FOSTERING DESIGN THINKING BASED CULTURE

DrBigyan P Verma
Director – GNIMS Business School.

Abstract
Today's world is driven by digitization and increased use of artificial intelligence, Internet of things, Machine learning, Predictive and big data analytics. Led by design thinking and its new principles, we are solving innumerable types of complexities for industries which include healthcare, education, automobile, telecom, IT, retail, FMCG and others. These principles are solving current problems and even anticipate those that lie ahead. Giant firms of the current millennia with billions of dollars of market capitalization like Apple, Airbnb, Uber, Amazon and others have used innovative design-thinking approach for creating customer delight. The overriding message of this paper is that Indian firms and institutions must create an ecosystem that supports and nurtures an intensive use of design thinking approach for customer satisfaction, market leadership and curriculum development. The paper presents the anatomy of design thinking based on secondary information from various research papers and annual reports of Indian firms.

Keywords: Design Thinking, Lateral Thinking, Hybrid Thinking, Designers, Scientific And Computational Thinking, Creativity And Innovation.

Introduction

 "Design" is defined by Webster as the creation of a plan or convention for the construction of an object, system or measurable human interaction as in architectural blueprints, engineering drawing, business processes, circuit diagrams and sewing patterns. However with time the word "design" has obtained different connotations in different fields, for example fashion design, sound design, spatial design, coding design etc. As designing involves aesthetic, functional, economic, and sociopolitical dimensions of both the design object and design process, considerable research, thought, modeling, interactive adjustment, and re-designing become necessary for effective designing. Designing is therefore an act of creativity and innovation.

On the other hand, "Thinking" is defined as the process of considering or reasoning about something in a rational and intelligent manner. Combining the definitions of "design" and "thinking", it may safely be concluded that design thinking is the creative strategy used by designers during the process of designing. Design thinking is also an approach that can be used to help resolve issues within professional design practice and has been applied in business as well as social context. Design thinking in business uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer delight and improved market share. Design thinking involves cognitive activities that designers apply during the process of designing.

Literature Review

Design thinking as a concept can be traced back to Herbert A. Simon's book in 1969 "The Sciences of the Artificial" wherein he suggested that certain phenomena or entities are "artificial" in the sense that they are contingent to the goals or purposes of their designer. In other words, they could have been different had the goals been different (as opposed to natural phenomena which are necessarily evolved given natural laws). Simon suggests that since artifacts are contingent, science of the artificial possibility remains a big question and he also deals with the artifacts empirically. He also deals with the notion of complexity because "artificiality and complexity are inextricably interwoven. Herbert A Simon argues that natural science is familiar to us, especially physics and biology, but the world around us is mostly man-made and artificial. It evolves with mankind's goals. So science must encompass both natural and goal-dependent artificial phenomena. He discusses how to relate the two perspectives on artifacts, synthetic vs. analytic. The science of the artificial is really the science (analytic or descriptive) of engineering (synthetic or prescriptive). Artifacts are synthesized, may imitate appearances of natural things, can be characterized in terms of functions, goals, adaptation, and are often discussed in terms of both imperatives and descriptive. Fulfillment of purpose involves a relation between the artifact, its environment and a purpose or goal. Alternatively, one can view it as the interaction of an inner environment (internal mechanism), an outer environment (conditions for goal attainment) and the interface between the two. In this view, the real nature of the artifact is the interface. Both the inner and outer environments are abstracted away. The science of the artificial should focus on the interface, the same way designfocuses on the "functioning".

Robert McKim's 1973 book "Experiences in Visual Thinking" believes that seeing is encountering reality with all of ones being. To encounter reality deeply, one cannot leave part of himself behind. All of senses, emotions, intellect, language-

making abilities - each contributes to seeing fully.McKim's Experiences in Visual Thinking presented a goldmine of information and activities for those interested in the ways in which perceptual thinking skills can be observed, utilized and improved, and how powerful these skills are in their "capacity to change your world of ideas and things".

Bryan Lawson's 1980 book How Designers Think, primarily addressing design in architecture, began a process of generalizing the concept of design thinking. He talks about "design" as a process, how that process works, what we understand about it and what we don't, and how it is learned and performed by professionals and experts. In this book, the author tries to summarize his various researches and experiment works with design and designers - both professionals and students. He uses various examples for the various topics he covered. Suitable quotes have been given in every chapter to just communicate the essence in a simple way. With a unique viewpoint, Lawson follows a very scientific approach towards explaining various aspects of design. He describes design as a "negotiation between problem and solution through the activities of analysis, synthesis and evaluation." Lawson further describes designers as the creators of future and the responsibility that they have. "The designer has a prescriptive rather than descriptive job. Unlike scientists who describe how the world is, designers suggest how it might be."Paying attention to the thought processes which are required to identify and understand those design problems and create design solutions. From his discussions, we will come to realize that it is common for designers to carry some set of guiding principles with them through their working lives. This intellectual baggage is most frequently gathered during that career, with each project contributing to it in some way.

Nigel Cross (2006), in his article 'Designerly Ways of Knowing' starts to explore what is specific to design knowledge, and what is specific to design compared to other scientific knowledge. This and other articles on similar themes were published as a book with the same name. Cross first explore the likeness and difference between design and other (natural) sciences. He then goes on to describes three different approaches to design within the scientific field. To deal with this unclear relation between science and design different approaches have been taken, and Cross identifies three, which he calls 'scientific design', 'design science', and 'a science of design'.
1. Scientific Design "refers to modern, industrialized design based on scientific knowledge but utilizing s mix of both intuitive and non intuitive design methods".
2. Design Science "refers to an explicitly organized, rational, and wholly systematic approach to design; not just the utilization of scientific knowledge of artifacts, but design in some sense as a scientific activity itself".
3. A Science of Design means to approach design in itself as a subject of scientific investigation. The science of design is the study of design.

Finally Cross promotes design as, not necessarily a science, but a discipline. He says design as a discipline "can mean design studied on its own terms, and within its own rigorous culture. It can mean a science of design based on the reflective practice of design: design as a discipline, but not design as a science." He says that "what [designers] especially know how to do is the proposing of additions to and changes to the artificial world. Their knowledge, skills, and values lie in the techniques of the artificial."

Peter Rowe's 1987 book Design Thinking provides a systematic account of the process of designing in architecture and urban planning. He examines multiple and often dissimilar theoretical positions whether they prescribe forms or simply provide procedures for solving problems -- as particular manifestations of an underlying structure of inquiry common to all designing. Over 100 illustrations and a number of detailed observations of designers in action support Rowe's thesis.

Richard Buchanan's 1992 article "Wicked Problems in Design Thinking" expressed a broader view of design thinking as addressing intractable human concerns through design. Design thinking, being a holistic, integrated process whereby diverse bodies of knowledge converge on a given subject, is poised to use technology as a vehicle for reviving the liberal arts' mission. According to Buchanan, technology is not "knowledge of how to make and use artifacts or the artifacts themselves. For Buchanan technology is an art of experimental thinking. It is, in fact, intentional operations themselves carried out in the sciences, the arts of production, or social and political action." The artifacts, or computers, phones, political science, etc., are not technology per se, but the fruits of technological thinking. The object is a manifestation of a convergence of art, science, sociology, anthropology, and any number of disciplines.Buchanan explains how this concept plays out in contemporary life in different areas. The works of graphic designers, industrial designers, managers, and architects have traditionally understood roles, but each have expanding meanings that touch human experience in multifaceted ways.He gave an example of graphic designers communicating ideas through "synthesis of words and images" like immersive websites.

Research Problem
Firms are faced with dwindling level of customer delight and their own survival in the current scenario has become difficult. Things have become all the more complex due to the globalization of entities, technological enhancements and the overall change in the needs, wants and behavior of the society. The ability to retain leadership has become critical for all types of institutions.

Research has shown that organizations with high levels of design thinking culture are likely to yield better results and foster a stronger environment of innovation and creativity. The overriding purpose of this paper is to find out whether Indian firms are using the design thinking approach to enhance customer satisfaction, market leadership and curriculum development.

Research Objective & Survey methodology
The paper presents the anatomy of design thinking based on secondary information from various resources.The main aim of this paper is to study the anatomy of design thinking based on secondary information from various research papers. This research also involves survey method for obtaining information through informal interviews on use of design thinking in institutions.

Dissecting "Thinking"
Everyone thinks and this is one of the most common fundamental human activity and yet no generally accepted definition of what thought is or how is it created has been arrived at so far. In simpler terms, the act of producing thoughts or the process of producing thoughts is referred as thinking. Many human actions are driven by thoughts and therefore understanding its genesis and metaphysical origin has been the main focus of several disciplines artificial intelligence, machine learning, predictive analysis, biology, philosophy, psychology, and sociology.

In order to make sense of, interpretation, represent or model the world they experience, and to make predictions about that world, thinking is an integral part of the process. Therefore, organism with needs, objectives, and desires as it makes plans or otherwise attempts to accomplish goals must think, and think wisely.

One need not get confused between the thinking and attention. The cognitive process of selectively concentrating on one thing while ignoring other things is referred as attention. For example, listening carefully to what someone is saying while ignoring other conversations in the room (e.g. the cocktail party problem, Cherry, 1953). The cocktail party effect is the phenomenon of being able to focus one's auditory attention on a particular stimulus while filtering out a range of other stimuli, as when a partygoer can focus on a single conversation in a noisy room. This effect is what allows most people to "tune into" a single voice and "tune out" all others. It may also describe a similar phenomenon that occurs when one may immediately detect words of importance originating from unattended stimuli, for instance hearing one's name in another conversation.

Attention can also be split, as when a person drives a car and talks on a cell phone at the same time.Attention is one of the most intensely studied topics within psychology and cognitive neuroscience. Of the many cognitive processes associated with the human mind (decision-making, memory, emotion, etc), attention is considered the most concrete because it is tied so closely to perception. As such, it is a gateway to the rest of cognition.

Metacognition or awareness and understanding of one's own thought processes refers to thinking about how you think. Many educational policies provide learners with more resources (e.g., new learning activities, study materials, or technologies), but less often do they address whether students are using these resources effectively. Hypothesizing students become more self-reflective& proactive about how they should improve their class room performance from the resources available to them can produce positive results. Researches have shown that use of metacognition helps students improve their performance.
On the other hand if students were made more self-reflective about how they approach their studies and the available resources, they could do better since blind effort alone, without directing that effort in an effective manner, doesn't always get you to where you want to go.

A control group if it receives regular reminders of a test is expected to de better the ones who do not. Further, if the group receives periodic useful resources, they are likely to do even better. The challenge then is to provide a well designed structure of questions that will prepare them effectively to perform better. Researcher have found that strategic thinking had additional psychological benefits, helping students feel more empowered about their education. Students in the intervention group were also less stressed out about the upcoming exams.

Scientific vs Design Thinking
Design thinking is the creative strategies used by designers during the process of designing. It is defined as a formal method for creative and practical resolution of problems which lead to solutions, with the intent of an improved future result. In this regard it is a form of solution-based, or solution- focused thinking – starting with a goal (a better future situation) instead of solving a specific problem. In short, a solution based thinking is referred as design thinking with the intent of improved and constructive results.

It differs from scientific method which essentially begins with a hypothesis mechanism, continues iteratively to form a model or theory. Design thinking on the other hand has a lot of cognitive component which cause emotional engagement to problem solving. Further, scientific method collects through observational evidences with respect to observable/measurable facts, design thinking on the other hand collects feedback by judging consumer's emotional state regarding the problem, as well as their stated and latent needs.

With the growth of artificial intelligence, growing interest in the application of Design Thinking in software engineering and healthcare innovation can be seen all around. Scientific methods ignores the emotional elements of human side and lays more emphasis on math or physics.

Design thinking identifies and investigates both known and ambiguous aspects of the current situation in an effort to discover parameters and alternative solution sets which may lead to one or more satisfactory goals. Because design thinking is iterative, intermediate "solutions" are potential starting points of alternative paths, allowing for redefinition of the initial problem, in a process of co-evolution of problem and solution.

In one of the famous experiments, Bryan Lawson in 1979 published results from an empirical study to investigate the different problem-solving approaches of designers and scientists. He took two groups of students – final year students in architecture and post-graduate science students – and asked them to create one-layer structures from a set of coloured blocks. The perimeter of the structure had to optimize either the red or the blue colour; however, there were unspecified rules governing the placement and relationship of some of the blocks. Lawson found that:

The scientists adopted a technique of trying out a series of designs which used as many different blocks and combinations of blocks as possible as quickly as possible. Thus they tried to maximize the information available to them about the allowed combinations. If they could discover the rule governing which combinations of blocks were allowed they could then search for an arrangement which would optimize the required color around the layout. By contrast, the architects selected their blocks in order to achieve the appropriately colored perimeter. If this proved not to be an acceptable combination, then the next most favorablycolored block combination would be substituted and so on until an acceptable solution was discovered
Nigel Cross concluded that Lawson's studies suggested that scientists problem solve by analysis, while designers problem solve by synthesis. Kelley and Brown argue that design thinking uses both analysis and synthesis.

Analysis & divergent thinking vs synthesis& convergent thinking
A systematic examination and evaluation of data or information, by breaking it into its component parts to uncover their interrelationships is referred as analysis. On the other hand combination of parts or elements so as to form a whole or combination of often diverse conceptions into a coherent whole is called synthesis. Bothe these terms come from classical Greek and mean literally "to loosen up" and "to put together" respectively. However, as scientific methods, both analysis and synthesis go hand in hand and complement one another. Every synthesis is built upon the results of a preceding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results.

A way to ensure that many solutions are possible makes use of divergent thinking in the process of design thinking. Conversely, Convergent thinking narrow these down to a final solution. Divergent thinking is the ability to offer different, unique or variant ideas adherent to one theme while convergent thinking is the ability to find the "correct" solution to the given problem. Design thinking encourages divergent thinking to ideate many solutions (possible or impossible) and then uses convergent thinking to prefer and realize the best resolution.

Processes of Design thinking for problem-solving
As discussed earlier, analytical thinking involves systematic examination and evaluation of data or information, by breaking it into its component parts to uncover their interrelationships. Whereas design thinking includes the "stacking up of ideas", with few or no limits, inside or outside of the box during a "thinking and brainstorming" phase. This helps reduce chances of failure and encourages input and participation from a wide variety of sources in the ideation phases. The phrase Outside the box thinking has been coined to describe one goal of the brainstorming phase and is encouraged, since this can aid in the discovery of hidden elements and ambiguities in the situation and discovering potentially faulty assumptions.

The seven steps of design thinking which are non linear, can occur simultaneously and can be repeated in any manner are as under.

1. Definition of problem: Decide issues to be resolved, agree on who the audience is, prioritize the project in terms of urgency, determine what will make this project successful.
2. Research: Establish a list of terms, conduct research, review the history of the issue; Collect examples of other attempts to solve the same issue.
3. Ideation: Note the project supporters, investors, and critics, talk to end-users which may bring the most fruitful ideas for later design, take into account thought leaders' opinions, identify the needs and motivations, generate as many ideas as possible to serve these identified needs.
4. Prototyping: Combine, expand, and refine ideas, create multiple drafts, seek feedback from a diverse group of people, present a selection of ideas to the client, reserve judgement and maintain neutrality, create and present actual working prototype(s), choose, review the objective.
5. Selection: Select the powerful idea(s).
6. Implementation: Plan tasks, determine resources, assign tasks, execute.
7. Learning: Make task descriptions, deliver to client and learn, gather feedback from the consumer, determine if the solution met its goals, discuss what could be improved, measure success; collect data, document.

Although design is always influenced by individual preferences, the design thinking method shares a common set of traits, mainly; Creativity, Ambidextrous thinking, Teamwork, User-Centeredness (Empathy), Curiosity and Optimism.

Principles of Successful Design Thinking
Many authors have advocated for different principles for the success of design thinking. According to Christoph Meinel and Larry Leifer, following four core principles are necessary for the successful implementation of design thinking:

1. The human rule, which states that all design activity is ultimately social in nature, and any social innovation will bring us back to the 'human-centric point of view'.
2. The ambiguity rule, in which design thinkers must preserve ambiguity by experimenting at the limits of their knowledge and ability, enabling the freedom to see things differently.
3. The re-design rule, where all design is re-design; this comes as a result of changing technology and social circumstances but previously solved, unchanged human needs.
4. The tangibility rule; the concept that making ideas tangible always facilitates communication and allows designers to treat prototypes as 'communication media'.

Creativity and Innovation has become a part everything we do today. Every one of us is affected by it and it just doesn't matter whether you are a manager in a local or global organization, an entrepreneur of a start up firm, an official in a governmental organization of any other service pertaining to education, healthcare, finance or whatever. We all are expected to do things in a smarter manner which is different and lasting.

Innovations combined with dramatic design have time and again improved experience of products and services. Innovations lead by design mode of thinking creates systems, processes add procedures which have improved the quality of life for end customers. Innumerable examples exist to tell the story that products or service models using design principles have outperformed the best of the best companies over the past ten years.

Many Fortune 500 companies of the world like Apple, Airbnb and others have proved that design has become an integral value of these firms which enables to think like designers and develop effective strategies for development and bringing change.

A New Way to Look At Design Thinking
As design thinking is a human-centered and collaborative approach to problem-solving that offers creative, iterative & practical solutions, it integrates business, technology, and people with a common thread on innovativeness for creative opportunities.

With the constantly changing world, a more advanced concept of design thinking is now in practice. It now starts with people by understanding that their explicit and implicit needs that can be met by using design solutions.

Design thinking in Business
The digital world in which we live today is obsessed with ever improving customer experience and therefore creativity and Innovation has become a part everything we do today. Every one of us is affected by it and it just doesn't matter whether you are a manager in a local or global organization, an entrepreneur of a start up firm, an official in a governmental organization of any other service pertaining to education, healthcare, finance or whatever. We all are expected to do things in a smarter manner which is different and lasting.

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Many Fortune 500 companies of the world like Apple, Airbnb and others have proved that design has become an integral value of these firms which enables to think like designers and develop effective strategies for development and bringing change. The world has already become VUCA (Volatile, Uncertain, Complex and Ambiguous) and moving to an era of inter-dependent challenges. The answer to all these rests on the integration of knowledge from various sources to seek solutions from ambiguous data and develop competitive strategies with holistic, integrated approaches.

Uber, Airbnb and many others are excellent example of design thinking. Who would have thought that a new ridesharing service like Uber, an aggregator like Airbnb launched few years back could be worth $200 billions by 2016? Uber has quickly transformed the market for taxicabs and limousines, and it did it by using user-centred design principles to 'reimagine' the taxi experience. Taxis became complacent and failed to understand or respond to the needs of their customers. Customers anxious, waiting for taxis to get to important appointments? Provide a visualisation of the taxi's approach and a way to contact the driver directly. Drivers didn't like the risk of fare-dodgers running from cabs without paying? Create a cashless payment service. Customers worried about safety? Improve safety through driver ratings and one-to-one mapping of customers to drivers. By focusing on the customer needs, both expressed and latent, Uber could disrupt a traditional business model by applying design thinking in its approach.

With an endeavour to "Make in India", a holistic approach to design thinking can play a huge role in ensuring that initiatives such as Swachh Bharat Mission integrate a design thinking approach — they could do this by involving different stakeholders in understanding and identifying the key issues and looking at solutions from their point of view.

Indian educators too must look at design thinking-based pedagogy to help students gain insights from various perspectives, giving them the aptitude to solve world problems based on critical thinking and analysis.

However, Dev Patnaik in his article, "Forget Design Thinking and Try Hybrid Thinking," suggests that having someone experienced in the design field wouldn't necessarily be more advantageous for innovation than someone with a business background. Of course, this depends on the individual and the flexibility of their thinking, but, with some design thinking added into the mix, even accountants can be creative designers. Patnaik cites the example of a well known design thinker who was hired 2000 at Proctor P&G as VP for design strategy and innovation. The company was struggling with the digital and media transition taking place, so they needed someone to turn things around for them, and that is exactly what Claudia did. Thought she had an accounting background, with the right design thinking she doubled the company's revenue over the course of the next eight years. She did this by placing designers in the company's business units, educating businesspeople about design's strategic impact, and forming a board of external design experts. While advocating for hybrid design thinking, Patnailk believes that confluence of various disciplines creates new things. When a businessperson is given the task of design innovation, they must change themselves and immerse themselves in the new school of thought. Otherwise, stagnation results. Once they understand this new discipline and begin to apply both types of thought to the problem, creativity abounds. They are free to attack the problem from multiple angles. So, while design thinking is ultimately the key for success in the future of business in the world, it alone will not change things.As design thinking is a human-centered and collaborative approach to problem-solving that offers creative, iterative & practical solutions, it integrates business, technology, and people with a common thread on innovativeness for creative opportunities.

With the constantly changing world, a more advanced concept of design thinking is now in practice. It now starts with people by understanding that their explicit and implicit needs that can be met by using design solutions.

Design Thinking: Examples from Corporate
Infosys
Infosys aspired for a customer-obsessed culture for effective digital innovation and by making use of design thinking principles at the core of the innovation process, it sparked a cultural change. Infosys used Design Thinking to shift its innovation culture and has motived its clients too to change their approach for innovation.

Apple & Google
Both Apple, Google and many others innovate products which give "wow" factor and sets them apart from others. All these firms including some startups have discovered, that the secret lies in 'Design Thinking', which is what drives their competitive edge.As a result of this, while Apple products are sought after by one and all, Google search is simply brilliant and has transformative design. Even though Google has not churned out well-designed too many products, its Google Maps is arguably the only other Google product that truly disrupted incumbents through its design.

P&G& Pfizer
At P&G and Pfizer, support for innovation is a combination of people, resources, technology and a "do-it-yourself" approach modeled by leaders. One of the most notable examples of design thinking for FMCG giant, Procter & Gamble, who harnessed design thinking to inform product development for Oil of Olay.After observing consumers in store, P&G realized that by targeting women over fifty, the skincare industry had overlooked a key segment: younger women in their thirties and forties. P&G then tested prototypes, pricing models and store displays with these consumers, ultimately leading to the launch of a new product range designed to meet consumer needs.

IBM
Another example of design thinking in a large corporate comes from IBM. IBM has infused a corporate culture with the very best of design thinking. IBM has drawn its own manifesto and guidelines for design thinking. At its heart is The Loop, a continuous process made up of three key stages: Observe (focusing on the user by observing them in the real world), Reflect (sharing knowledge and coming together as a team) and Make (transforming ideas to reality). Thousands of IBM employees have been trained in these principles to date. As a result, more than 100 products been developed with the help of design thinking.

Sanitation in Cambodia and Vietnam
Design thinking isn't just confined to big business. A case study of social innovation in Asia, where design thinking has shaped the provision of sanitation facilities is from Cambodia and Vietnam. By observing villagers in context, the design team unearthed important cultural insights, which influenced the decision to create sanitation systems which could be upgraded over time: the same approach taken by villagers to improving their own homes.Not only did this allow the team to identify how to optimize the sanitation systems but it helped them to identify use cases: they soon found that what mattered most to villagers was being able to wash their hands in the kitchen to prevent illness through contaminated food.

Design Thinking in Education
One of the experiments for demonstrating effectiveness of the use of design thinking in education was conducted by Stanford Education when its students, researchers, teachers, and coaches worked together to create hands-on curriculum that engaged and challenged students. They prototyped, iterated and did experiments all again with our real world partners. Following seven steps were used by them on K 12 students and they found the results very satisfying. These steps are:
1. Understand: Understanding is the first phase of the design thinking process. During this phase, students immerse themselves in learning. They talk to experts and conduct research. The goal is to develop background knowledge through these experiences. They use their developing understandings as a springboard as they begin to address design challenges
2. Observe: Students become keen people watchers in the observation phase of the design thinking process. They watch how people behave and interact and they observe physical spaces and places. They talk to people about what they are doing, ask questions and reflect on what they see. The understanding and observation phases of design thinking help students develop a sense of empathy.
3. Point of View: In this phase of design thinking, students the focus is on becoming aware of peoples' needs and developing insights. The phrase "How might we...." is often used to define a point of view. This statement ends with a suggestion about how to make changes that will have an impact on peoples' experiences.
4. Ideate: Ideating is a critical component of design thinking. Students are challenged to brainstorm a myriad of ideas and to suspend judgment. No idea is to far-fetched and no one's ideas are rejected. Ideating is all about creativity

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and fun. In the ideation phase, quantity is encouraged. Students may be asked to generate a hundred ideas in a single session. They become silly, savvy, risk takers, wishful thinkers and dreamers of the impossible.

5. Prototype: Prototyping is a rough and rapid portion of the design process. A prototype can be a sketch, model, or a cardboard box. It is a way to convey an idea quickly. Students learn that it is better to fail early and often as they create prototypes.

6. Test: Testing is part of an iterative process that provides students with feedback. The purpose of testing is to learn what works and what doesn't, and then iterate. This means going back to your prototype and modifying it based on feedback. Testing ensures that students learn what works and what doesn't work for their users.

An Ideal Model for Design Thinking

Several experiments have been conducted to check the efficacy of design thinking in educational institutions. Following model involving six steps are recommended as an ideal structure for educational institutions for adoption of design think. They are:
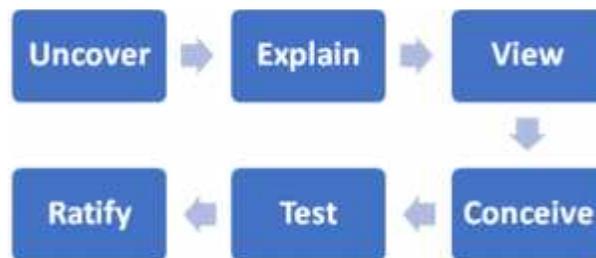
Recommended Model for Design Thinking in Education

1. **Uncover:** The first phase of design thinking includes uncovering the thinking process wherein students should be immersed for learning. Here they should be encouraged to talk to experts and conduct research. The phase of uncovering should be used for developing understandings in students as a springboard as they begin to address design challenges.

2. **Explain:** As students become keen to feel the problem they are solving, they must explain the possible solutions with each other – by way of reflections, questioning, doing or observations. The uncover and explain phase make students appreciate the problems with empathy.

3. **View:** In this stage, students are asked to focus on becoming aware of needs and developing insights. Using phrase "How might we...." takes place here. Having different point of view will bring in changes that will have an impact on peoples' experiences.

4. **Conceive:** Conception is a critical component of design thinking. Pupils are challenged to brainstorm with several ideas. Here no idea should be rejected, no matter how far fetched or they are. In this phase, quantity is encouraged. Students may present savvy, silly or weird ideas, but that should not matter.

5. **Test:** Testing is a rough part of the design process. A test can be a sketch, model, or a cardboard box. It is a way to convey an idea quickly. Students learn that it is better to fail early and often as they create tests.

6. **Ratify:** Ratification provides with the feedback. The purpose of phase is to learn what works and what doesn't.

Design Thinking Vs Computational Thinking In Education

Computational thinking as a thought process has been defined by Jeanette Wing (2012) as formulating a problem and expressing its solution in a way that a computer-human or machine can effectively carry out. It is the process of abstraction by; choosing the right abstractions, operating in terms of multiple layers of abstraction simulations and defining the relationships between layers guided by efficiency, correctness, and flexibility. Computational thinking can best be related to as writing codes or software's. Every action or non-action is accounted for in the way computational artifacts are constructed. Computational thinking is great for working out a solution but there is an argument that computational thinking does not put enough emphasis on the problem itself.

Design thinking, on the other hand, attempts to understand the intent or problem before looking at any solution - computational or otherwise. Design thinking attempts to identify why the problem exists in the first place before solving it. The difference between the two can best be explained by an experiment wherein one needs to move 20 boxes from one part of the town to the other side of the town. A computational thinker would ask questions like what are the sizes of the box, how

heavy are they or they contain anything fragile. A design thinker on the other hand would ask the basic question as to why one would want to move the box at all. Such a type of question may throw a new light and interesting conclusions may be drawn that there may not be any need to move boxes as something inside the box needs to be moved, and not the box itself. Design thinking shapes computational thinking and it is design thinking that needs to be given the highest priority in our education system when teachers teach complex theories in childhood and kids always wonder as to why should they learn all these at the first place.

Conclusion

Businesses are dominated by IoT, AI, ML, Gamification, Big Data and Predictive Analysis, design thinking as an approach would help solve not only today's problems but even anticipates those that lie ahead. Many Indian and foreign firms are banking on developing a design thinking approach to creating the optimum value for customers and survival in the VUCA world. The aim of firms of all ages, including which are still at the incubation stage should be to create an ecosystem that supports the growth of design thinking approach. Design Thinking benefits from starting both bottom-up and top-down at once; inviting everyone who wants to be an innovator, not forcing everyone to go to class.

As design thinking encourages institutions to focus on "next best practices", a robust architecture that creates creative and innovative approach of thinking and execution will become the sine qua non for existence. All institutions, irrespective of their product, services or program must create an ecosystem that supports the growth of design thinking based learning with the freedom to learn and experience. While the originality of ideas and understanding of the target group will decide on the approach to design thinking, collaborative learning must be the bedrock for an effective implementation of Design Thinking.

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