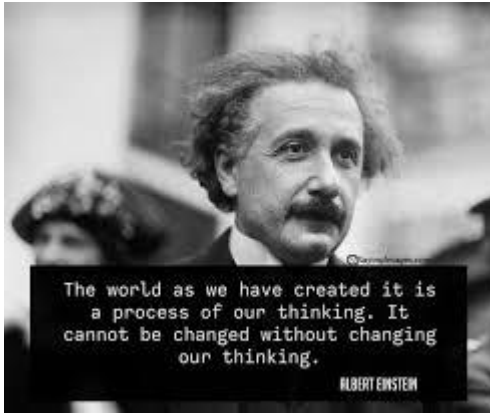


Design Thinking

Unit-1

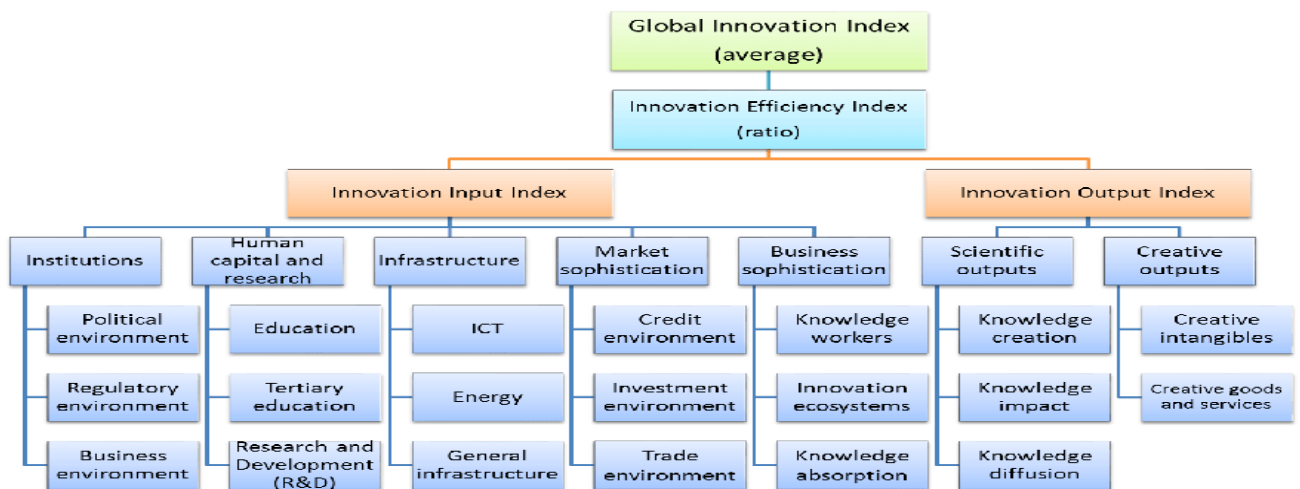
1.0. Preface:

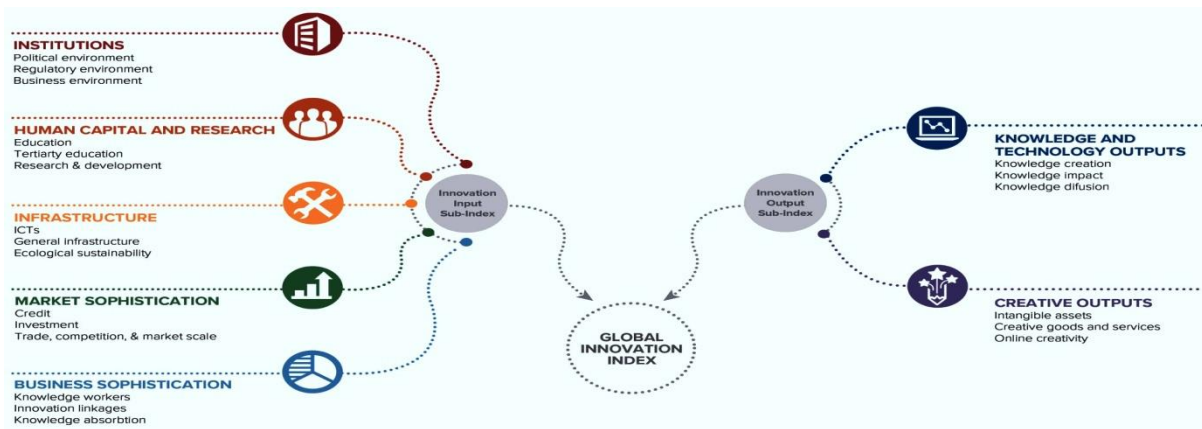


GLOBAL INNOVATION INDEX

- The global innovation index aims to capture the multi-dimensional facets of innovation and provide the tools that can assist in tailoring policies or promote long-term output growth, improved productivity, and job growth.
- The global innovation index is an **annual report**.
- It gives the annual ranking of countries by their capacity for and success in innovation.
- Published by **Cornell University** (New York), **INSEAD** (business school) and **World Intellectual Property Organization**.
- **Data taken sources:** international Telecommunication union, World Bank, World Economic Forum.
- Started in :2007.

Frame works:





Global Innovation Index 2019 rankings

Country/Economy	Score (0–100)	Rank	Income	Rank	Region	Rank	Median 33.86
Switzerland	67.24	1	HI	1	EUR	1	
Sweden	63.65	2	HI	2	EUR	2	
United States of America	61.73	3	HI	3	NAC	1	
Netherlands	61.44	4	HI	4	EUR	3	
United Kingdom	61.30	5	HI	5	EUR	4	
Romania	36.76	50	UM	8	EUR	33	
Chile	36.64	51	HI	40	LCN	1	
India	36.58	52	LM	4	CSA	1	
Mongolia	36.29	53	LM	5	SEAO	11	
Philippines	36.18	54	LM	6	SEAO	12	
Costa Rica	36.13	55	UM	9	LCN	2	

In this contest **NITI (National Institution for Transforming India)) Aayog** released the India Innovation Index (III) 2019.

The India Innovation Index 2019 is calculated as the average of the scores of two dimensions –Enablers and Performance.

The enablers are the factors that underpin innovative capacities, grouped in five pillars.

- Human capital
- Investment
- Knowledge workers
- Business environment
- Safety and legal environment

Performance dimension captures benefits that nation derives from inputs, divides into

- Knowledge output
- Knowledge diffusion

India innovation ranking for top 10 states (2019)

Top 10 states	Rank	Enablers Rank	Performance rank
KARNATAKA	1	3	1
TAMILNADU	2	5	2
MAHARASHTRA	3	1	3
TELANGANA	4	9	4
HARYANA	5	2	7
KERALA	6	4	8
UTTAR PRADESH	7	15	5
WEST BENGAL	8	11	6
GUJARAT	9	6	9
ANDHRA PRADESH	10	8	10

In this direction government starts working to improve rank in the global index.

- On March 2019 prime minister of India said that India is aiming to rank in top 25 of Global Innovation index in coming 4years through air news.

According to skill India report 2019

WHICH DOMAINS HAVE MORE EMPLOYABLE TALENT?

← YEARS →

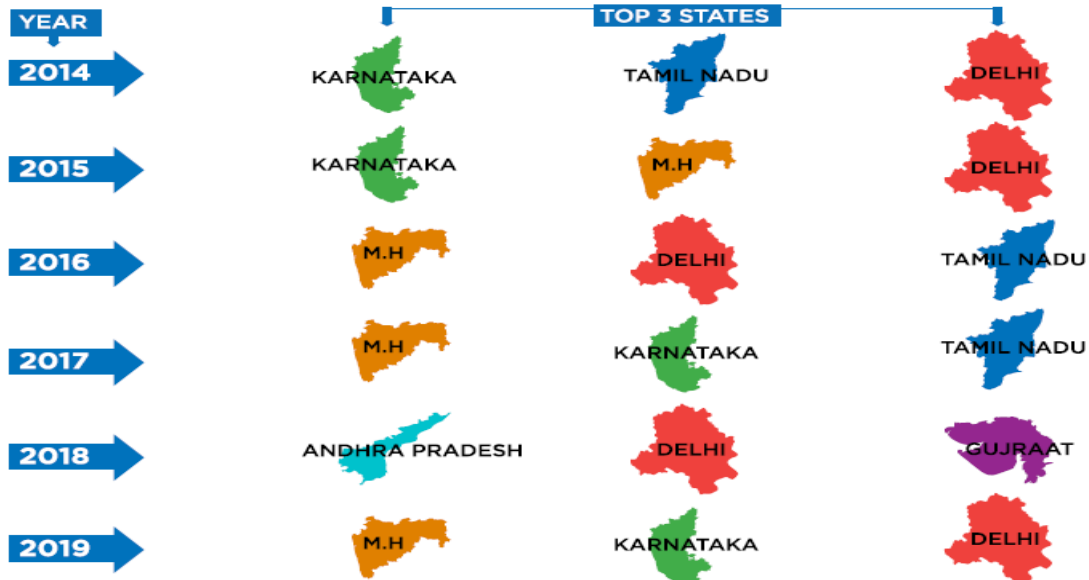
SKILLS	2014	2015	2016	2017	2018	2019
B.E/B.Tech	51.74%	54.00%	52.58%	50.69%	51.52%	57.09%
MBA	41.02%	43.99%	44.56%	42.28%	39.4%	36.44%
B.Arts	19.10%	29.82%	27.11%	35.66%	37.39%	29.3%
B.Com	26.99%	26.45%	20.58%	37.98%	33.93%	30.06%
B.Sc	41.66%	38.41%	35.24%	31.76%	33.62%	47.37%
MCA	43.62%	45.00%	39.81%	31.36%	43.85%	43.19%
ITI	46.92%	44.00%	40.90%	42.22%	29.46%	NA
Polytechnic	11.53%	10.14%	15.89%	25.77%	32.67%	18.05%
B.Pharma	54.65%	56.00%	40.62%	42.30%	47.78%	36.29%

WHICH SECTORS HAVE HIRED THE MOST?

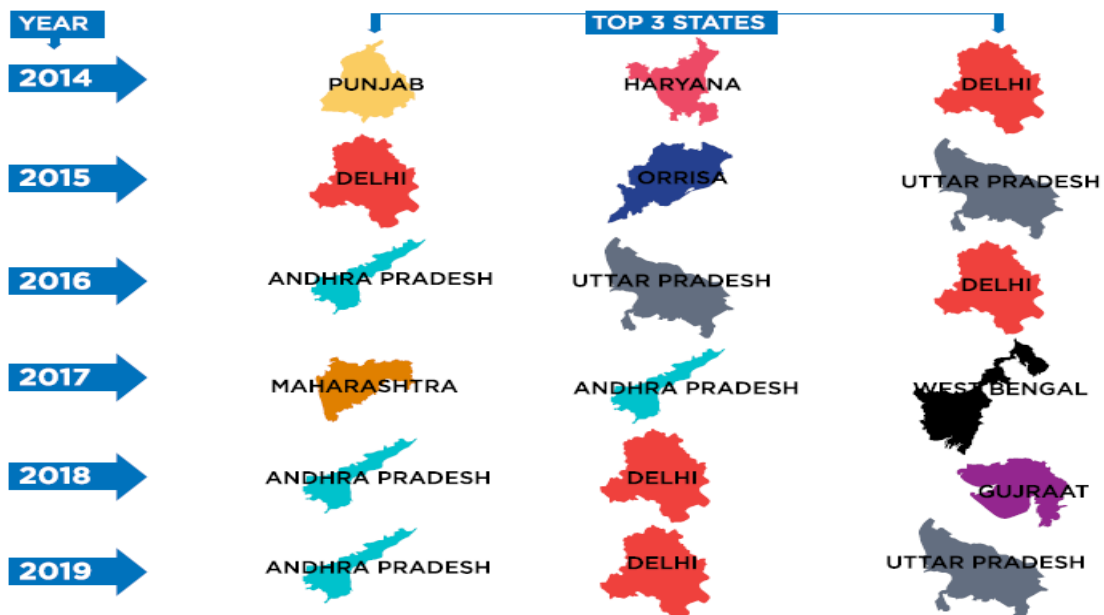
YEAR	TOP SECTORS
2014	BFSI, Pharma & Healthcare, Telecom
2015	Hospitality (including Aviation , Tour Travels), BFSI, Core Sector (Oil, Gas, Steel etc.)
2016	Retail ,E-commerce & Transport, Pharma & Healthcare
2017	Core Sector(Oil & Gas, Steel Minerals), Software/Hardware, Auto Ancilliary
2018	BFSI, Retail
2019	BFSI, Software/Hardware, Manufacturing



WHICH WERE THE STATES WITH MAXIMUM HIRING ACTIVITY?



WHICH WERE THE STATES WITH MAXIMUM SUPPLY OF EMPLOYABLE TALENT?



- In the inaugural function of 107th session of Indian Science congress which was held in Bangalore on Jan-2020 prime Minister of India urges the young scientists to “Innovate, Patent, Produce and prosper. These four steps will lead country towards faster development.”
- Based on the skill India Report and government policies the technical and higher educational institutes take the measurable steps to enhance the framework (human capital and research) of innovation model for further development.
- So, people seeking for innovation globally in all aspects in every domain.

- The Department of science and technology within the government of INDIA has developed the **INDIA INNOVATION INITIATIVE (i3)** to create an innovation network, encouraging and promoting innovators and commercialization across the country
- **India innovation initiative:**
This programme is jointly promoted by the confederation of India industry, the Department of science & technology, Government of India and the All-India council for Technical Education (AICTE)
- Not only are innovation initiatives underway at the national level, but many companies have developed innovation centers to drive new product, process, and service development.
- Companies like Microsoft, Procter &Gamble, Accenture, IBM, AT&T, computer sciences corporation, Qualcomm (wireless technology), Verizon (smart phones, internet) etc have all opened innovation centers focused on developing key scientific and technological innovations.
- **Central Board of Secondary Education (CBSE)** is introducing three new subjects at class 11 from the session **2020-2021**. The CBSE said the subjects '**Design –thinking**', physical activity trainer and artificial intelligence have been introduced keeping view what has been mentioned in the **Draft New Education Policy 2019**
- The **Draft national Education policy 2019** prepared by a committee chaired by **Dr .K. Kasturi rangan** has been shared by Ministry of Human Resource and Development for public comments. The **policy** aims at making India a knowledge superpower by equipping students with necessary skill and knowledge.
- The national Education policy was framed in 1986 and modified in 1992.in this context that the education sector modifies towards the demands of the 21st century.
- Quality, Innovation, **and research** will be the pillars for this new policy.
- The Government had initiated the process of formulating a new education policy through considering expert opinions, filed experience, empirical research, stakeholder's feedback, as well as lessons from best practices.
- Meeting with **State Education Secretaries of school Education** and with **state secretaries of higher & technical Education** were held.
- Education Dialogue with honorable Mps of **Andhra Pradesh**, Telangana, Tamil Nadu, Kerala, Karnataka, and Odisha

TOP 6 METHODS OF INNOVATION TO COME UP WITH UNIQUE PRODUCT IDEA ARE:

- ❖ Innovation is the process of generating new and unique ideas or solutions and applying them to create value for the service.

1. Brainstorming
2. Six sigma DMAIC
- 3. DESIGN THINKING**
4. Lean Canvas
5. Consumer trend canvas
6. Other methods



Kangaroo pouch



Baby pouch



Snail



Cd track



Spiral climber



Stair case



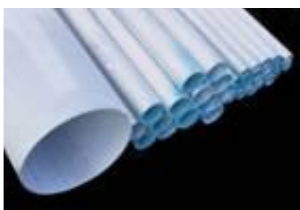
Egg



Medicine capsules



Human anatomy



Pipes



Butter fly



Industrial pipe lines



Spider net



Fishing net



Basket ball net



Soccer ball net



Pelican



Pouch bags



Sapling



Leaf spring



Joints of Finger (Flexing)



Automobile



Closed Fist (Bending)



Elbow joints



Machine part joints



Blister on skin



Medicine pack



Pen drives pack



Lion fur



Crocodile skin



wrapped baby



Scales



Wrapped suitcase

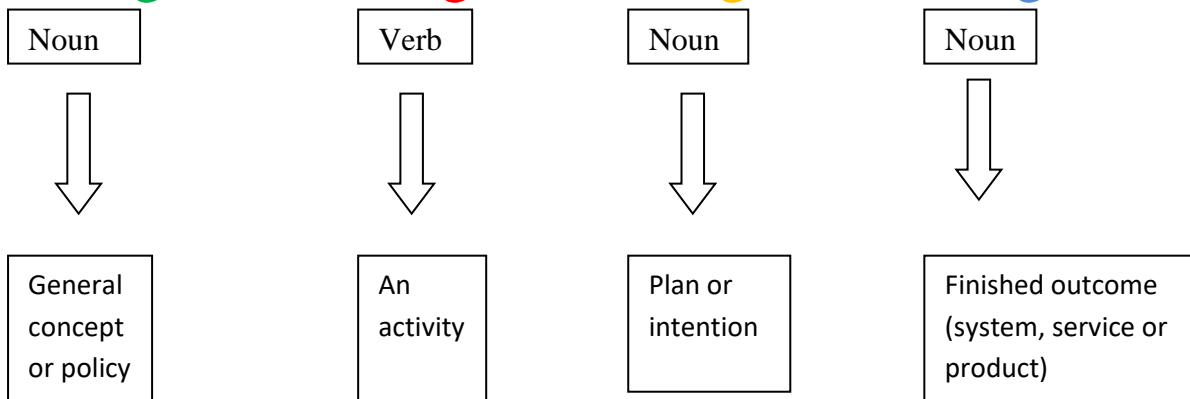
1.2. Definition of Design:

- ❖ “The future is best found in the opportunities that go unnoticed in the present”—*peter drucker* (Father of Management Thinking)
- ❖ ‘Everything that needs to be said has already been said. But since no one was listening, everything must be said again.’

According to Dictionary Design means

“A plan or drawing produced to show the look the function or working of a building, garment, or other object before it is made.”

Design is to design the design of a design.



➤ Design (Noun):

Blueprint of something—a plan for change

Under desirable situation (present) + Implemented plan = Desirable situation (future)

- Whether a situation is undesirable and what aspects are desirable depends on matter of perception
- Whose perception, where it is perceived, and when it is perceived plays important role.

➤ Deign(verb):

- Understanding & solving a problem: termed as Designing
- **Problem understanding:** process or activities for identifying undesirable situations and desirable situations.
- **Problem solving:** Developing a plan with the intent of changing undesirable situations to desirable situations
- **Designing involves both problem understanding and problem solving**
- Designing becomes easier when problem is understood thoroughly

Example: cooking



Undesirable situation: food tasteless

Plan: add adequate salt

Implementation: salt added

Desirable situation: tasty food

Example: Electric sockets



Undesirable situation: open sockets accessible to children is unsafe

Plan: to cover the sockets

Implementation: make and use socket cover

Desirable situation: socket covered and safe

What is Design?

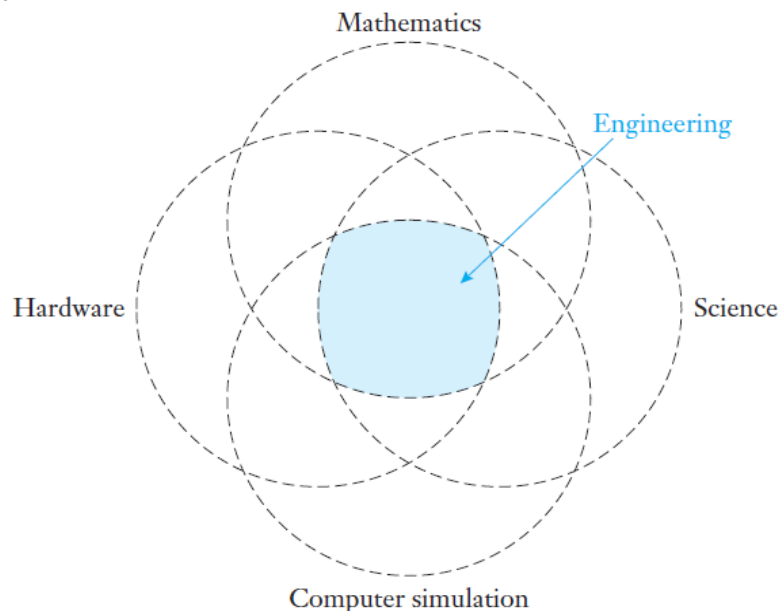
Design: **plan** of a system, its implementation and utilization for attaining a **goal** (change undesired to desired)

Designing: **How** a design is developed (**Both Goal and Plan**)

Designs can be for: Technical systems, Educational systems, aesthetic systems (logo design, advertisements), legal systems, social, religious or cultural systems, theories, Models etc.

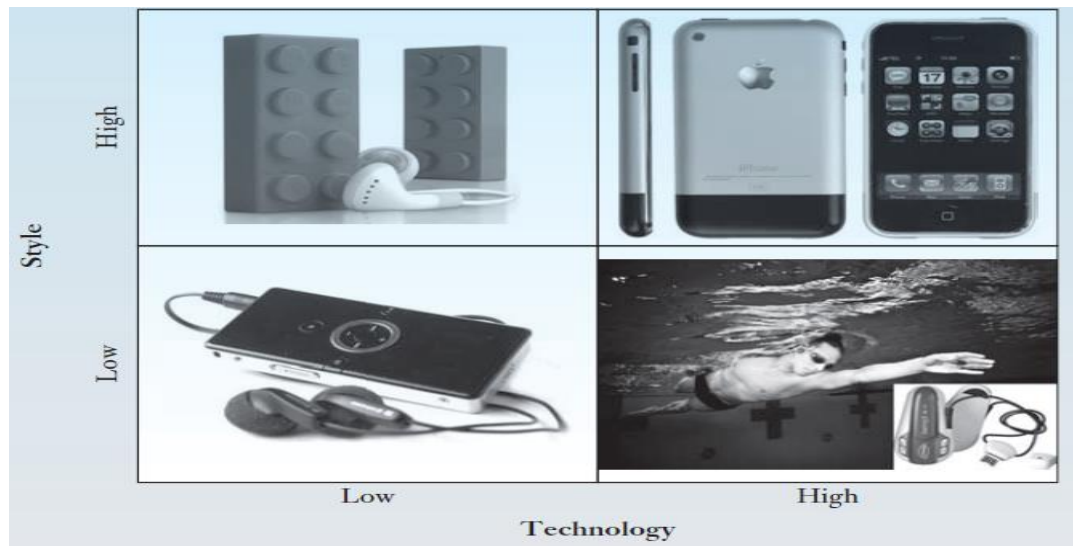
Design Vs Engineering Design

- Engineering is the practical endeavor in which the tools of mathematics and science are applied to develop cost effective solutions to the logical problems facing society.
- Engineers design many of the consumer products that use everyday life.
- Engineering is all about making useful things that work and impact lives
- The word “Engineering” derives from the Latin root *ingeniere*, meaning to **design or to devise**, which also forms the basis of the word “ingenious
- Engineering is essentially a bridge between scientific discovery and product applications
- Engineers apply their knowledge of **mathematics, science, and materials**—as well as their skills in **communications and business**—to develop new and better technologies
- Engineering is essentially a bridge between scientific discovery and product applications
- Engineers combine their skills in mathematics, science, computers, and hardware



- “**Engineer creates the new things and makes the old things better and better**”

Style Vs Technology chart for digital music players:



- The above chart shows style on the vertical axis and technology on the horizontal axis.
- This chart provides a frame work to strategically develop innovative products for a wide range of customers.
- In each quadrant is a different digital music player
- **In the lower left:**
The low-style/low-technology is standard affordable player designed for customers who want just to play music. The player, while not the most stylish or high technology, provides solid, expected playback of digital music
- **In the lower right:**
The low style/high tech version is the SwiMP3 player from FINIS. This player integrates water proof technologies with revolutionary bone conduction of sound to provide swimmers with clear sound in under water
- **In the upper left:**
The high style/low tech version is a standard player shaped like a Lego Block, designed for customers who are very style conscious.
- **In the upper right:**
The high style/high tech version is and APPLE I phone for customers who want the latest technologies along with stylish features.

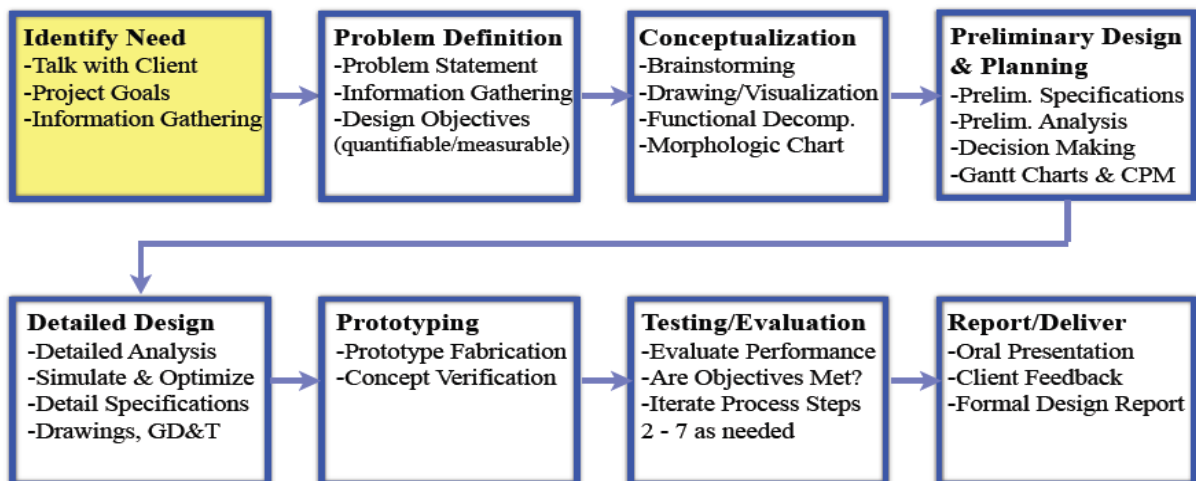
Conclusion:

- Developing technically effective, consumer safe, globally aware and environmentally friendly product to meet wide range of social, cultural demands, for that **Engineers can think innovatively**.
- Effective Design through innovation is one of the skills that Engineers will be acquiring during graduation.

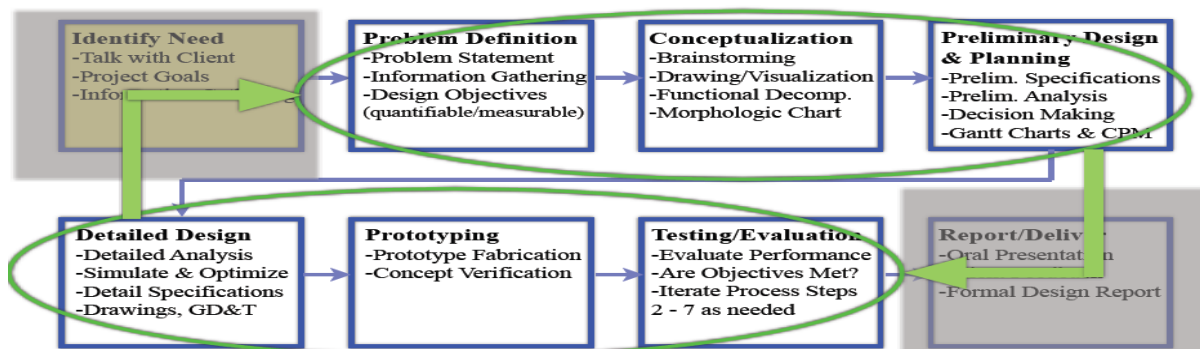
1.3. Difference between Design and Engineering Design

Design	Engineering Design
The specification of an object manifested by an agent , intended to accomplish goals in a particular environment using a set of primitive components, satisfying a set of requirements subjected to constraints	Engineering Design is the process of devising a system , component or process to meet desired needs. It is decision –making process (often iterative), in which the basic sciences, mathematics and Engineering sciences are applied to convert resources optimally to meet the stated objective
Design is often used in two different contexts: Action or understanding (verb) Physical construct of object of plan (noun)	The fundamental elements of the Engineering design process include: the establishment of objectives and criteria, synthesis, analysis, construction, testing and evaluation.
There are many ways to define design and they may depend on a specific context or field of design	The formal definition of engineering design depends on the specific engineering

❖ The “General Design “process Model.



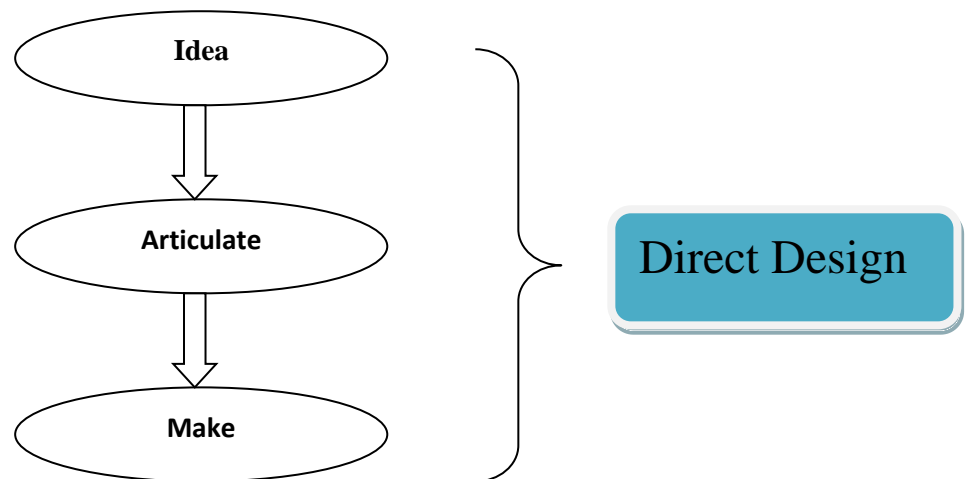
Design Process Iteration



1.4. Origin of Design thinking:

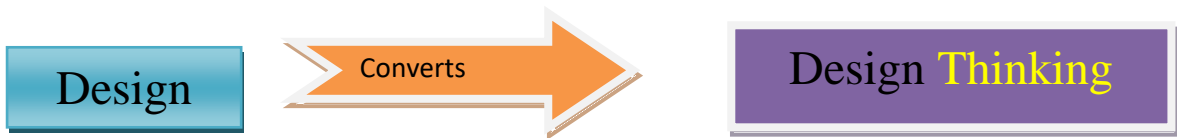
Design to Design thinking





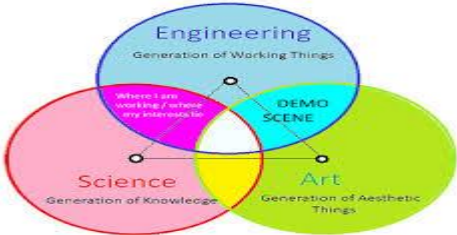
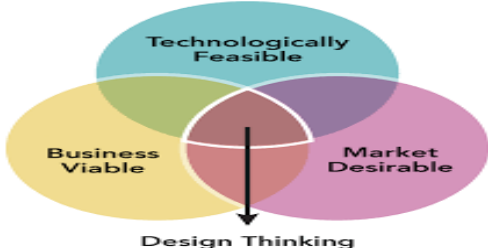
- **Design or making**, has been **classically** understood to be a process of **turning ideas into things**
- In this design process there is a vision or an idea, it can be figured out by some drawings work with fabrications of crafts and if everything worked out right then it be materialized.
- So, there is a direct correspondence between ideas, drawings, and finished products. This design process called as **Direct Design**
- This is what most people understand design to be, and what they understand designers to do that they turn their creative ideas into things.



- The primary issue to direct design is preeminence to ideation. The core logic of direct design is that ideas come first and then making comes after.
- While doing the direct design it marginalizes and ignores the **agency of things, environments, users and relations**.
- In 21st century these direct designs were taught as type of closed design process where designers have ideas and figure out how to realize separately from a deep engagement with the world.
- It becomes obvious that human making could not effectively happen separate from the world of users, practices, problems, needs, politics so on.
- Direct designs are criticized that these are not responsive to real world conditions.
- From an awareness of the power of engagement, a new and expanded form of design emerged called as **Responsive design**
- **Responsive design** is just that it begins in a considered response of the world rather than an idea comes from designers.
- Responsive design at its best shifted the focus of design way from the narrow idea of designers and design as being focused on independently making beautiful things.
- Design now becomes about all the **interactive processes** needed to make anything come into being. Responsive design came in many from **environmental design to human centered design**
- In responsive design the most popular form is “**Design thinking**”

- “Design thinking is simply a form of human centered responsive design broad name “Design Thinking”
- The simplest way to understand how responsive design transforms direct design is to see that it adds a new critical step prior to beginning of direct design called **Consultation**. Responsive design does not replace direct design so much subsumes it.
- During consultation the design thinking variants of design asks: what are up to? What are the problems? Then the phase of ideation becomes collective: brain storming, group improvisation and other collaboration exercise are added to mix.
- Then response design works as iterative loop. This loop is significant because it allows the object to evolve through testing and use and not come out of designers thought.
- Response design has had an enormous impact for good. Environmentally centered design is of great value as is user centered design
- A huge part of design thinking appeals that it claims to be an exceptional source of **innovation**



 <p style="text-align: center;">individual</p>	 <p style="text-align: center;">Teams</p>
 <p style="text-align: center;">Products</p>	 <p style="text-align: center;">Experience</p>
 <p style="text-align: center;">Design is a combination of Engineering +science +Art</p>	 <p style="text-align: center;">Design thinking is a combination Technology(Engg) +Business+ Humans</p>

1.5. Definitions of Design Thinking:

- Design thinking is a methodology that designers use to brainstorm and solve complex problems related to Designing and Design engineering.

Or

- Design thinking is a human- centered approach to innovation that draws from the designer’s toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success—Tim Brown CEO of IDEO

Or

- There is no general agreement on precise definition of design thinking. There are variations across disciplinary cultures, and different meanings depending on its context

Or

- A process that results in a plan of action to improve situation

Or

- An approach that frames problems creatively and generates innovative solutions, strategies, systems and paradigms at the nexus of domain

Or

- Design thinking is a human centered innovation process that emphasizes observations, collaboration, fast learning, visualization and rough prototyping. The objective is to solve not only the stated problems at hand, but the real problems behind the obvious—Thomas Lockwood

Or

- Design thinking refers to creative strategies’ designers utilize during the process of designing

Or

- Design thinking can be described as a discipline that uses the **designer’s sensibility** and **methods** to match **peoples’ needs** with what is **technologically feasible** and what a viable business strategy can convert into **customer value** and **market opportunity**---Tim brown.

1.6. Timeline of Design thinking:

Year	context
1963	The idea of using Design as a way of solving complex problems in a simplified manner in sciences originated in the book ‘The science of the Artificial’ authored by Herbert A. Simon
1973	The idea of design was achieved for Design Engineering by the book ‘experiences in visual thinking’ authored by Robert McKim
1982	Design methodology is defined by “cross” the study of the principles, practices and procedures of design are developed .and includes the study of how designers work and think
1987	Peter Rowes Book Titled “Design thinking” describes methods and approaches that planners, designers and architects use
1980s to 1990s	The work of Robert Mckim was consolidated by Rolf Faste at Stanford university during this period

1991	David M Kelly Founded IDEO and adapt Design thinking to business interests
2009	The design thinking process itself is human centered, offering methods for inspiration, ideation and learning to designers --Brown
2012	Apply the study of design thinking principles in engineering.
2015	Verbal protocol analysis, cognitive Ethnography, controlled laboratory experiments, and other formal methods from cognitive science have been rigorously applied in engineering
2017	Design thinking reflected in many applications like prototyping, solution-based method is often useful way to encourage inspiration, ideation and organization learning and human centered methods.

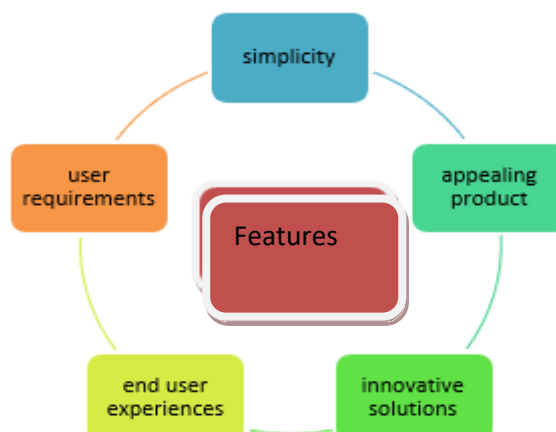
- The term design thinking has been applied in two different approaches related to areas of conceptual development.
- The first established body of knowledge, starting in the late 1960's **investigates how designer** (architects, industrial designers, graphic artists) **perform their craft** and seeks to identify the skills, abilities and knowledge of expert designers.
- The second use of design thinking is related to **business management**. since the mid 1980's interest within the business community grew in exploring how "designer" thinking could be applied to business challenges, and be performed by employees and leaders not trained formally as designers.
- Design thinking is a **blend of logic, powerful imagination, systematic reasoning** and intuition to bring to generate the ideas that consists to solve the problems of the clients with desirable outcomes .it helps to bring creativity with business insights.
- Design thinking helps to **gain a balance between the problem statement and the solution** developed.

1.7. Features of design thinking:

Design thinking provides multi dimensional solutions to the problems.

Features are:

- Finding simplicity in complexities
- Having a beautiful and aesthetically appearing products
- Improving clients and end user's quality of experience
- Creating innovative, feasible and viable solution to real world problems.
- Addressing the actual requirements of the end users.

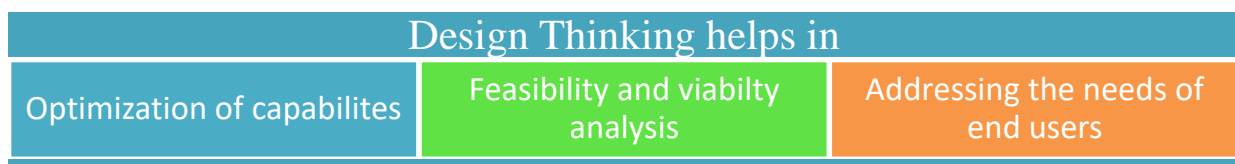


1.8. Use of design thinking:

- The basic principle of design thinking is that innovation can be disciplined.

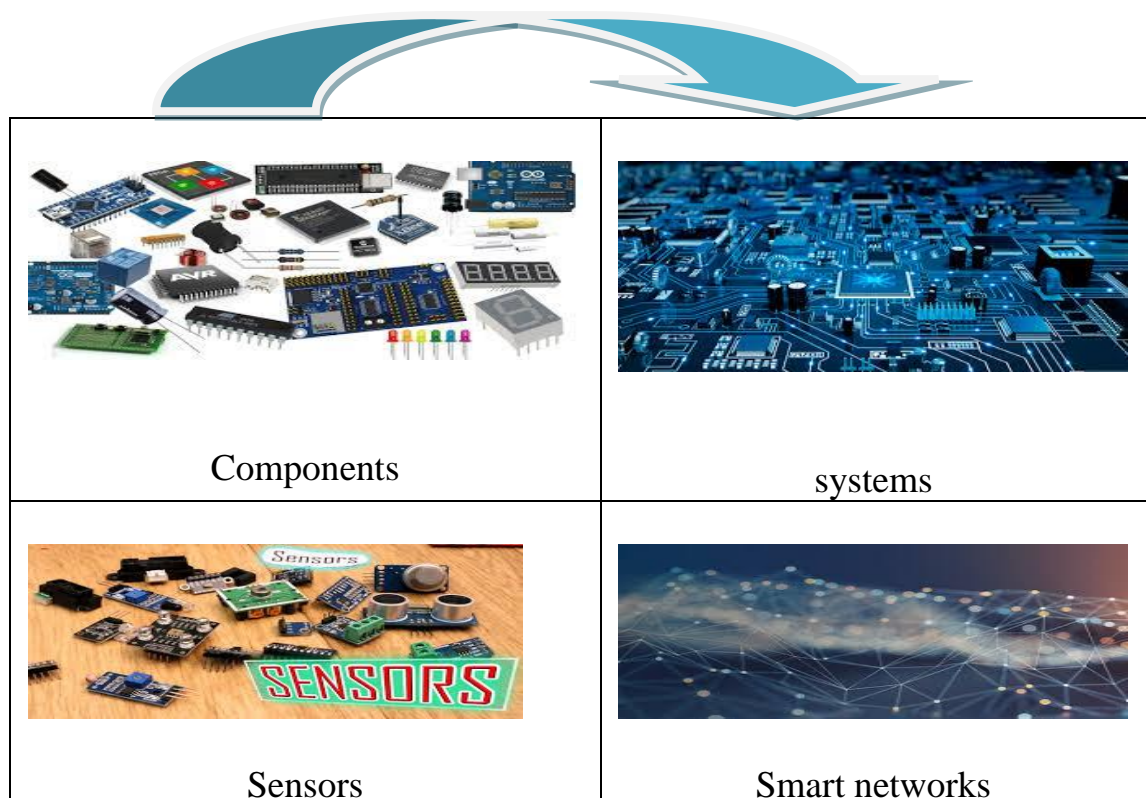
Design thinking helps to learn the following

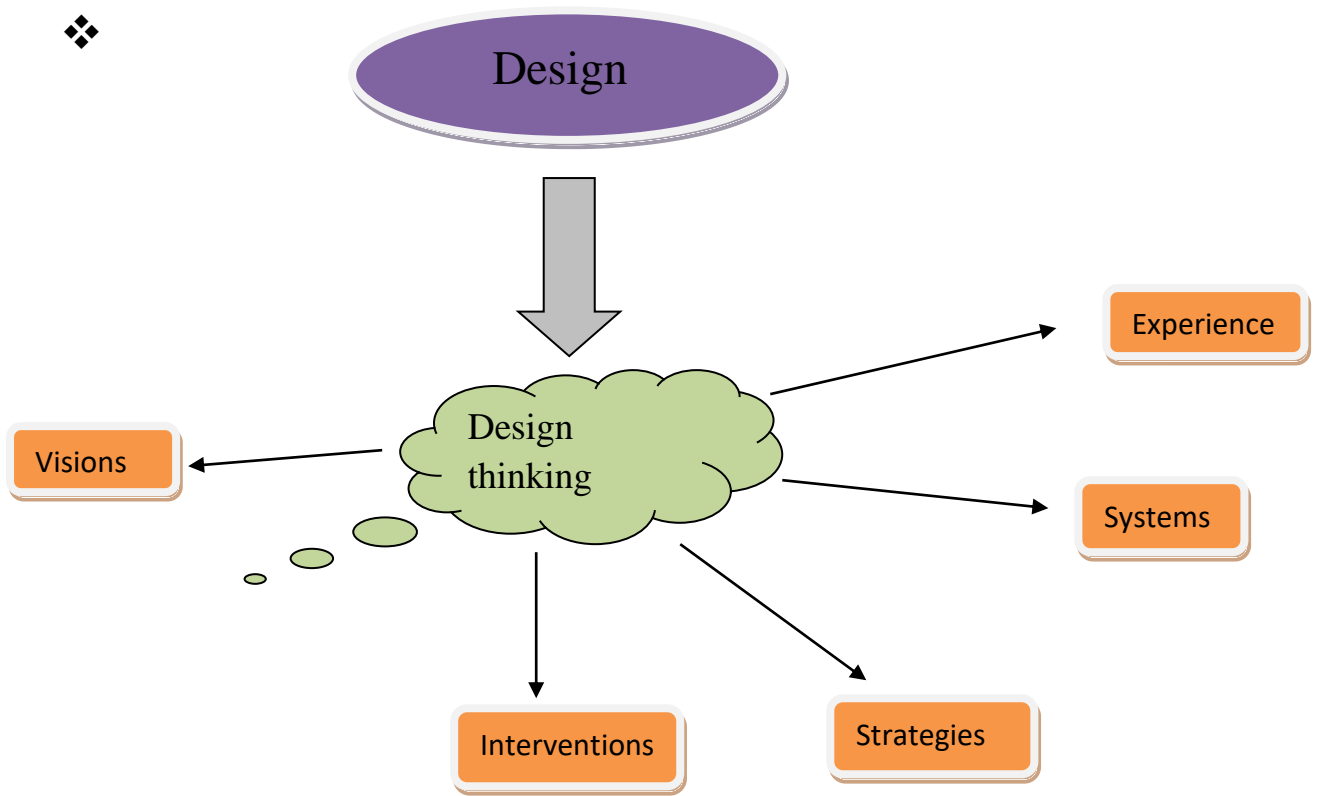
- How to optimize the ability to innovate
- How to develop a variety of concepts, products, services, processes etc for end-users.
- How to leverage the diverse ideas of innovation
- How to convert useful data, individual insights and vague ideas into feasible reality
- How to connect with the customers and end-users by targeting their actual requirements.
- How to use the different tools used by designers in their profession for solving customers problems



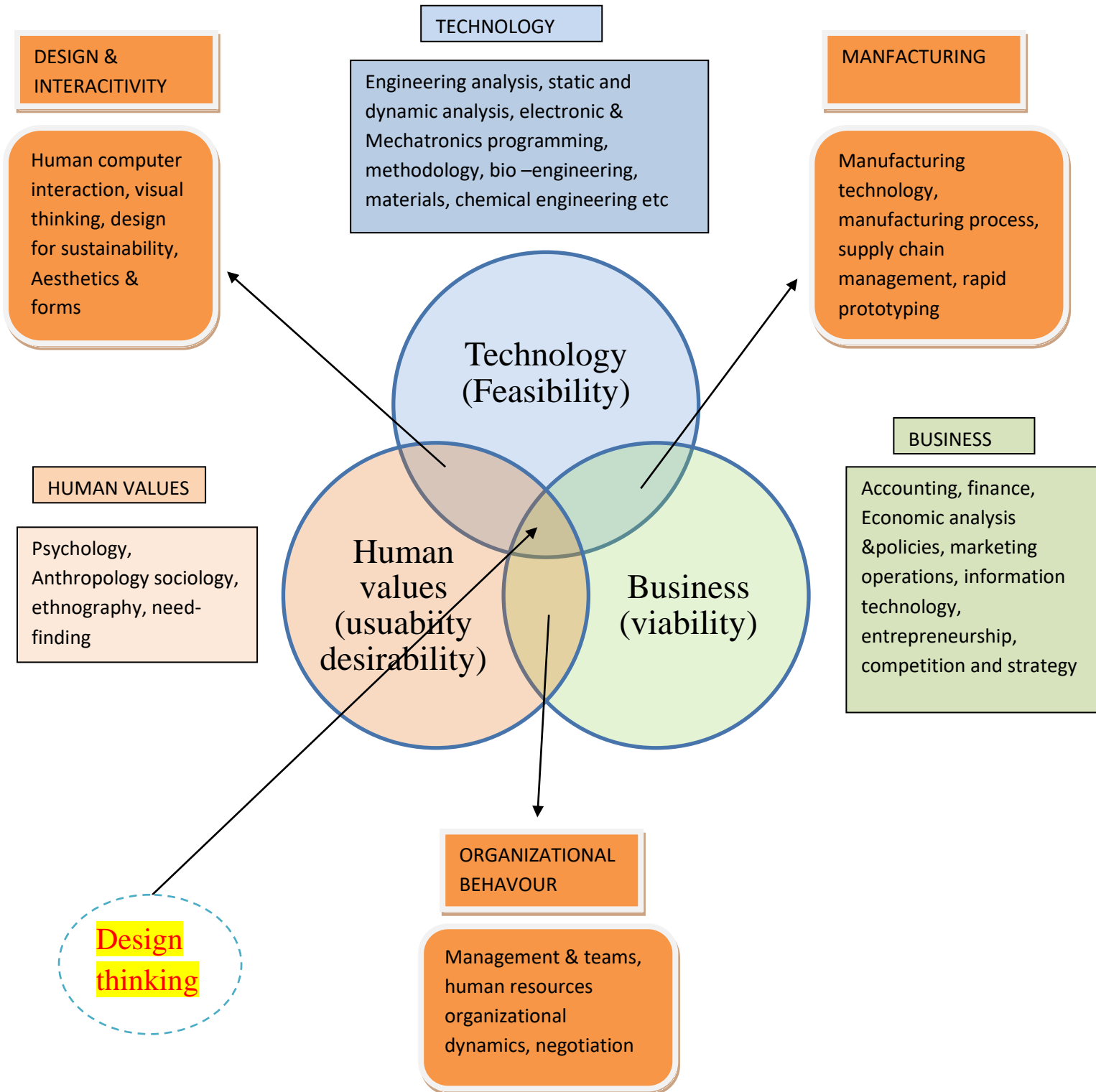
1.9. Changing paradigms:

- Changing paradigms can be essential to achieving and attracting what you desire into your life.
- A paradigm is: 'a typical example or pattern of something' or a model. Paradigm is a pattern or programming through constant repetition of a thought, phrase, belief or habit.
- Some paradigms that take place over the last few decades

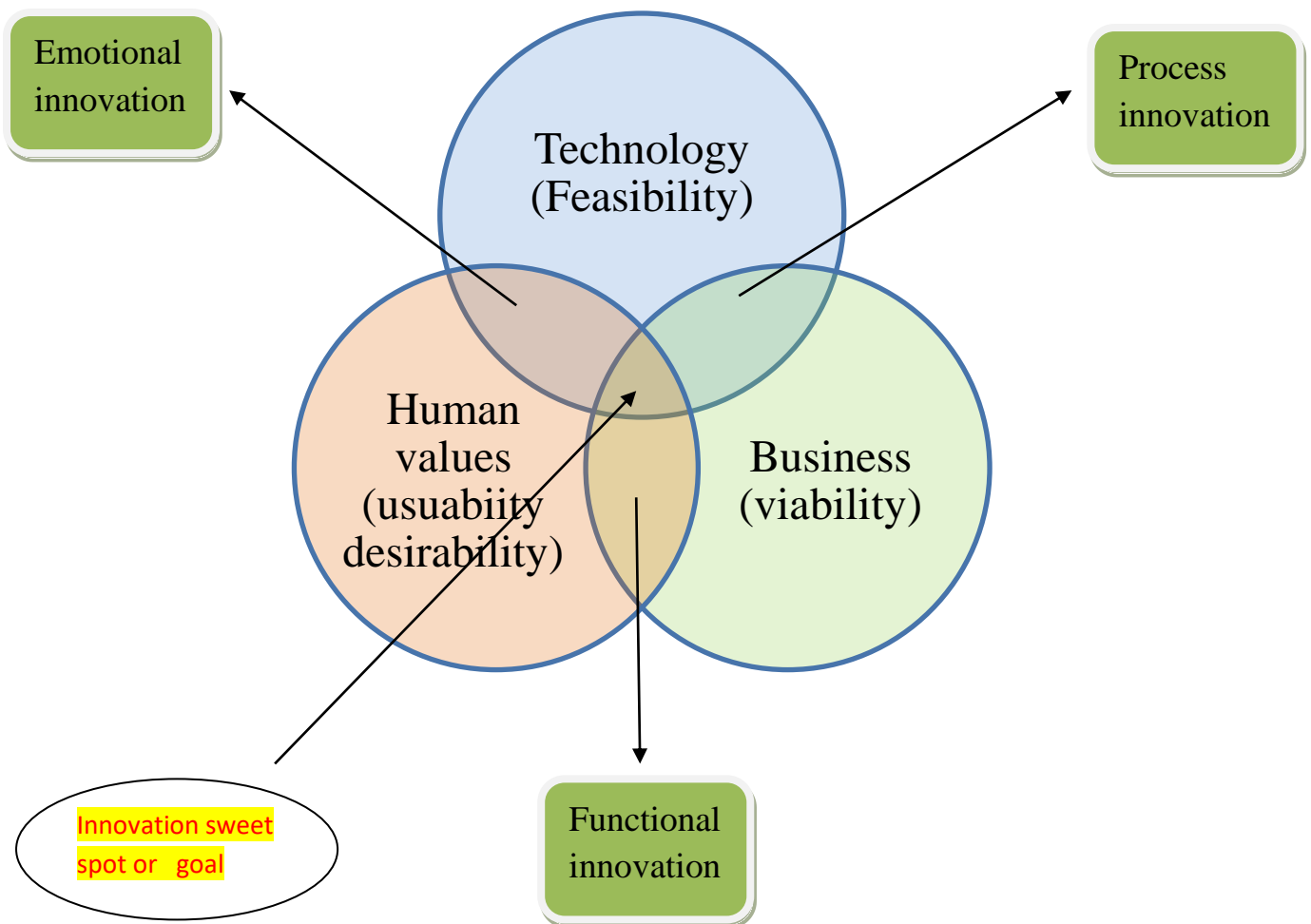




1.10. Venn diagram of Design Thinking:









- Desirability tests whether the innovation is solving the customer problem rightly
- Feasibility tests whether the innovation strengthens the business or not
- Viability tests the value chain for long term sustainability












- Desirable, feasible and viable are three important lenses for innovation through design thinking
- Desirable (people want it), feasible (what can actually do it) and it has to be viable (don't go break)

1.11. Design thinking resources:

- In order for design thinking to succeed, the right ingredients need to be assembled. The desirable workspace, the materials often used in design thinking, and finally the needed integration and cooperation between the design –thinker's team and the organization.
- The resources are 1. **People** 2. **Place** 3. **Materials** 4. **Organization**

<p>People</p>	<ol style="list-style-type: none"> 1. The individuals that are needed are those who are willing and able to adopt the design –thinking mindset. So, the people working on a design thinking are critical to its success. 2. These people are experts in system or field or area of the business. They are observant and they listen. 3. They could frame problems and solve them. 4. They can think strategically and execute tactically. 5. They are both creative and analytical. 6. They are communicative and comfortable to flexibility. 7. The team that emerges from assembling these people should have a spirit of shared purpose, flexibility, collaboration, and mutual support. 				
<p>Place</p>	<ol style="list-style-type: none"> 1. A space needs to be located that facilitates collaboration and imagination. 2. Design thinking produces many physical artifacts. These artifacts are most useful when they are accessible and visible. 3. Design thinking requires the content under consideration be visible. This translates to the need for stationary and mobile white boards, pin boards display screens, storage buddies and large surfaces on which to hang 4. Flexibility of furniture is essential. 5. According to Lewrick he recommended that 5m² per participant be used as sizing parameter for good space 6. Space, like money and time is often a scarce resource 7. The actual size of the space may become a limiting factor on how large the team and collaborative activities can be. 				
<p>Materials</p>	<ol style="list-style-type: none"> 1. Making and visual idea transfer are essential elements of design thinking, for that materials are needed 2. list of materials typically needed <table border="1" data-bbox="443 1375 1401 1874"> <tr> <td data-bbox="443 1375 719 1630"> <p>white boards</p> </td> <td data-bbox="719 1375 1401 1630">  </td> </tr> <tr> <td data-bbox="443 1630 719 1874"> <p>pin boards</p> </td> <td data-bbox="719 1630 1401 1874">  </td> </tr> </table>	<p>white boards</p>		<p>pin boards</p>	
<p>white boards</p>					
<p>pin boards</p>					

whiteboard markers	
colored pencils	
sticky notes of various shapes and colors	
colored adhesive dots	
Hanging strings	
colored sheets of paper (A4)	
pipe cleaners	

	flip charts	
	large rolls of paper	
	tape (cellophane, masking)	
	Glue	
	Lego blocks	
	Scissors	
	index cards	

audio and video capture tools and analyzers



Paper



play dough



popsicle sticks,



foam core






Push pins



Notepads & pens



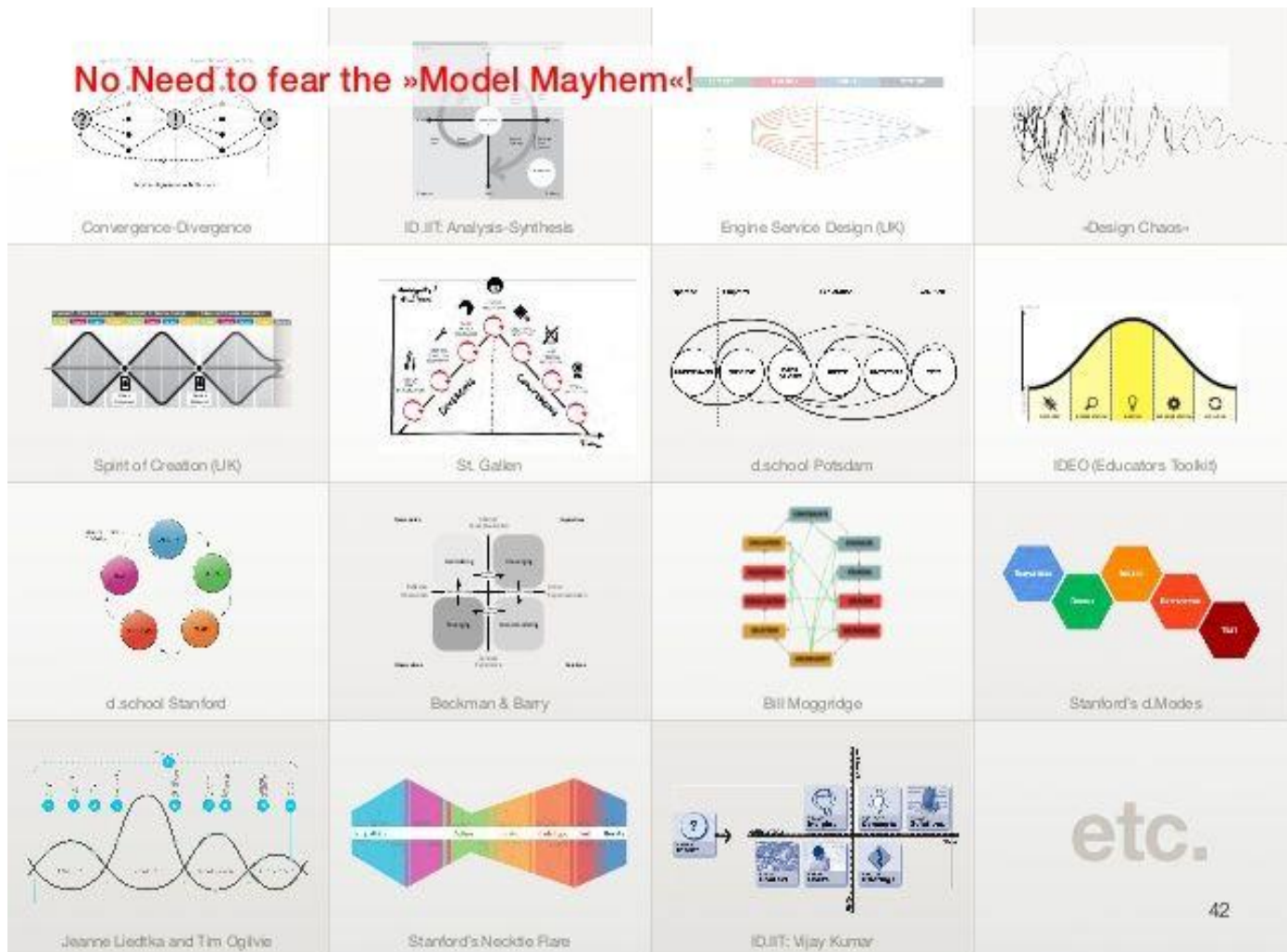
	Tooth picks	
	Laptops	
		
organizations	Locating and accessing design thinking people may require the organization to permit the functional structure to relent and allow enterprise benefit to supersede design thinking objectives	

1.12. Design thinking process Models:

- “Some people think design means how it looks. But of course, if you dig deeper, it’s really how it works” ----Steve jobs, Apple
- Models:
 1. convergence –divergence
 2. Id.iit-analysis –synthesis model
 3. Engine service design (uk)
 4. Design chaos
 5. Spirit of creation
 6. St gallem
 7. D. school post dam
 8. IDEO (Educator toolkit)
 9. D. school stand ford
 10. Beckman & Barry
 11. Bill Moggridge

- 12. Stanford's modes
- 13. Jeanne Liedtka & Tim Ogilvie
- 14. Stanford's necktie flare
- 15. IIT: Vijaykumar

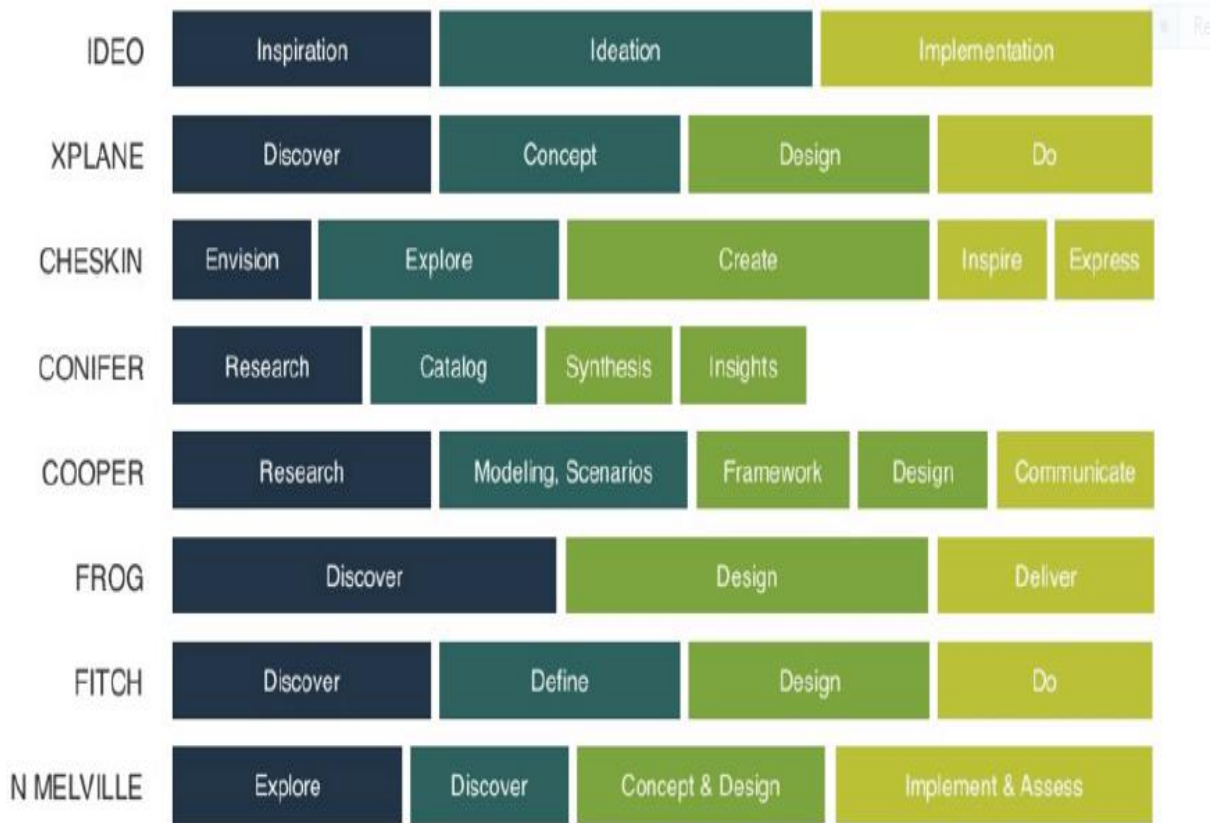
➤ Innovate problem solving = design thinking



Design thinking methodologies:

Stanford	Empathize	Define	Ideate	Prototype	Test
Frog CAT	Seek	Build	Imagine	Plan	Make
IDEO Ed.	Discovery	Interpretation	Ideation	Experimentation	Evolution

DIFFERENT MODELS TO DO DESIGN THINKING



DIFFERENT KINDS OF THINKING:

ENGINEERING
THINKING



Solve your way forward

BUSINESS
THINKING



Optimize your way forward

RESEARCH
THINKING



Analyze your way forward

DESIGN
THINKING

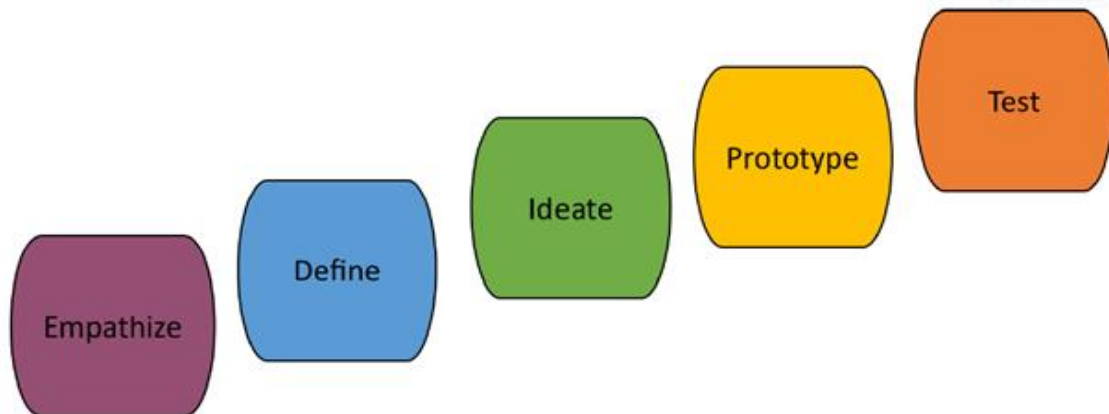


Build your way forward

1.13. Five (5)-Stage d. School Process:

- In 1958, four months after **Sputnik (first artificial Earth Satellite)** launched and President Eisenhower created NASA, a Stanford Engineering Professor named **John Arnold** proposed that Design engineering should be human centered.
- This was a strange thing for Arnold to introduce. It was an era in which Engineers were largely focused on twin cold war driven goals: the space race and the optimization of hydrogen bomb.
- Inspired by Arnold's work, Engineering professor **Bob Mckim**, with the help of **art professor Matt Kahn**, created an Engineering Program called **Product Design.**
- Within this program **Mckim** and others helped create a **design thinking process** that became the **foundation** for **Stanford's d. school**, as well as the guiding framework for design –driven companies like **IDEO.**
- The Stanford d. school, more formally called the Hasso Plattner Institute of Design at Stanford, is an academic collaboration between Hasso Plattner Institute in Potsdam, Germany and Stanford University in Stanford, California.
- The Stanford d. school was one of the first d. schools or design schools formed around design –thinking approaches to design.
- Their process model has changed from 6 stage model of understand, observe, point of view, ideate, prototype, and test to a 5-stage process model of **Empathize, Define, Ideate, Prototype and test.**
- The stages of **understand and observe** were consolidated to **Empathize** according to **Lewrick**. The stage titled **point of view** was adjusted to become **define** in 5-stage model
- Design thinking brings everyone into the process, not just designers: using the design process helps companies to solve the wicked problems with clear eyes
- Design thinking is making organizations think about how to move faster ...with iterative speed
- The organizations that use the toolset of design thinking can confidently create better, human-centered user experiences and disruptive products.
- The design thinking process is not necessarily linear nor is there one canonical way to approach it. It is an iterative system with many variations. However, **Stanford's d. school teaches a framework that can help to start the process for almost any problem**

Stanford d. school 5stage process model



- In the Stanford d school’s process model, the stages have the following objectives

Empathize	The stage is oriented towards understanding the intended users and the problem from their viewpoint by observation, engagement and immersion.
Define	At this stage the needs and insights discovered in empathize are transformed into an actionable problem statement or design vision tailored for the users.
Ideate	Within the context of the problem statement, the team generates many radical design alternatives that explore the solution space
Prototype	At this stage, promising design alternative are made tangible with which the team, users and others will experience and interact
Test	Prototypes are placed into appropriate contexts of user’s lives the goal of gathering thoughtful feedback, learning and refining solutions.

- Beyond suggesting the 5-stage process model, Stanford d. school advocates for six attributes of the design-thinking mindset.
- Those are
 - Human centered
 - Bias towards action
 - Radical collaboration
 - Culture of prototyping
 - Show, don’t tell
 - Mindful of process.




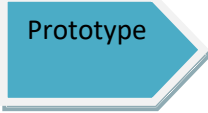
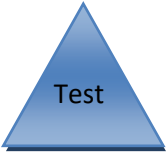
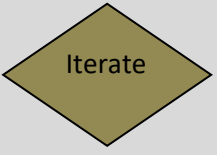






Human centered	It is the idea that design thinkers should identify with the users challenges and develop solutions that address their needs.
Bias towards action	It directs design thinkers to solve problems instead of finding additional ones. Team members should prototype to learn insights instead of expressing self –important personal opinion.
Radical collaboration	It suggests breakthroughs come from a team consisting of members with diverse view points, education and experiences.
Culture of prototyping	It is related to the notion that solutions will arise from trying out concepts and getting users input early and often.
Show, don't tell	Emphasizes the need to communicate visually rather than verbally
Mindful of process	It encourages teams to be aware of stage the project is in, and what needs to accomplish in the current stage.

❖ In addition to the above mind sets views the following points are also considered for good designing thinking process

Those are

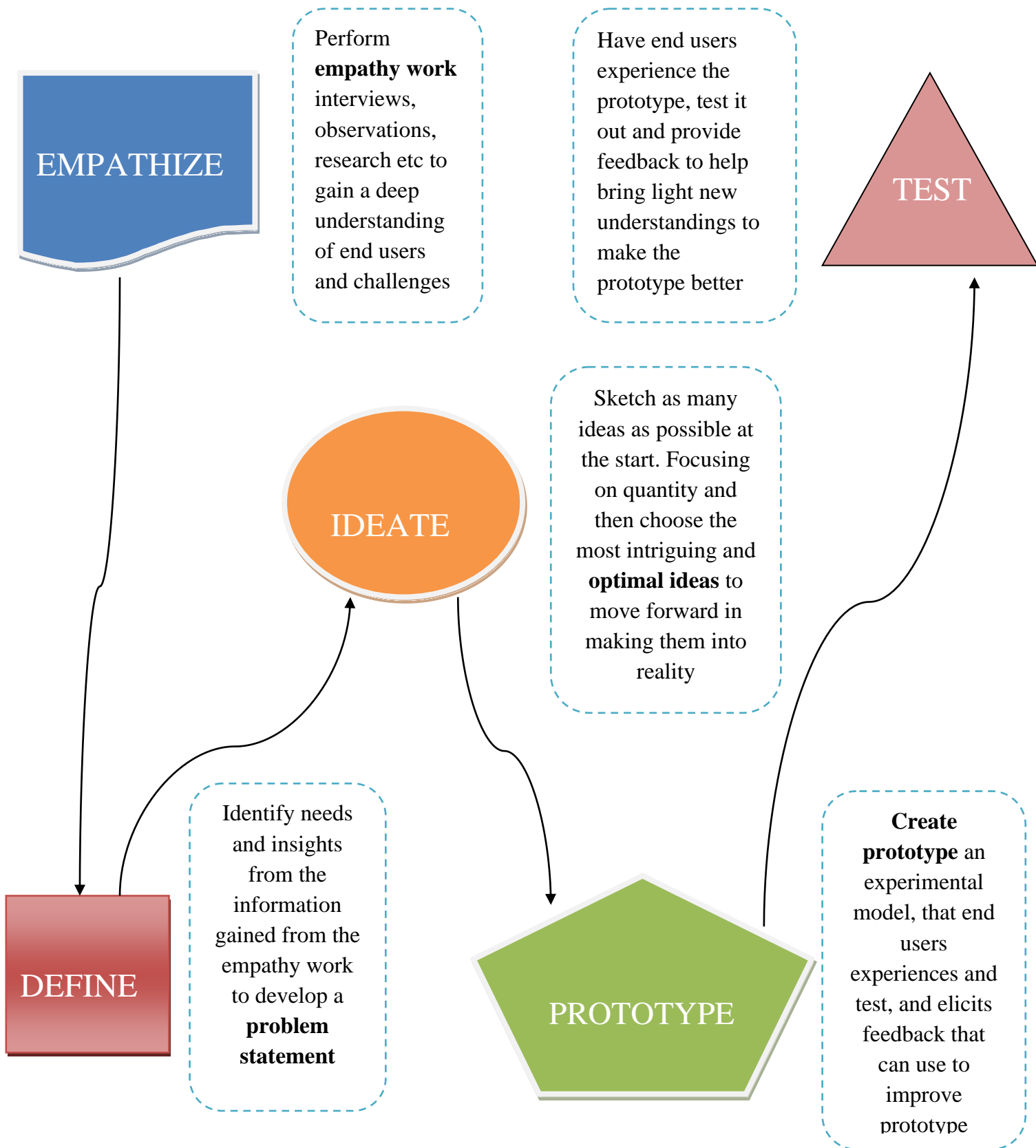
- Improve and learn from failure
- Creative confidence
- Growth mindset
- Beginner's mindset

5 stages of Stanford:

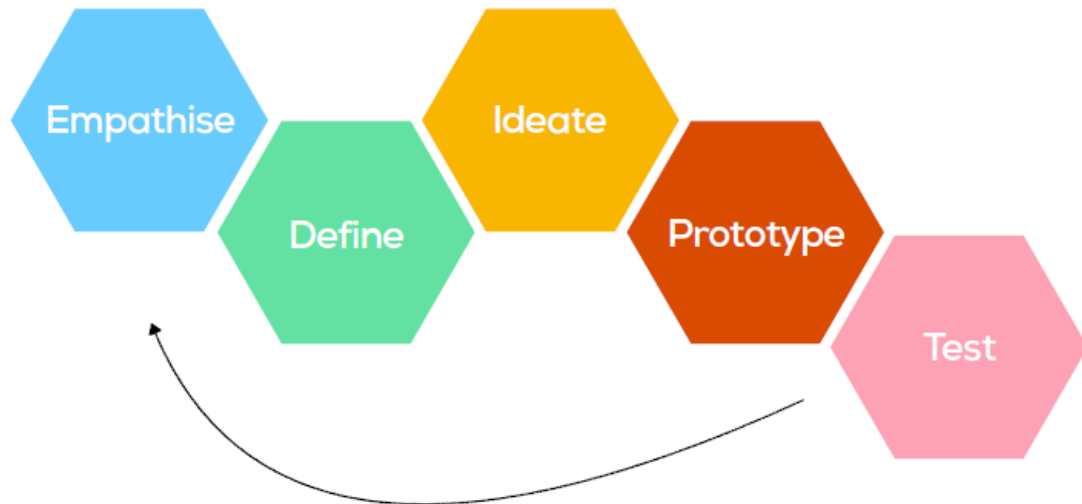
1	2	3	4	5	
					
					

Supporting points of Stanford d school framework.

Design thinking is toolkit for creating problem-solving. The **process does not have to be linear**. It can jump from one phase to any other phase based on need.



An iterative cyclic proces



Empathise

Understand the experience, situation and emotion of the person who you are working for

- **Observe** users and their behaviour in the context of their lives.
- **Engage** with people in conversations and interviews. Ask why.
- **Watch and listen:** ask someone to complete a task and tell you what they are doing



Define

Process and synthesise the findings in order to form a user point of view that you will address

- **User:** develop an understanding of the type of person you are designing for
- **Needs:** synthesise and select a limited set of needs that you think are important to fulfil
- **Insights:** express insights you developed and define principles



Ideate

Focus on idea generation. You translate problems into solutions. Explore a wide variety and large quantity of ideas to go beyond the obvious solutions to a problem.

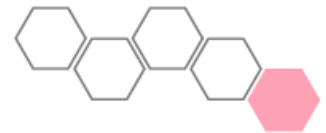
- **Creativity:** combine the un/conscious with rational thoughts and imagination
 - **Group synergy:** leverage the group to reach out new ideas and build upon other's ideas
 - Separate the generation and **evaluation** of ideas to give imagination a voice
-



Prototype

Build to think. A simple, cheap and fast way to shape ideas so you can experience and interact with them.

- **Start building:** Create an artefact in low resolution. This can be a physical object or a digital clickable sketch. Do it quick and dirty.
- **Storyboard:** create a scenario you can role play in a physical environment and let people experience your solution



Test

Ask for feedback on your prototypes. Learn about your user, reframe your view and refine your prototype.

- **Show:** let people use your prototype. Give it in their hands and let them use it. Listen to what they say.
- **Create experiences:** let people talk about how they experience it and how they feel

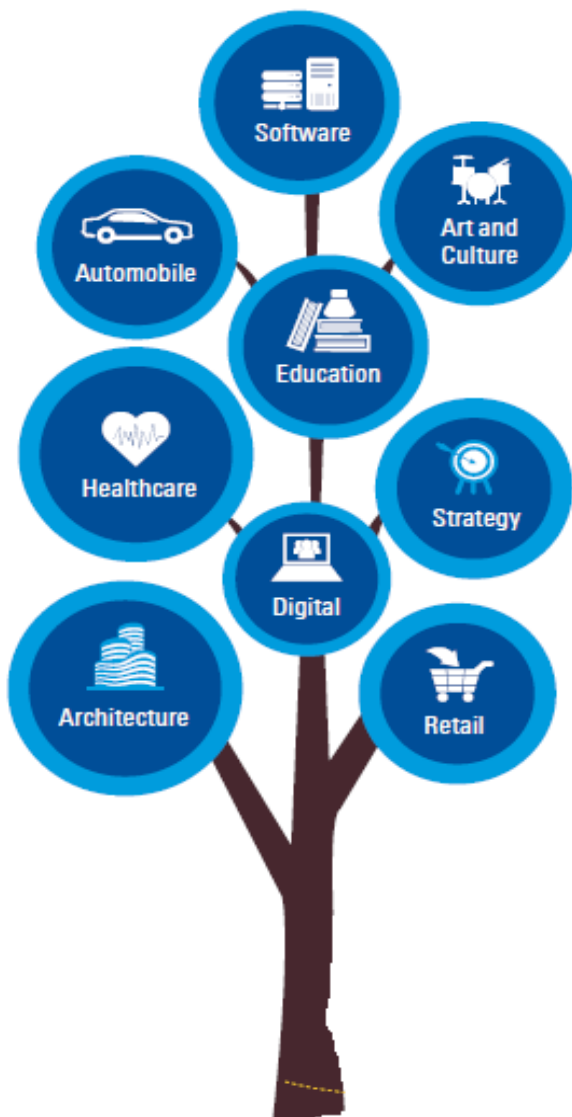
❖ **The more discussion on the above steps will learn on the subsequent chapters**

1.14. Application of Design thinking:

- Design thinking is a problem solving that focus on users and their emotional needs while experiencing products and services.
- Design thinking approach is useful for Designers, **Engineers**, planners, Managers, strategists, Economists, Teachers and many other Professions

Design thinking having wide range of applications across different domains:

- Automobile
- Health care
- Architecture
- Software
- Education
- Digital
- Retail
- Art and culture
- strategy



Applications of DT

❖ **Business:**

- Design thinking helps in business by optimizing the process of product creation, marketing, and renewal of contracts.
- All these processes require a companywide focus on the customers and hence, design thinking helps in these processes immensely.
- Design thinking helps the design thinkers to develop deep empathy for their customers and to create solutions that match their needs exactly.

❖ **Information technology:**

- The IT industry makes a lot of products that require trials and proof of concepts.
- The industry needs to empathize with its users and not simply deploy technologies.
- IT is not only about technology or products, but also it is process.
- The developers, analysts, consultants, and managers have to brainstorm on possible ideas for solving the problems of the clients. This is where design thinking helps a lot.

❖ **Education:**

- The education sector can make the best use of design thinking by taking feedback from students on their requirements, goals and challenges they are facing in the classroom.
- By working on their feedback, the instructors come up with solutions to address their challenges.

❖ **Health care:**

- Design thinking helps in health care as well as the expenditure on healthcare. The cost of healthcare facilities is growing day by day.
- Experts worldwide are concerned about how to bring quality healthcare to people at low cost
- Using design thinking, the efficiencies in the system and the perennial crises were addressed

1.15. Design thinking for Engineering:

- **Design thinking** and **Engineering systems thinking** are two complementary approaches to understanding **cognition, organization**, and other nontechnical factors that influence the design and **performance of Engineering systems**
- **Design thinking** methods have been applied to **industrial design** and **product development**, while **engineering systems thinking** is used in professional systems engineering practice and **large-scale, complex system design**.
- System dynamics is a foundation method in system engineering –an interdisciplinary field of formalized approaches for designing and managing large-scale, complex engineered systems throughout the life cycle.
- Systems engineering methodology offers a process for technical management of sophisticated quantitative techniques are used to organize and coordinate work activities, evaluate technical systems interactions, and assure system quality and performance.
- Systems engineering has drawn from operations research and management science to develop mathematical models of human performance. Example of classical quantitative approaches to management includes Markov analysis, linear /dynamic programming, decision theory, and game theory etc.
- Systems engineers are well-trained to manage technical system consolidation, but the **associated between social and organizational** are more **difficult to govern** in **practice**.
- Existing analytical methods hard OR methodology is in applicable or ineffective for solving problems associated between social and organization. Nonetheless, systems engineering are expected to play ambidextrous roles and have the professional responsibility of “**system thinking**” i.e **designers who manage technical as well as social and organizational constraints in dynamic environments**
- Understanding how systems engineers **evaluate technical and social relationships-** and leverage this information to **successfully design** and manage complex systems – is a **challenge** in **modern systems engineering** practice.
- Engineering systems thinking shares a foundation with systems science, thus values and applications bear strong resemblance to those of general systems theory, cybernetics, and systems dynamics.
- Systems receive inputs from the environment, execute processes that transform these inputs into outputs, and send these outputs back into the environment in feedback loop.
- Engineering systems thinking is **system-centered**, i.e it is used for conceptualizing systems, their individual components, and interactions between those components to help designers anticipate emergent features and design robust and resilient systems.

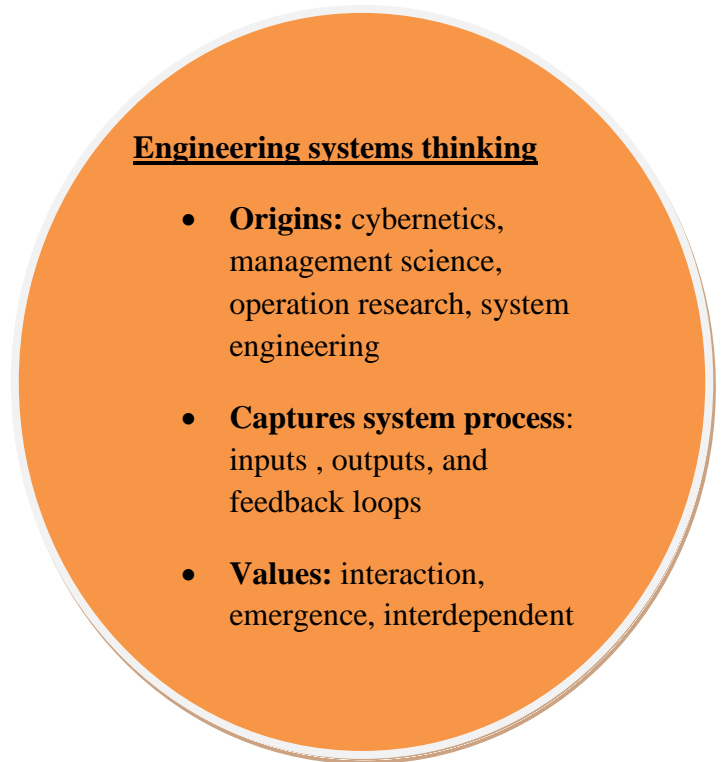
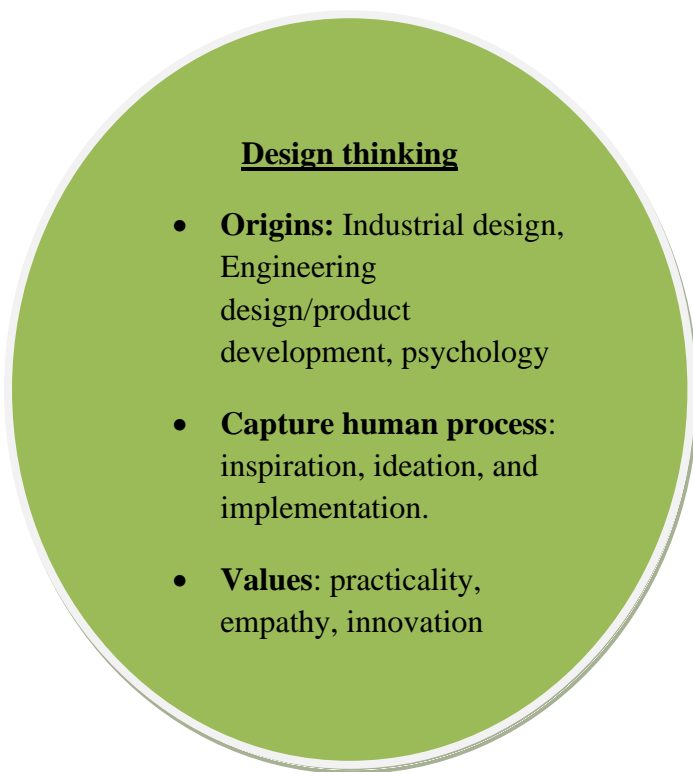
- Contemporary research in **Engineering system thinking** **seeks** to make the approach **more human-centered** (design thinking approach)

Concept models for comparing design thinking and engineering systems thinking:

- ❖ Design thinking and engineering systems thinking are using four general themes: history, values, applications, and methods.
- ❖ By organizing these themes into models called “**concept models**”.
- ❖ Concept models visually represent different perspectives on the relationship between design thinking and engineering systems thinking.
- ❖ The models are
 - I. Distinctive concept model
 - II. Comparative concept model
 - III. Inclusive concept model
 - IV. Integrative concept model
 - The Distinctive concept model, positions design thinking (DT) and Engineering system thinking (EST) as separate concepts, each with unique history, set of values, practical application and methods
 - The comparative concept model, suggests that design thinking(DT) and Engineering system thinking(EST) are similar underlying concepts with different applications and methods
 - The inclusive concept model describes engineering systems thinking as a specific application of design thinking, in which design thinking principles, methods and processes are applied to complex systems design problems.
 - Integrative concept model suggests that design thinking might be the critical skill for design at both the product and system level and the Engineering system thinking might (EST)not be practically distinguishable from design thinking (DT)
 - These models do not suggest single correct representation of the design thinking and Engineering system thinking relationship. Further research and studies are going on these models.

The Distinctive Concept Model:

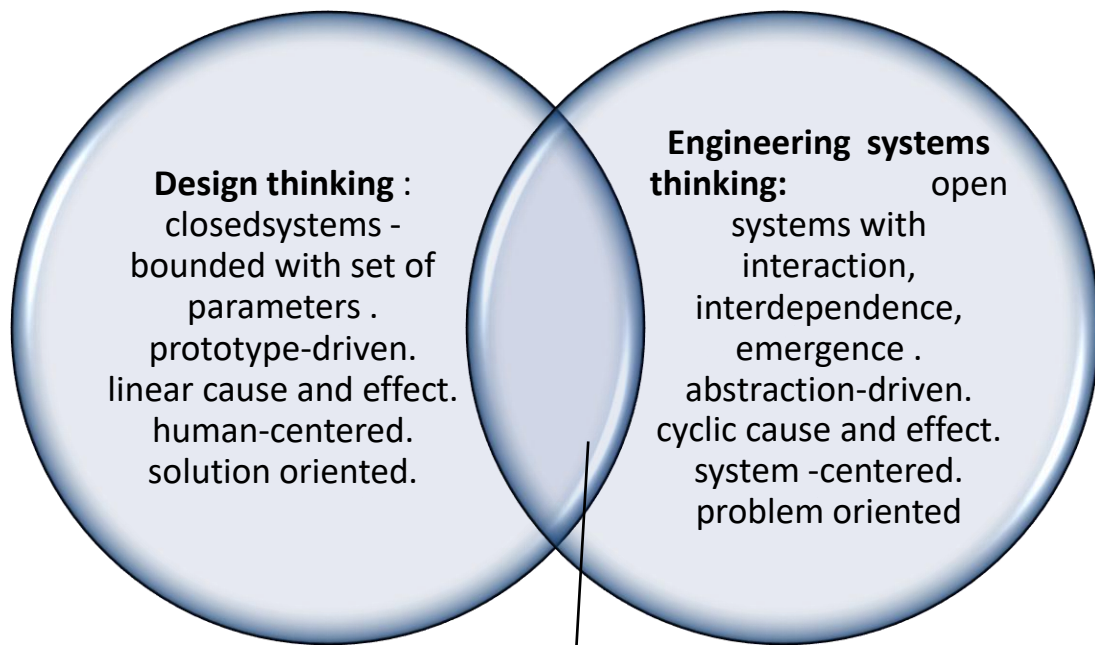
- The distinctive concept model of design thinking and engineering systems thinking describes two unique concepts with different histories, values, themes, and applications.



- Design thinking has origins in psychology, industrial design, and product development, and is a method for generating innovative, user-centered products and services. Empathy is a key driver of the design thinking process.
- Systems thinking, on the other hand, originated from cybernetics and operations research and are intended to capture stock and flow structures and feedback loop dynamics. It is system focused and used for identifying potential interactions between system elements that might result in unintended system performance.

The Comparative Concept Model:

- Design thinking and Engineering systems thinking positions the two_concepts as distinct, but with several major overlaps.



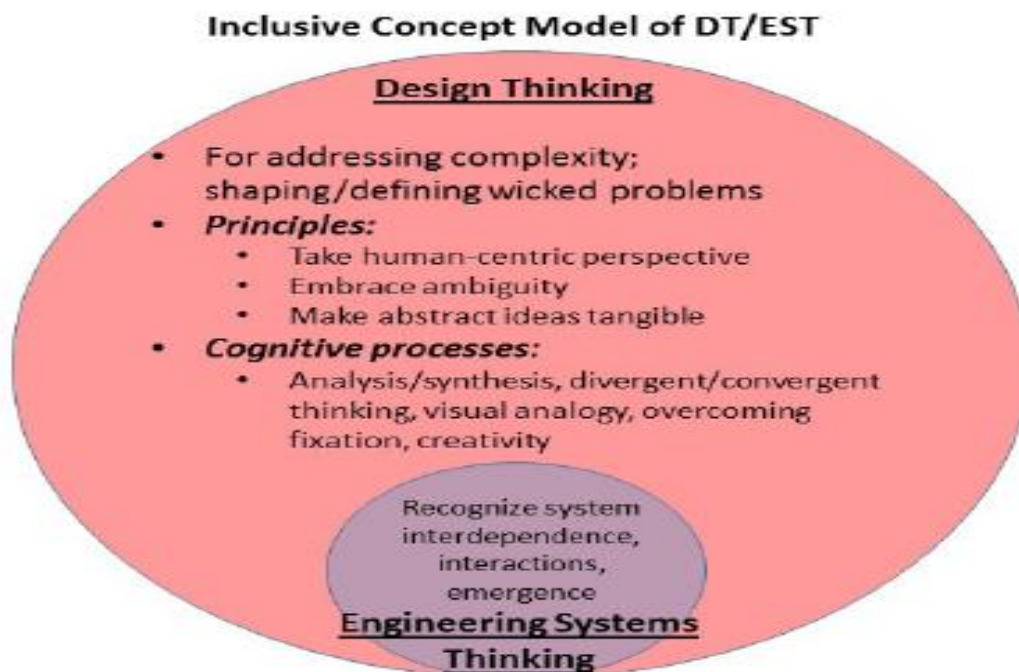
- Require similar cognitive skill set (e.g analogy, ability to overcome fixation)
- Require empathy/ faculty for human relations
- Similar inquiry: at individual/team level in engineering, business, and education

- While DT and EST have different origins, applications and approaches, both require a similar cognitive skill set in practice.
- Design thinkers and engineering systems thinkers alike must be creative, flexible, curious, and emotionally intelligent.
- Design thinkers and engineering systems thinkers both utilize divergent and convergent thinking strategies, use analogical, visual, and spatial reasoning, and embrace ambiguity and emergence.

The Inclusive Concept Model:

- The inclusive concept model suggests that engineering systems thinking might not be a standalone methodology.

- the specific application of design thinking principles to the design of large scale, complex engineering systems such as software enterprise systems, aerospace vehicles, or nuclear power stations etc
- DT and EST are both approaches for addressing design complexity, defining and solving wicked problems, and understanding the role of cognitive and social processes on system design and performance.
- The key distinction here is the emphasis placed on abstraction, interdependence, and emergence in EST, versus tangibility, prototyping, testing, and redesign in DT.
- It is important to note that EST is included as a subset of DT and not the other way around.



The Integrative Concept Model:

- The philosophies of design thinking and engineering system thinking might be better understood as part of a single overarching framework.

Design thinking/ Engineering systems thinking:

- Design thinking: required for successful design, of consumer products, complex systems etc.
- Similar inquiry, definition, purpose, cognitive/social process
- Findings from empirical studies on designer thinking likely apply to engineering system and its design

- Design thinking could be the fundamental skill required for design across all contexts and levels of complexity; engineering systems thinking might not be distinguishable from design thinking in practice.

Conclusion:

- Design thinking and engineering systems thinking are similar frameworks for exploring principles and processes of engineering design.
- Exploring contemporary applications and methods is useful for identifying opportunities to share knowledge and tools between communities in the future.

Summary

- Design thinking is more than a methodology; it represents a philosophy that places end users firmly at the centre of innovation process and the development of new products and services.
- **This is a win-win scenario.** Where the end users benefits, so too does the creative organization. Importantly design thinking has a powerful strategic element, which needs to be firmly aligned with an organization's culture and brand.
- The concept of design thinking can be applied across diverse disciplines. From education, law, and medicine to ICT, business management, human resource management and design it, design thinking principles enable and empower a professional to approach the problem statement in a step-by-step manner and take into account all the necessary factors for arriving at the best solution.
- The entire flow of design thinking is generally broken down into five components. These components are:
 - Empathize or Understand
 - Define
 - Ideate
 - Prototype
 - Test or Verify
- In **Empathize stage**, the design thinker puts himself or herself into the shoes of the end user and tries to understand the needs of the customer.
- The **Define stage** helps to frame the problem definition. Problem shaping occurs in this phase itself
- In the **Ideate phase**, a design thinker brainstorms on the ideas suggested by others and also brings forward his/her own ideas
- In the **Prototype phase**, a design thinker focuses on testing the ideas on the grounds of feasibility and viability.

- In the **Test phase**, the prototype or the **model is presented to the customer** and the customer experiences it completely on a full scale
- The concept of **iteration** is hence central to the process of design thinking.

Design thinking not only helps to come up with innovative solutions, but also helps to address the exact problems faced by the customer and target the customer's requirements in the best possible manner.

