Design Thinking and Product Innovation
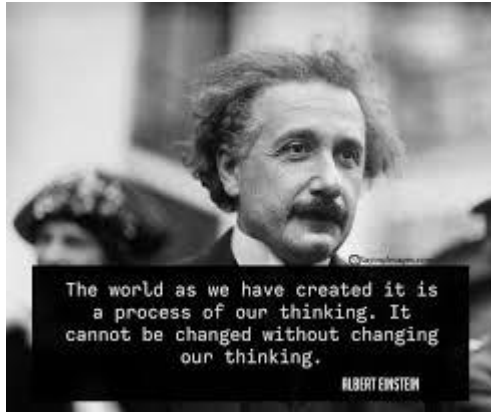
Unit-1

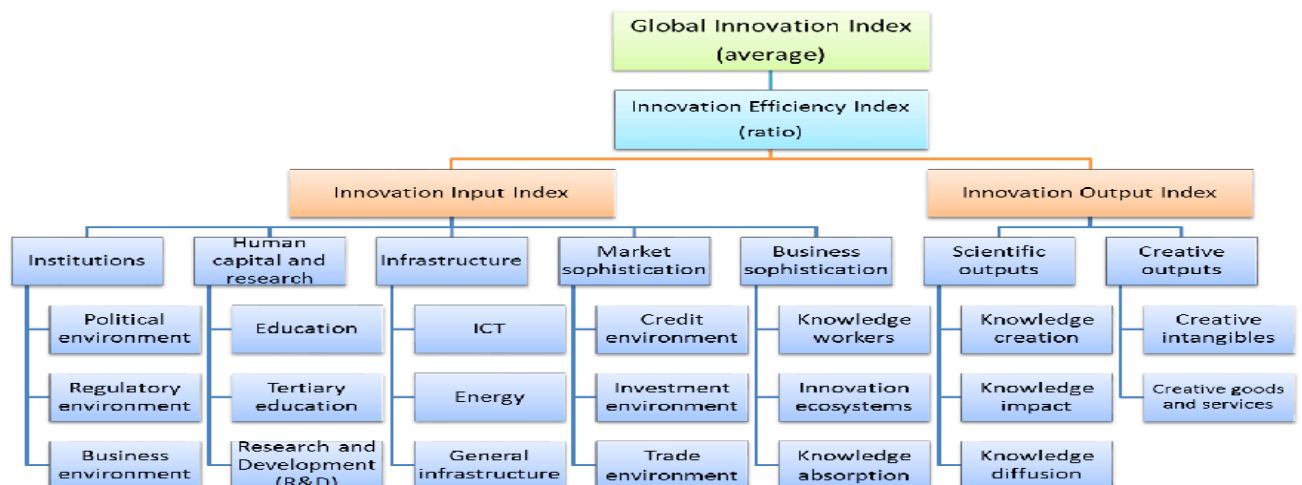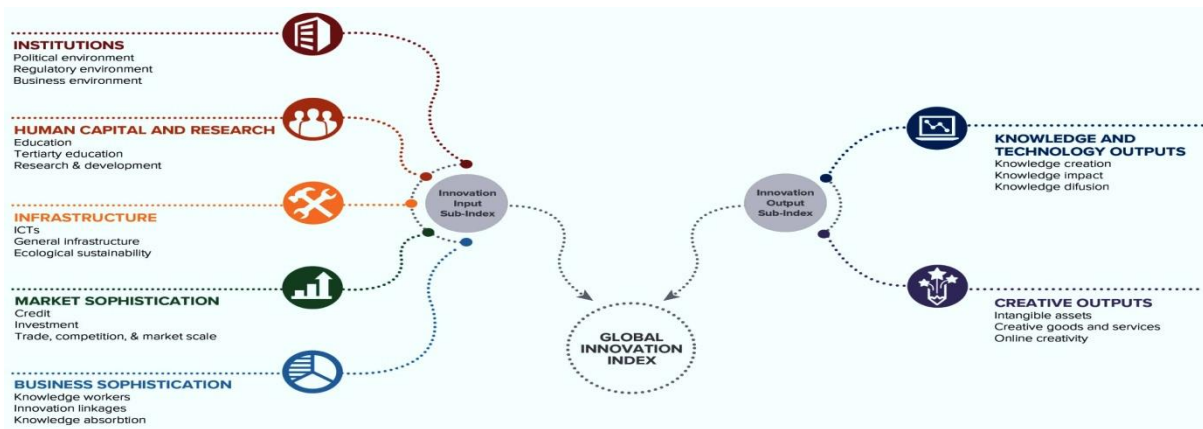## GLOBAL INNOVATION INDEX

- The global innovation index aims to capture the multi dimensional facets of innovation and provide the tools that can assists in tailoring policies or promote long term output growth, improved productivity, and job growth.
- The global innovation index is 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
TAMILANADU	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
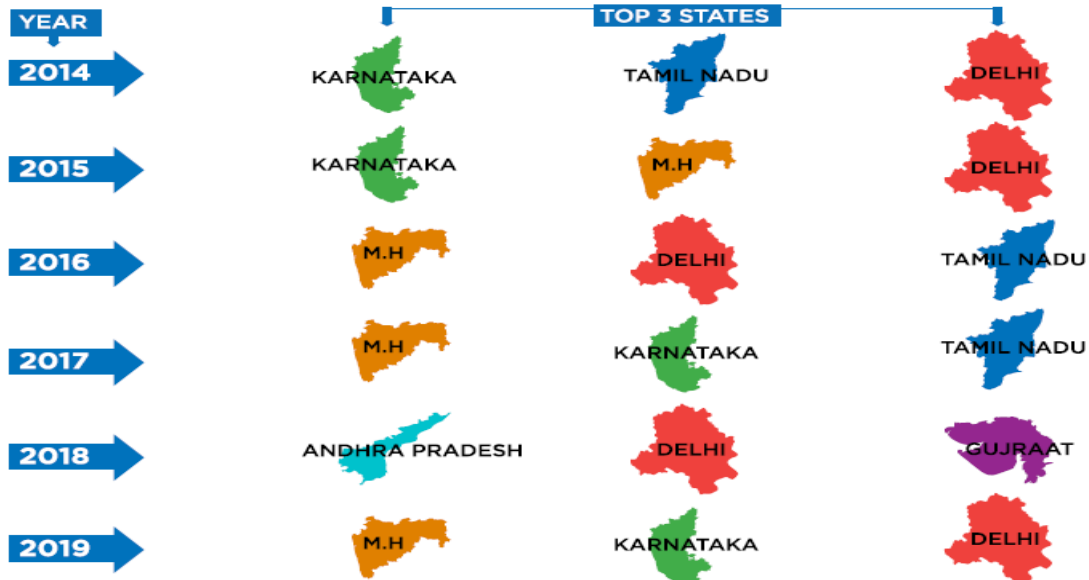
WHICH DOMAINS HAVE MORE EMPLOYABLE TALENT?

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?

YEAR	TOP 3 STATES		
2014	KARNATAKA	TAMIL NADU	DELHI
2015	KARNATAKA	M.H	DELHI
2016	M.H	DELHI	TAMIL NADU
2017	M.H	KARNATAKA	TAMIL NADU
2018	ANDHRA PRADESH	DELHI	GUJRAAT
2019	M.H	KARNATAKA	DELHI

WHICH WERE THE STATES WITH MAXIMUM SUPPLY OF EMPLOYABLE TALENT?

YEAR	TOP 3 STATES		
2014	PUNJAB	HARYANA	DELHI
2015	DELHI	ORRISA	UTTAR PRADESH
2016	ANDHRA PRADESH	UTTAR PRADESH	DELHI
2017	MAHARASHTRA	ANDHRA PRADESH	WEST BENGAL
2018	ANDHRA PRADESH	DELHI	GUJRAAT
2019	ANDHRA PRADESH	DELHI	UTTAR PRADESH
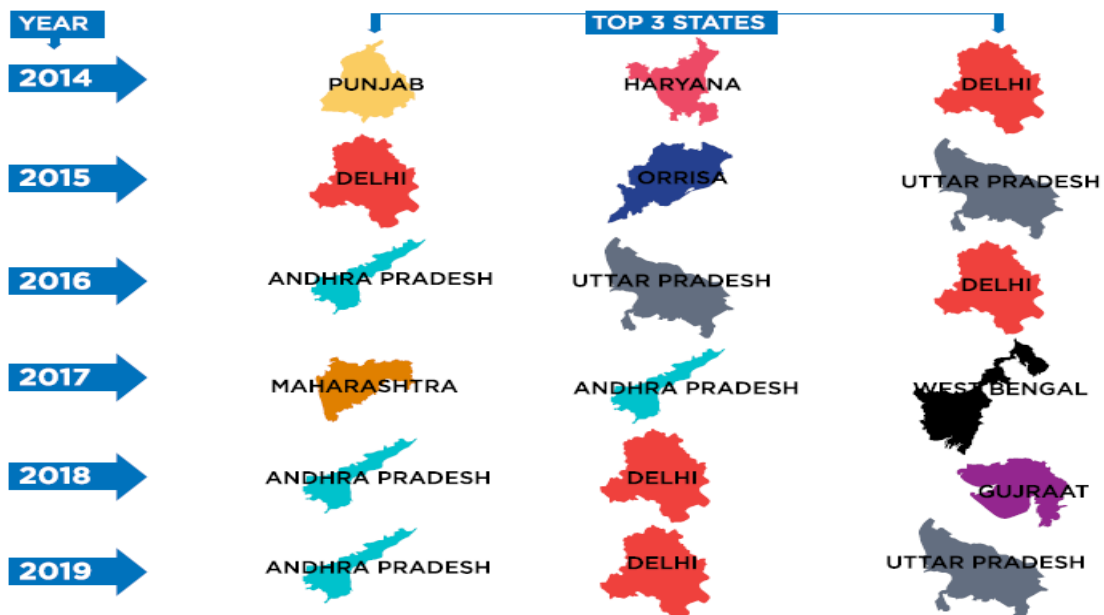
➢ In the inaugural function of 107th session of Indian Science congress which was held in Bangalore on Jan-2020 prime Minister of India urges the young scientists to "Innovate, Patent, Produce and prosper. These four steps will lead country towards faster development"

➢ Based on the skill India Report and government policies the technical and higher educational institutes take the measurable steps to enhance the frame work (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 21th 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
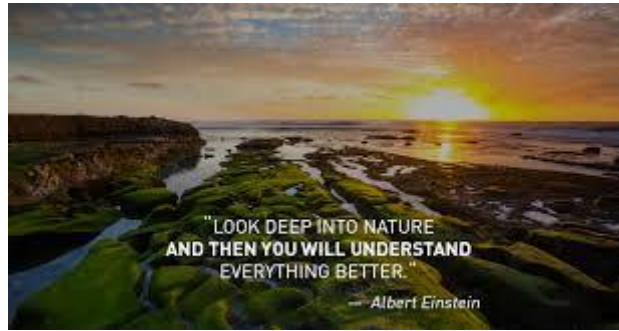
TOP 6 METHODS OF INNOVATION TO COME UP WITH UNIQUE PRODUCT IDEA ARE:

❖ 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

Nature Vs human

"LOOK DEEP INTO NATURE
AND THEN YOU WILL UNDERSTAND
EVERYTHING BETTER."
— Albert Einstein
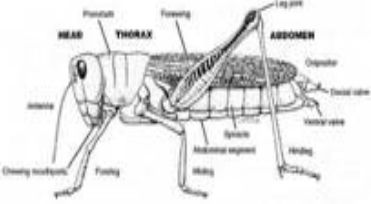
Plants, animals and human beings are creation of nature and one of the theories of evolution suggests that life forms began simply and then became more complex. Such a theory proposes that human beings are possibly a highly evolved creation with the ability to understand the mysteries and mechanisms of nature.

Designs inspired by nature:

Nature made	Man made
Aves	**Flying suit**
Crane bird	**Crane**
Grasshopper	**Grasshopper structure**

Kangaroo pouch	**Baby pouch**
Snail	**Cd track**
Spiral climber	**Stair case**
Egg	**Medicine capsules**
Human anatomy	**Pipes**
Butter fly	**Industrial pipe lines**
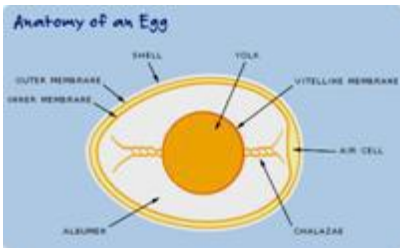
Spider net	**Fishing net** **Basket ball net** **Soccer ball net**
Pelican	**Pouch bags**
Sapling **Joints of Finger (Flexing)**	**Leaf spring** **Automobile**
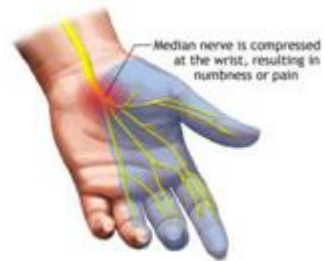
Closed Fist (Bending)	
Elbow joints	**Machine part joints**
Blister on skin	**Medicine pack** **Pen drives pack**
Lion fur **Crocodile skin**	 **wrapped baby**

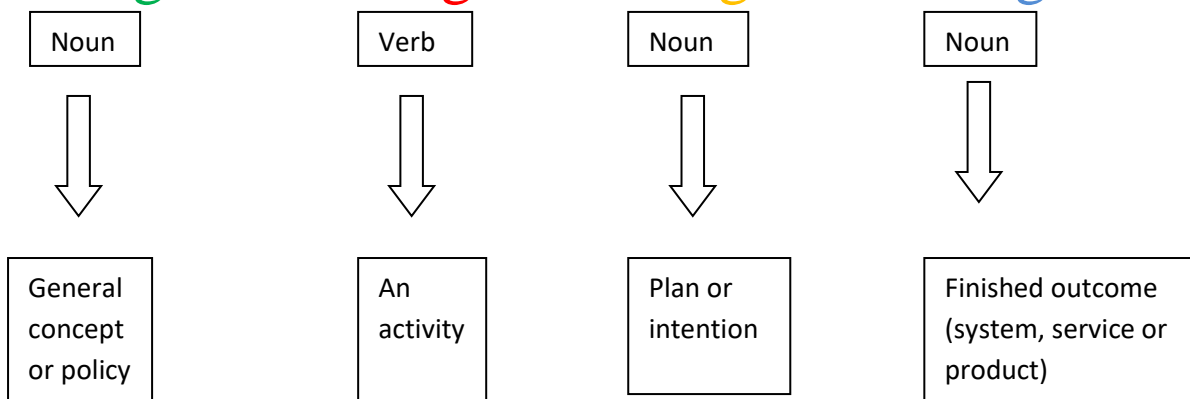|	
Scales	**Wrapped suitcase**

> ❖ "The future is best found in the opportunities that go un noticed 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

Noun	Verb	Noun	Noun
⬇	⬇	⬇	⬇
General concept or policy	An activity	Plan or intention	Finished outcome (system, service or product)

> ➢ Design(Noun):

Blue print of something-a plan for change

Undesirable 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.

- 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

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 needed in 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
- ➢ Engineers combine their skills in mathematics, science, computers, and hardware
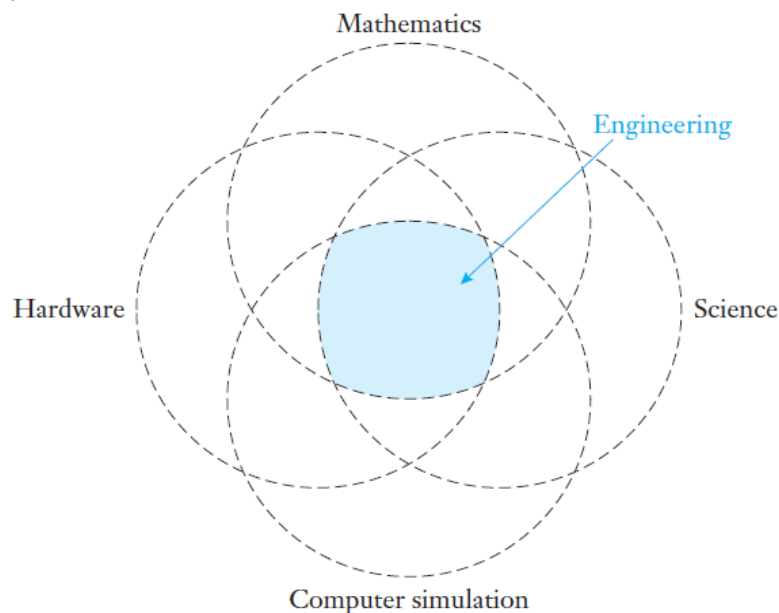
- ➢ "Engineer creates the new things and makes the old things better and better"

Style Vs Technology chart for digital music players:
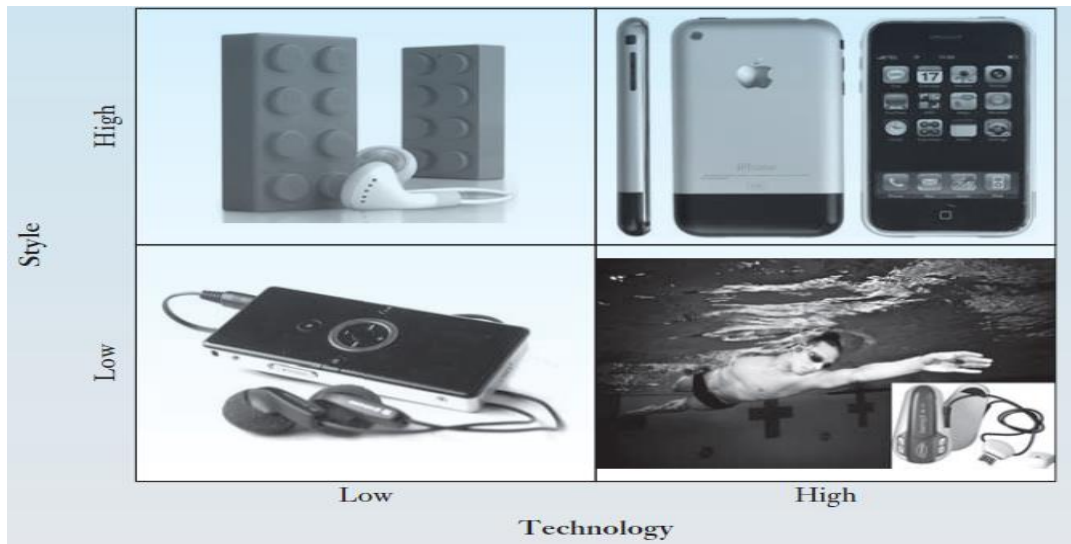
- ➢ The above chart shows style on the vertical axis and technology on the horizontal axis.
- ➢ This chart provides a frame work to strategically develop innovative products for a wide range of customers.
- ➢ In each quadrant is a different digital music players
- ➢ **In the lower left:**
  The low-style/low-technology 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.

❖ Difference between Design and Engineering Design

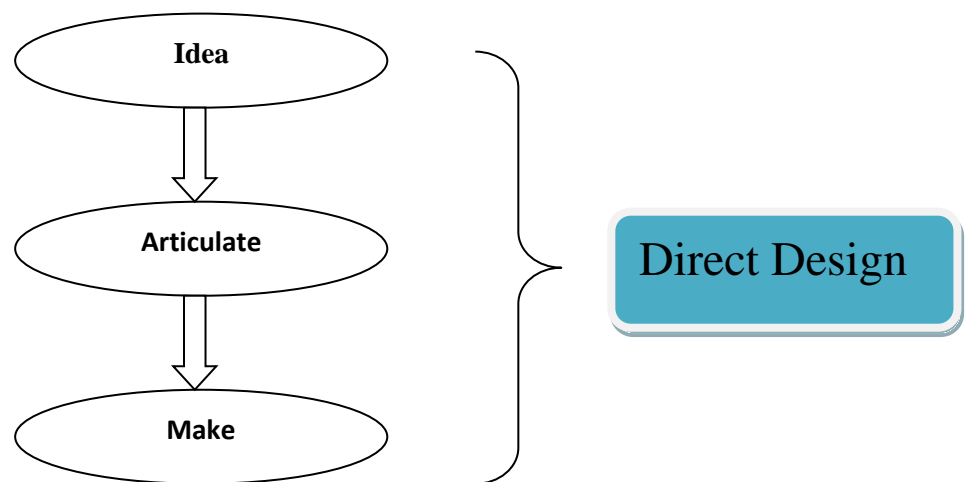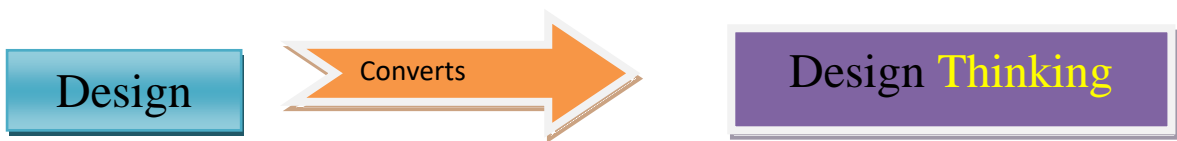| Design	Engineering Design
The specification of an object manifested by an agent, intended to accomplish goals in a particular environment using a set of primitive components , satisfying a set of requirements subjected to constraints	Engineering Design is the process of devising a system, component 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 filed of design	The formal definition of engineering design depend on the specific engineering

❖ The "General Design "process Model.
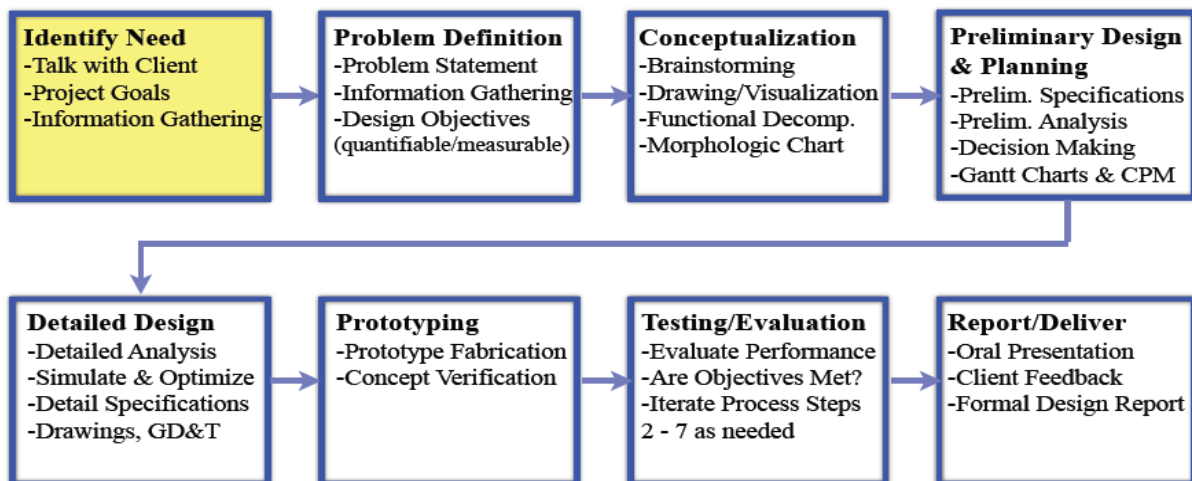
Design Process Iteration
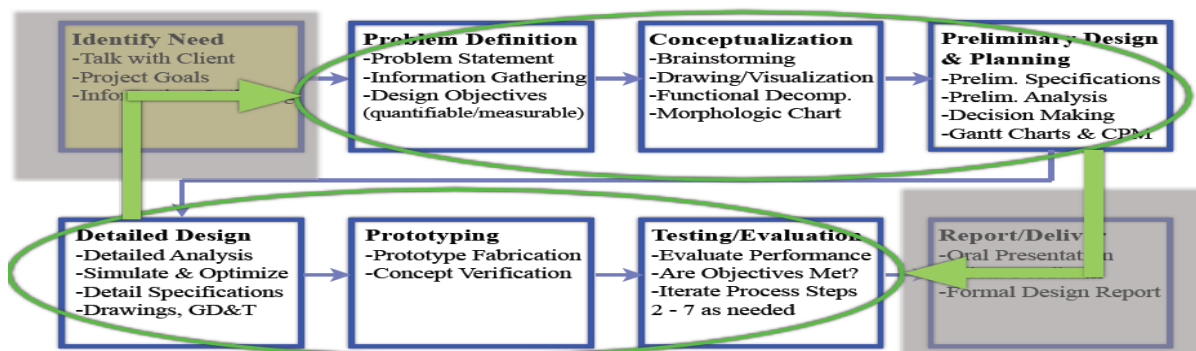
Origin of Design thinking:
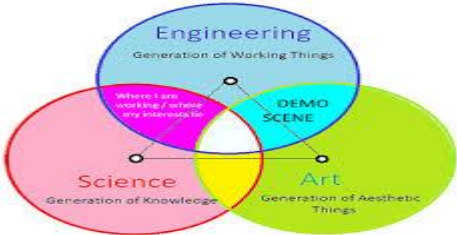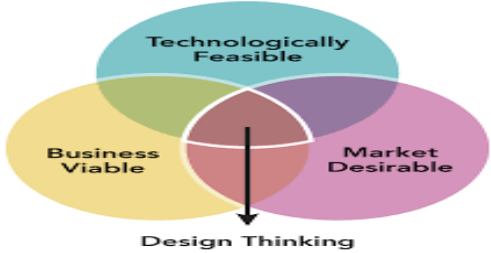
Design to Design thinking

➢ 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.

```
        ┌─────────────┐
        │    Idea     │
        └─────────────┘
               │
               ▼
        ┌─────────────┐
        │  Articulate │         ┌──────────────┐
        └─────────────┘         │ Direct Design│
               │                └──────────────┘
               ▼
        ┌─────────────┐
        │    Make     │
        └─────────────┘
```

➢ 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 become 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

| Design | Converts | Design Thinking |

individual

Teams

Products

Experience

Design is a combination of Engineering +science +Art

Design thinking is a combination Technology(Engg) +Business+ Humans

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

Time line 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

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 users quality of experience
- Creating innovative, feasible and viable solution to real world problems.
- Addressing the actual requirements of the end users.
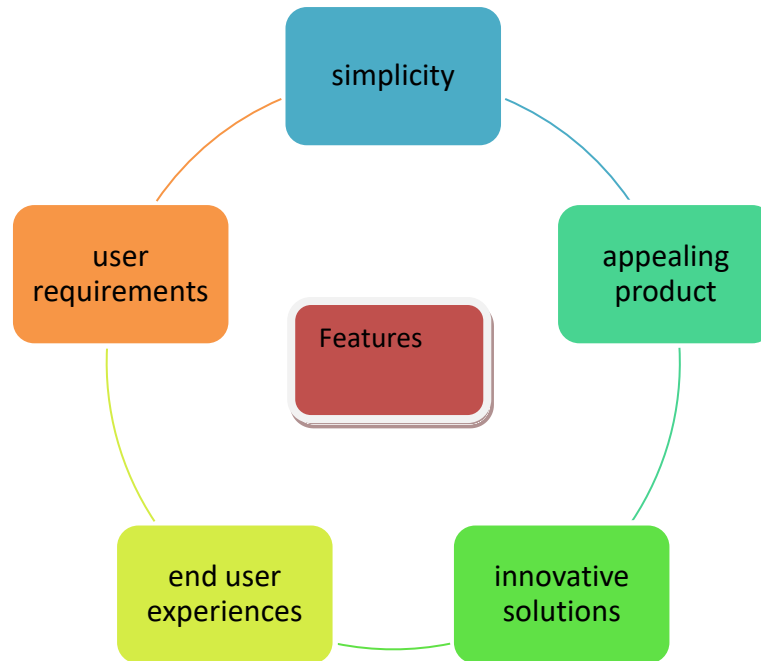
Use of design thinking:

> 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

Design Thinking helps in		
Optimization of capabilites	Feasibility and viabilty analysis	Addressing the needs of end users

Changing paradigms:

➤ Changing paradigms can be essential to achieving and attracting what you desire into your life

➤ A paradigm by definition 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 takes place over the last few decades

Components	systems
Sensors	Smart networks
Products	Services & experiences
Stand alone system	Cloud

Conclusion: all these shifts take place not by <mark>Doing the right things but Doing the things right</mark>

Doing the right things shows path to the problem finding ways

Doing the things right shows path to problem solving ways

Doing the things right be one of the strategy for <u>design thinking</u>

➢ Design thinking draws upon logic ,imagination, intuition and systemic reasoning , to explore possibilities of what could be and to create desired outcomes that benefit the end user (customer)

➢ A design mindset is not problem-focused; its solution focused and action oriented. It involves both analysis and imagination.

❖ Thinking <u>of</u> Design ➡ To imaging, visualizing, dream -up, new understanding, new practice and new applications

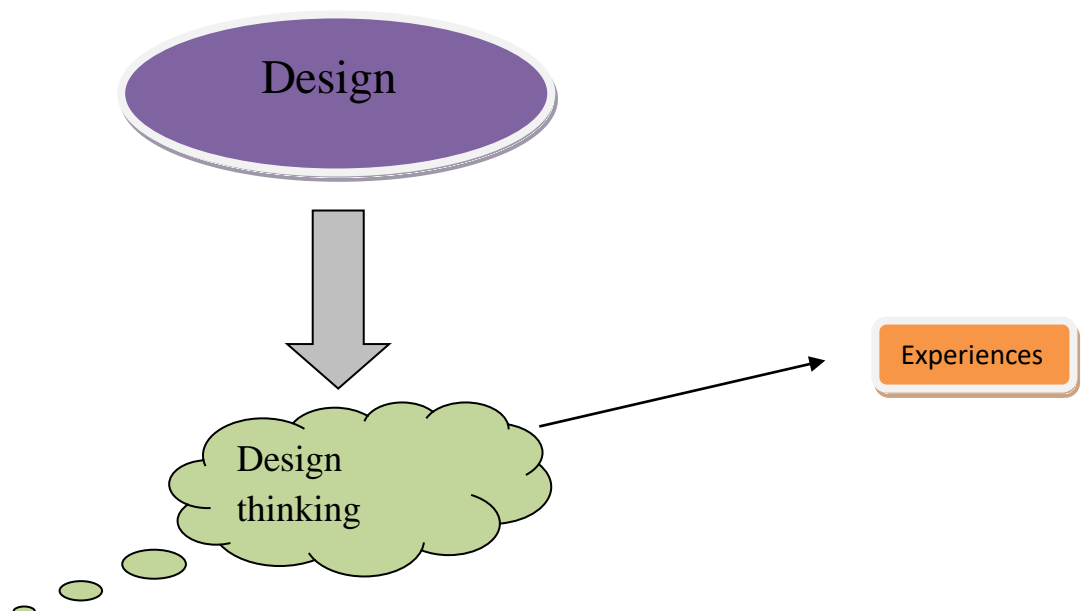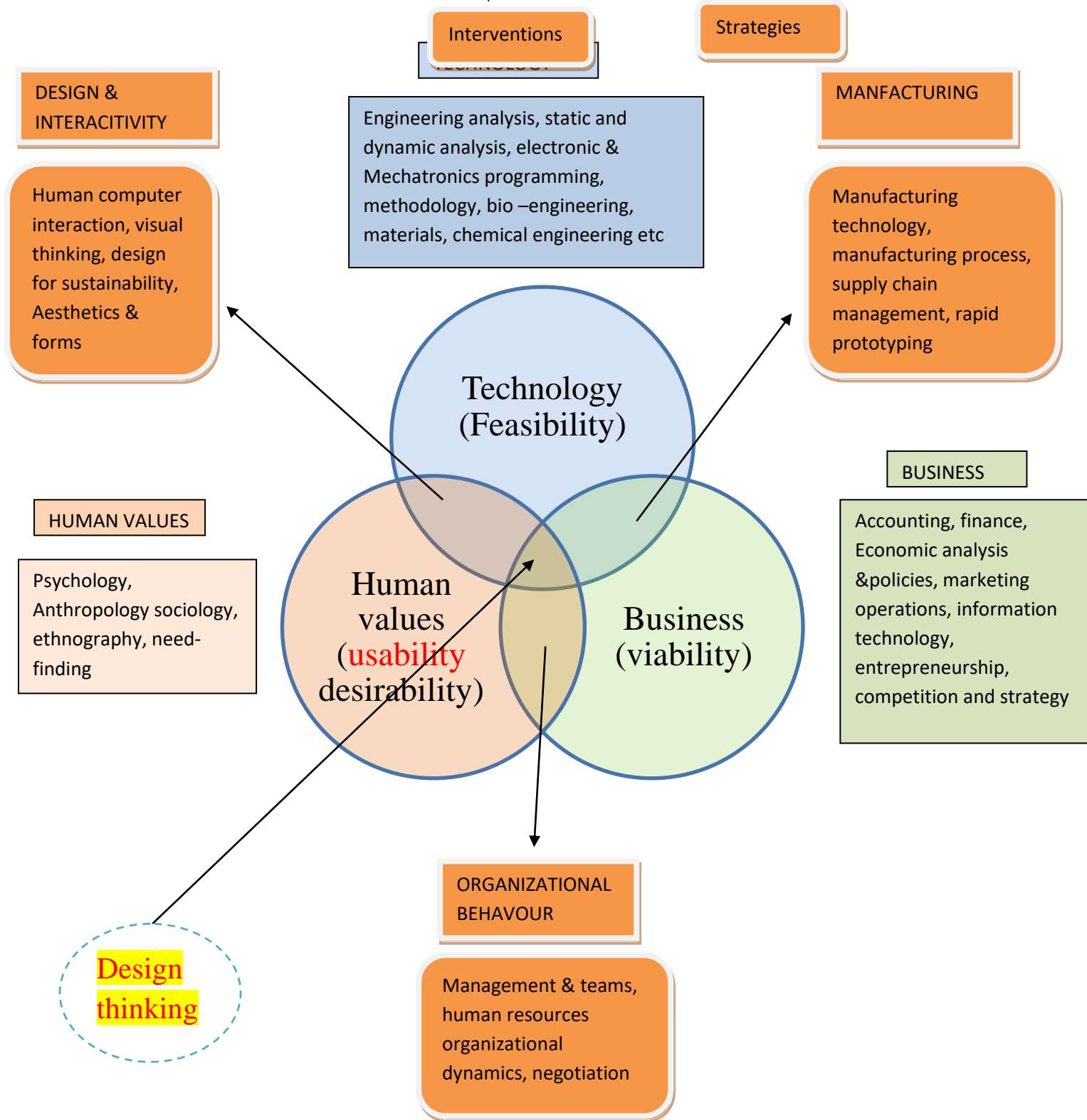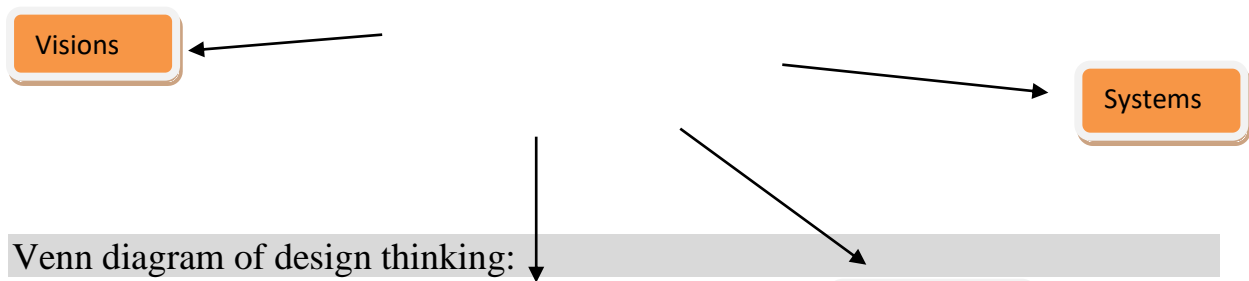❖ Thinking <u>about</u> Design ➡ To consider, expectations, capabilities and collaborations

❖ Thinking <u>through</u> design ➡ The ability to use design methods and principles to address uncertainty and complexity

❖

Design ⬇ Design thinking ➡ Experiences

Visions

Systems

Venn diagram of design thinking:

Interventions

Strategies

DESIGN & INTERACITIVITY

MANFACTURING

Human computer interaction, visual thinking, design for sustainability, Aesthetics & forms

TECHNOLOGY

Engineering analysis, static and dynamic analysis, electronic & Mechatronics programming, methodology, bio –engineering, materials, chemical engineering etc

Manufacturing technology, manufacturing process, supply chain management, rapid prototyping

Technology
(Feasibility)

BUSINESS

HUMAN VALUES

Psychology, Anthropology sociology, ethnography, need-finding

Human values
(usability desirability)

Business
(viability)

Accounting, finance, Economic analysis &policies, marketing operations, information technology, entrepreneurship, competition and strategy

Design thinking

ORGANIZATIONAL BEHAVOUR

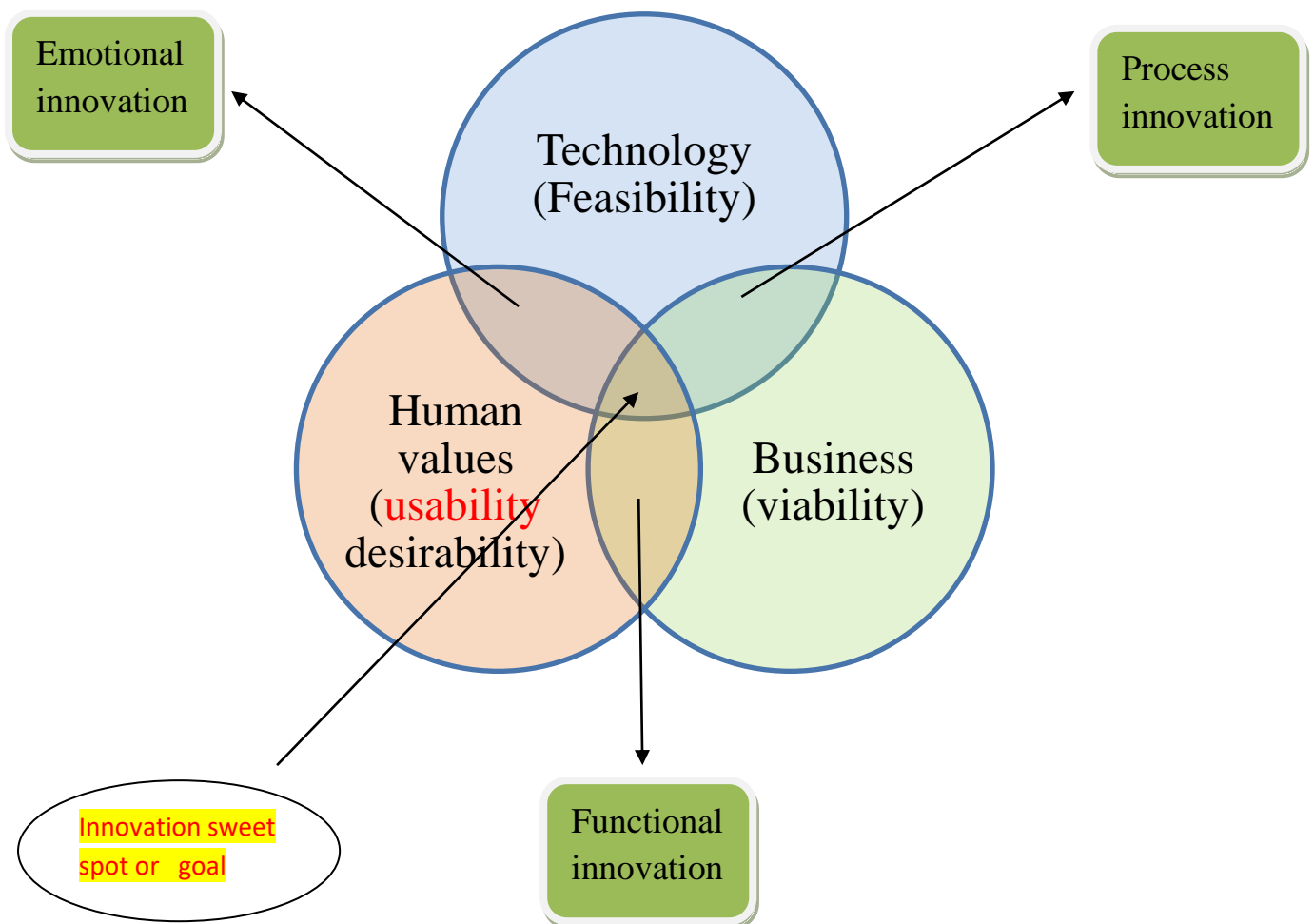Management & teams, human resources organizational dynamics, negotiation

➢ 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

❖ Design thinking & value creation (innovation)

➢ 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)

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**

People	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 have the ability to 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 theses people should have a spirit of shared purpose, flexibility, collaboration, and mutual support.
Place	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 **$5m^2$** per **participant** be used as sizing parameter for good space 6. Space, like money and tine is often a scare resource 7. The actual size of the space may become a limiting factor on how large the team and collaborative activities can be.
Materials	1. Making and visual idea transfer are essential elements of design thinking, for that materials are needed 2. list of materials typically needed

white boards	

		pin boards	
		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	
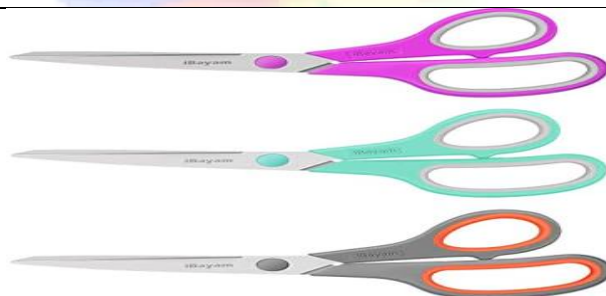
	index cards	
	audio and video capture tools and analyzers	
	Paper	
	play dough	
	popsicle sticks,	
	foam core	
	Push pins	

	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	

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. 1d.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 stanford
10. Beckman & Barry
11. Bill Moggridge
12. Stanford's modes
13. Jeanne liedtka & tim orgilnie
14. Standford's necktie flare
15. 1d IIT: Vijaykumar

> Innovate problem solving = design thinking
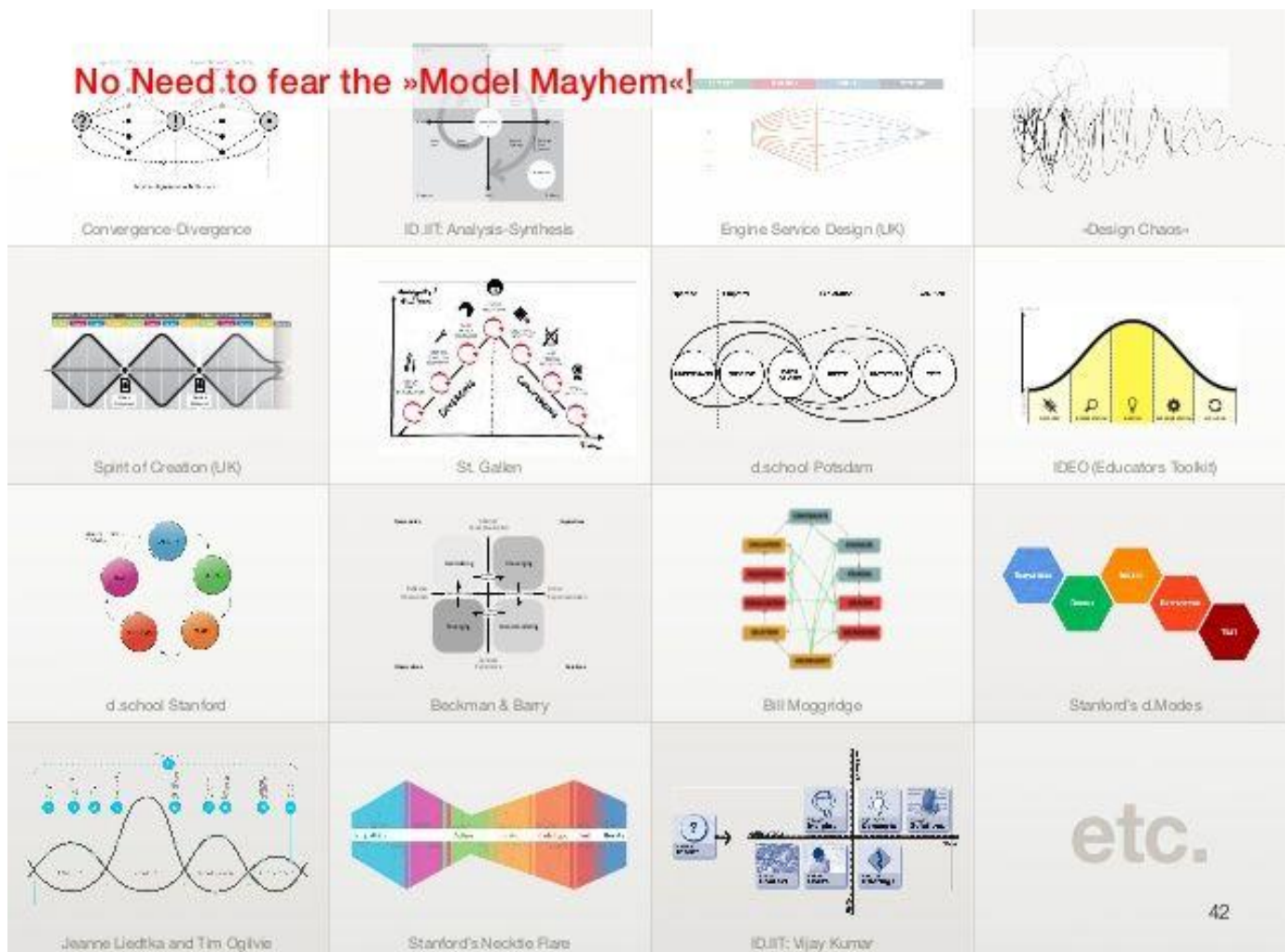
Design thinking methodologies:

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

IDEO	Inspiration	Ideation		Implementation	
XPLANE	Discover	Concept	Design	Do	
CHESKIN	Envision	Explore	Create	Inspire	Express
CONIFER	Research	Catalog	Synthesis	Insights	
COOPER	Research	Modeling, Scenarios	Framework	Design	Communicate
FROG	Discover	Design		Deliver	
FITCH	Discover	Define	Design	Do	
N MELVILLE	Explore	Discover	Concept & Design	Implement & Assess	

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

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 <u>wicked problems</u> 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, **stand ford's d.school teaches a framework that can help to start the process for almost any problem**
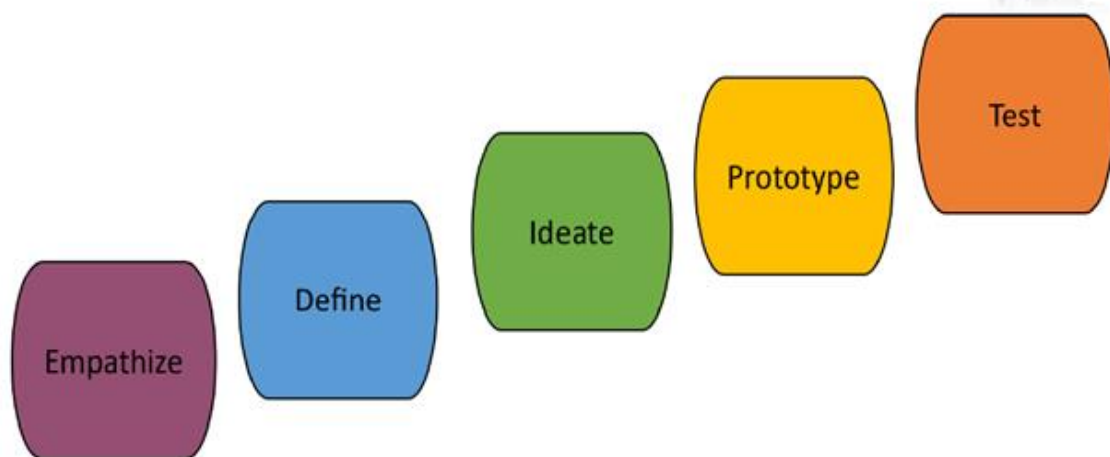
• In the Stanford d school's process model, the stages have the following objectives

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 alternative 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	
Empathize	Define	Ideate	Prototype	Test	Iterate
	Define	Ideate	Prototype		

Supporting points of Stanford d school frame work.

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.

EMPATHIZE

Perform **empathy work** interviews, observations, research etc to gain a deep understanding of end users and challenges

Have end users experience the prototype, test it out and provide feedback to help bring light new understandings to make the prototype better

TEST

IDEATE

Sketch as many ideas as possible at the start. Focusing on quantity and then choose the most intriguing and **optimal ideas** to move forward in making them into reality

DEFINE

Identify needs and insights from the information gained from the empathy work to develop a **problem statement**

PROTOTYPE

Create prototype an experimental model, that end users experiences and test, and elicits feedback that can use to improve prototype

Some more light on 5stage Stanford

An iterative cyclic proces

Empathise

Define

Ideate

Prototype

Test

Empathise

1
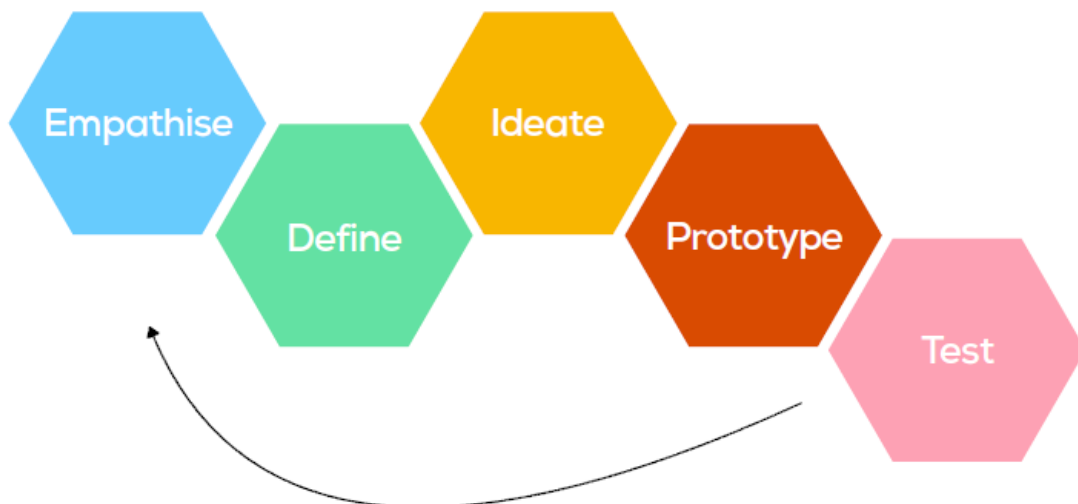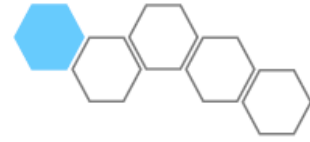
Understand the experience, situation and emotion of the person who you are working for

- **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

2 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

3 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 an build upon other's ideas
- Separate the generation and **evaluation** of ideas to give imagination a voice

4 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
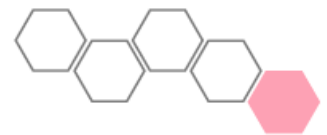
5 Test

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**

➢ 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
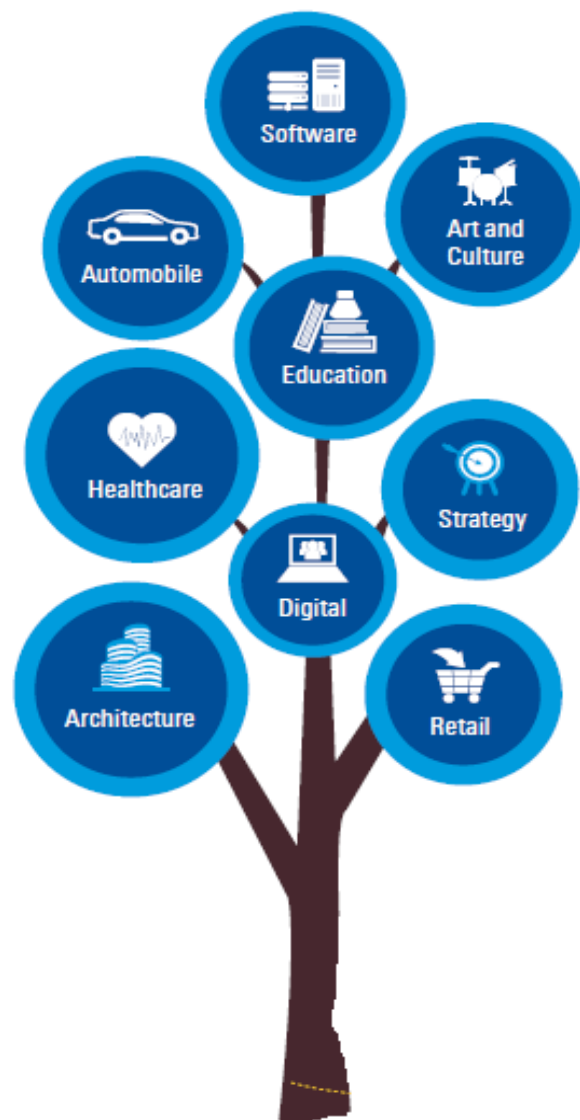
Applications of DT

❖ **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 mach 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 brain storms 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

➤ Design thinking for Engineering:

- Design thinking and Engineering systems thinking are two complementary approaches to understanding cognition, organization, and other non technical 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 are 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 theses 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

- **Origins:** Industrial design, Engineering design/product development, psychology

- **Capture human process**: inspiration, ideation, and implementation.

- **Values**: practicality, empathy, innovation

Engineering systems thinking

- **Origins:** cybernetics, management science, operation research, system engineering

- **Captures system process**: inputs , outputs, and feedback loops
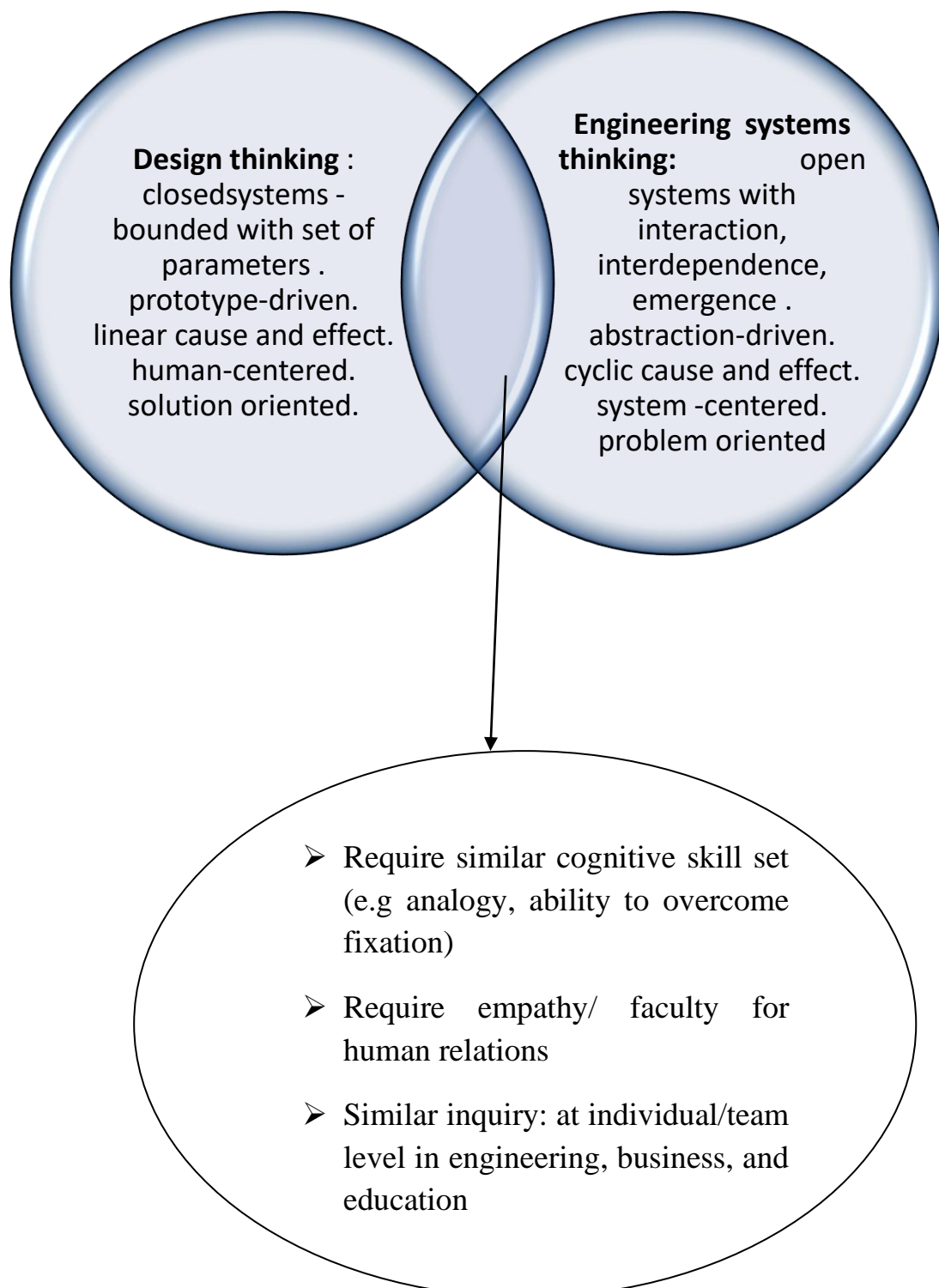
- **Values:** interaction, emergence, interdependent

➢ 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

Design thinking :
closedsystems -
bounded with set of
parameters .
prototype-driven.
linear cause and effect.
human-centered.
solution oriented.

Engineering systems thinking: open
systems with
interaction,
interdependence,
emergence .
abstraction-driven.
cyclic cause and effect.
system -centered.
problem oriented

➤ 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
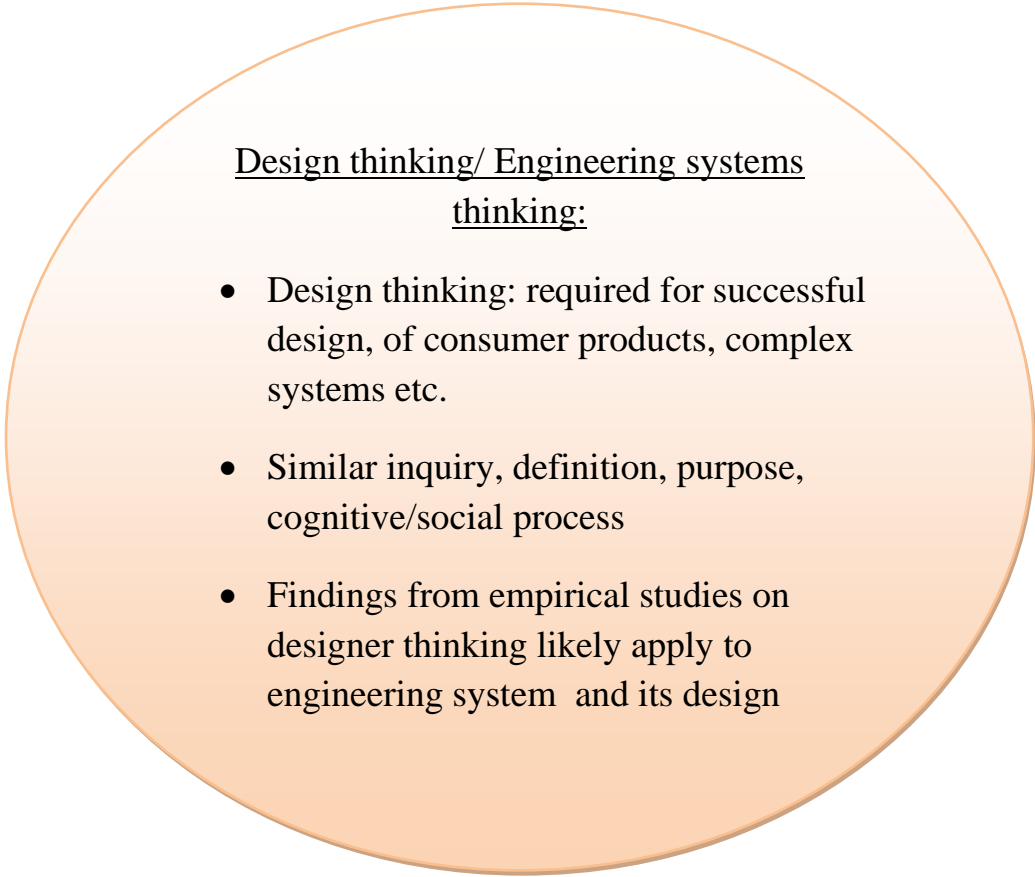
The Inclusive Concept Model:

- 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

Inclusive Concept Model of DT/EST

Design Thinking

- For addressing complexity; shaping/defining wicked problems
- *Principles:*
  - Take human-centric perspective
  - Embrace ambiguity
  - Make abstract ideas tangible
- *Cognitive processes:*
  - Analysis/synthesis, divergent/convergent thinking, visual analogy, overcoming fixation, creativity

Recognize system interdependence, interactions, emergence

Engineering Systems Thinking

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