relate the core subjects topics of respective semester and branch with their Design Engineering projects as one of the key objectives of this initiation is to infuse the Design Thinking mind-set into engineers of future with pervading the methodology into core subjects also.

GTU has implemented new syllabus for the students of Bachelor of Engineering from the AY 2018-19 as per AICTE guidelines. Design Engineering will be offered in Semester III, IV, V and VI. There will be internal evaluation for Design Engineering in Semester III and IV and external evaluation in Semester V and VI. The course content, process to carry out projects, evaluation pattern and guidelines etc. will be the same as earlier and equal importance must be given to Design Engineering by student, faculty members and colleges as given to other core subjects as it is very important for practical learning/application of subjects.

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Post-graduate Research Centre for Industrial Design

OPEN DESIGN SCHOOL

Design Engineering – 1A (3130008) (3rd Semester)

Module 1: Understanding Design Thinking

Name of the Discipline & the Programme: ***Every discipline of the Engineering***

Course category: ***Compulsory/Core - Basic***

Examination Pattern: ***Internal evaluation/viva at the end of semester***

Prerequisites: ***Optimistic mind-set, Enthusiasm of learning new things, Unlearn yourself***

				Credit				Marks				
Subject code	**Subject Name**	**Category**	**Sem.**	**L**	**T**	**P**	**Total**	**E**	**M**	**I**	**V**	**Total**
3130008	DE - IA	Project Work	3	0	0	2	1	0	0	20	80	100

*L=lectures, T=tutorial, P=Practical, E=Theory External, M=Theory Internal, I=Practical Internal, V=Practical External, OJT=On Job Training is equivalent to Practical

Relevance

This course is meant for beginners. The course is designed to imbibe Design Thinking understanding and mind-set for the 3rd semester students.

Objective: Understanding Design Thinking

The course aims to expose the students to the basic process and framework of Design Thinking and relevant tools & techniques for Creativity & Innovation.

Course Contents

This Course is designed to give very basic understanding of the Design Thinking methodology. The content is divided into week-wise activities to better understand the course and give enough time to all the learning parts of it, but depending upon the type and nature of projects, students and guide may allocate more/less time to the activities. In Design Engineering – 1A, student will select **very basic and small, individual or team project** of general topic/domain like designing something for yourself/parents/Teacher/Friends. Whole class may select single project topic or similar topic in different small groups to have healthy competition among the class. This kind of basic project would give good understanding of Design Thinking process. **In this module student will use whole Design Thinking process as shown in fig 1 above to complete their projects but here the learning objective or focus would be on Observation or Empathy process.** So students need to give more time to these phases and then reach up to the rough prototype phase.

Design Engineering – 1B (3140005) (4th Semester)

Module 2: Applying Design Thinking

Name of the Discipline & the Programme: ***Every discipline of the Engineering***

Course category: ***Compulsory/Core - Intermediate***

Examination Pattern: ***Internal evaluation/viva at the end of semester***

Prerequisites: ***Design Engineering – 1A***

				Credit				Marks				
Subject code	**Subject Name**	**Category**	**Sem.**	**L**	**T**	**P**	**Total**	**E**	**M**	**I**	**V**	**Total**
3140005	DE - 1B	Project Work	4	0	0	2	1	0	0	20	80	100

*L=lectures, T=tutorial, P=Practical, E=Theory External, M=Theory Internal, I=Practical Internal, V=Practical External, OJT=On Job Training is equivalent to Practical

Relevance

This is a revision course designed for those who have undergone the fundamentals of design thinking process in 3rd semester.

Objective: Applying Design Thinking

The course aims to validate the learnings from the understanding design thinking course by translating the concepts into exercises. Here branch specific topics need to be selected by students, apply reverse engineering, modify existing solutions and refine their learning for Design Thinking phases.

Course Contents

In the 3rd semester, students have learnt the basic Design Thinking methodology in DE-1A and undergone the phases of the same with necessary tools and techniques and worked upon general topic/domain irrespective of their branch. Now in 4th semester, they need to select **branch specific existing artefact/solution, apply Reverse Engineering and modify/redesign** it as per the User's needs using Design Thinking approach. Here, students will work on branch specific design projects and they would relate all stages/phases of Design Engineering with their regular core subjects of particular branch in current and further semester/s as one of the key objectives of Design Engineering subject is to imbibe Design Thinking approach into core engineering subject for practical learning. In this module also whole Design Thinking process will be used by students, but more emphasis on Ideation and initial Product Development phases.

Design Engineering – 2A (2150001) (5th Semester)

Module 3: Applying Design Thinking

Name of the Discipline & the Programme: ***Every discipline of the Engineering***

Usual time of occurrence: ***5th Semester***

Duration: ***Six (6) months***

Course category: ***Compulsory/Core - Advance***

Credits: ***03***

Examination Pattern: ***External evaluation/Viva at the end of semester***

Prerequisites: ***Design Engineering – 1A, Design Engineering – 1B***

Relevance

This is a mid-level course designed for those who have undergone the fundamentals of design thinking process in 2nd year.

Objective: Applying Design Thinking

The course aims to validate the learnings from the understanding design thinking course by translating the concepts into exercises. In this module, students will work upon community based projects to validate their learning of Design Thinking process and try to solve real issues.

Course Contents

Students have learnt the fundamentals of Design Thinking methodology in 2nd year and successfully gone through the process twice while working on general as well as branch specific topics. Now in 5th and 6th semester, students need to work on **community/society based project** and use whole design thinking process. Here in 5th semester, emphasis will be on Observation, Empathy and Ideation; while in 6th semester emphasis will be on product development, detail design, prototyping and validation of the solutions in real environment. At this stage, it is essential to identify parameters and check five basic design principles viz. 1) Technical, 2) Ergonomics, 3) Aesthetics, 4) Cost and 5) Environment keeping System Approach in mind. 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.

Design Engineering – 2B (2160001) (6th Semester)

Module 4: Building the Solution

Name of the Discipline & the Programme: ***Every discipline of the Engineering***

Usual time of occurrence: ***6th Semester***

Duration: ***Six (6) months***

Course category: ***Compulsory/Core - Advance***

Credits: ***03***

Examination Pattern: ***External evaluation/Viva at the end of semester***

Prerequisites: ***Design Engineering – 1A, Design Engineering – 1B, Design Engineering – 2A***

Relevance

This is an advance level course designed for those who have undergone the fundamentals of design thinking process.

Objective: Building the Solution

The course aims to validate the learnings from the understanding design thinking course by translating the concepts into exercises. In this module, student will continue their work from 5th semester on Community/Society based project and complete the Design Thinking cycle with emphasis on product development, detail design, prototyping and validation of the solutions in real environment.

Course Contents

Students have started community based projects and successfully gone through the process of Observation, Empathy and Ideation in 5th semester. Now in 6th semester, they will **continue their work** from Ideation to product development, detail design, prototyping and validation of the solutions in real environment. All students' team need to work towards final prototype and then test it in real environment. Final working model with YouTube video link is required for this module.

In the 6th semester, student's team will validate their concept and detailed design part with reference to (1) Modelling and Analysis of their design (2) Prototyping and sequential iteration of concepts, (3) Engineering Economics of Design, (4) Design for Use, Reuse and Sustainability and (5) Test the prototype and additionally students will also learn topic like (6) *Ethics in Design*.

Week-wise modules for each semester:

(**Note:** This is overall schedule; it may vary depending upon the type of projects)

Week	Design Thinking Modules			
	3rd Semester (Very basic, General Topic)	**4th Semester (Branch Specific – Reverse Engg. Topic)**	**5th Semester**	**6th Semester**
			Community/Society based Topic)	
1	○ Overview, objective and goal of this course ○ Design Thinking - Intro ○ Its importance, socio-economical relevance ○ Design thinking to foster innovation	○ Branch Specific topic – Reverse Engineering Topic ○ Team Selection	Domain Selection (Community/Society Based Project selection)	Based on revalidation, feedback from last semester plan for future aspects with Pre-design and LNM
2	○ Domain Selection ○ Team Building ○ Log book	Reverse Engineering – Detailed study for Branch Specific learning		
3	**Learning Tools** – Bio-mimicry, System Approach		**Empathy** – Observation, Immerse, Interviewing (Using Mind map, Empathy map)	**Detailed Design** (including all aspects of products, material, process, standards etc.)
4	**Empathy** – Observation, Immerse, Interviewing (Using Mind map, Empathy map)	**Empathy** (Modification based on User's need)		
5				
6		**Ideation** (with tools like Analogy, Heuristics, Gestalt)		**CAD Modelling & Analysis** (Branch specific software will be used depending on projects)
7	Define Problem Statement		**Ideation** (with tools like Analogy, Heuristics, Gestalt)	
8	**Ideation** (with tools like Analogy, Heuristics, Gestalt)			**Prototyping** (sequential prototyping for iterations) & Revalidation
9		**Product Development (Functions, Features, Components, SCAMPER tool)**		
10				
11	**Product Development (Functions, Features, Components)**		**Product Development (Functions, Features, Components, SCAMPER tool)**	
12		**Pre-Design, Rough Prototype & Revalidation** (Iterate till Final Prototype)	Revalidation with user	Final Prototype
13	**Rough Prototype**		Iteration & Modification	Project Showcase
14	Feedback & Report	Feedback & Report	Feedback & report	Feedback & Report

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FAQs related to Design Engineering

- *What is Design Thinking?*
  - ✓ Design Thinking is a problem solving methodology with Human Centred approach. It is cyclic process with various phases but includes lots of iterations at each phase. It is Human centred, iterative, collaborative and experimental process.

- *What are the objectives or goals of GTU behind the introduction of this subject? Or Why Design Engineering subject is introduced in curriculum?*
  - ✓ An Engineer must be a problem solver. Keeping this thought in mind, GTU introduced this Design Engineering course with ultimate goal of providing innovative environment so that students can develop the mind-set to identify right problem and then its solution.
  - ✓ The other important objective of University is to infuse the Design Thinking knowledge to various core subjects of the particular branch to have pedagogical innovation in Education System.
  - ✓ Also to cease the copy-paste type projects.
  - ✓ Learn the practical skills that are required in industry now-a-days.

- *How design thinking is in alignment with the industry need?*
  - ✓ "Learning by doing" is the central idea for this methodology, so students will learn the industry required skill set along with their projects and gain knowledge that will be useful to them in industry.
  - ✓ Also student with Design Thinking mind-set will perceive the Problem as an Opportunity with all kinds of Possibilities (not with only one solution).

- *What are the expectations of the industry today from their engineering staff?*
  - ✓ Industries expect to hire an engineer who should have multidisciplinary knowledge, who is a problem solver not only process manager. They require an engineer who can work effectively in team, have hands-on experience and who are ready to change or inculcate new things/knowledge/technology – an open minded personnel.

- *The objective of the Design Engineering course is to enhance the thinking ability and change the mind-set of an engineering graduate in positive manner. What kind of environment inside college should it be?*
  - ✓ Creativity is inherent, but of course it would be enhanced by providing and creating right environment for the students. For Design Thinking learning an open minded environment in terms of type of projects, branch, skills, team size should be created within institutions.

- ✓ One should appreciate the idea of students and motivate them for making it happen.
- ✓ Also ***failure*** needs to be start celebrating within colleges to enrich the Creativity among the students. One should learn from failure and build the solutions further.
- ✓ Multidisciplinary projects should be welcomed. No single products can be made by single discipline, so encourage students for multidisciplinary projects. Successful start-up have incorporated multidisciplinary team members in their team and they are growing with the needs of industry and technological advancements.

References for important documents for Design Engineering

- Concept note for GTU's - Centre for Industrial Design (OPEN Design School) http://files.gtu.ac.in/circulars/14SEP/25092014Centre%20for%20Indusrial%20Design.pdf

- Design Engineering Help Manual: http://gtu.ac.in/circulars/15Apr/04042015_Designmaual_2.pdf

- Stanford manual for various Design Methods: http://dschool.stanford.edu/wp-content/uploads/2013/10/METHODCARDS-v3-slim.pdf

- Revision on Design Engineering from AY 2019-20 circular: https://bit.ly/2JmbD16

- Important guidelines and schedule for Design Engineering course for Winter 2019 (AY 2019-20): https://bit.ly/2RPOnw8

- Report Format for AY 2015-16:
  - DE-1A (3rd Semester): http://files.gtu.ac.in/circulars/15Oct/07102015_DE1A.pdf
  - DE-1B (4th Semester): http://goo.gl/eiKQ0b
  - DE-2A (5th Semester): http://files.gtu.ac.in/circulars/15Oct/07102015_DE2A.pdf
  - DE-2B (6th Semester): http://goo.gl/Wt9go2

- Note on AEIOU and LNM theory: http://gtu.ac.in/circulars/15Apr/04042015_AEIOU.pdf

- Report on Design Bootcamp 2019 organized by Design Innovation Centre - HUB of GTU from 20th to 31st May 2019: https://bit.ly/2KXe5hK

- Report on National Symposium on Role of Design in Make in India and Start up India: https://goo.gl/610irH

- Report on International Conference on Design Thinking: http://files.gtu.ac.in/circulars/16Mar/10032016.pdf

- Report on One Day Workshop on "CHANGING CHARACTERISTIC OF ENGINEERING EDUCATION" by Dr. P V M Rao, IIT-Delhi: https://goo.gl/jIdTsk

- Report for 3rd FDP on Design Engineering: https://goo.gl/KuGg3m

- Statistical analysis report on feedback received during practical examination of Design Engineering – 1A during Winter 2014: http://files.gtu.ac.in/circulars/14DEC/31122014.pdf

- Report 33rd FDP: http://goo.gl/ywm0y7

- Report of Workshop with Prof. Libby Osgood, UPEI, Canada: http://files.gtu.ac.in/circulars/15Jul/08072015.pdf

- Report of Workshop with Prof. Bill Oakes, Purdue University, USA: http://files.gtu.ac.in/circulars/15Jul/28072015_12.pdf

- Report of ISY 2015: http://gtu.ac.in/circulars/15June/16062015_17.pdf

- Report on GIC coordinators for final year framework: http://old.gtu.ac.in/circulars/15June/22062015_11.pdf

- Report on Innovative Design Thinking workshop for Government officers: http://files.gtu.ac.in/circulars/15Oct/19102015.pdf

- GTU has represented as Director of India chapter in 5th Board of Directors Meeting of APEN on June 6th 2015 held at Institut Teknology Bandung, Indonesia, on behalf of GTU, Centre for Industrial Design presented Deign Based Learning initiation at GTU. A report on visit of the same: https://goo.gl/3s5uo3

For any query & suggestions, kindly contact course coordinator:

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