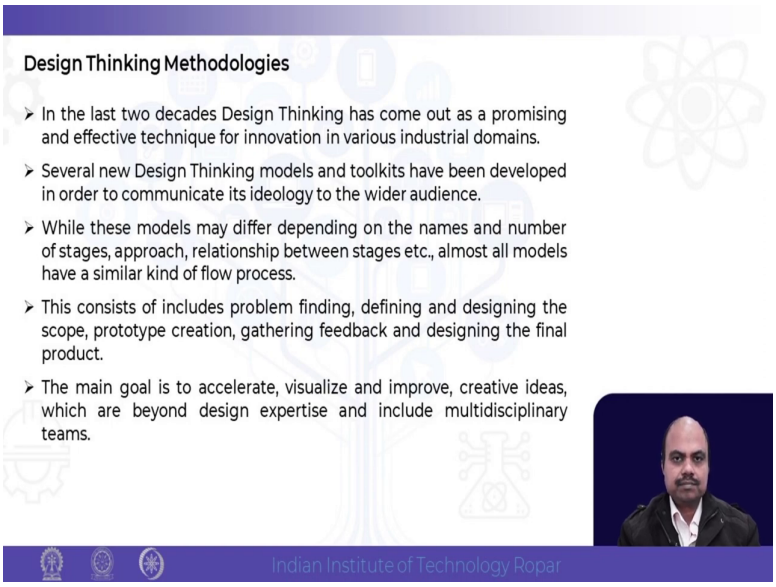
Product Engineering and Design Thinking

Prof. Prabir Sarkar
Department of Mechanical Engineering
Indian Institute of Technology, Ropar

Module - 07
Product Complexity, Affordability and Design Thinking
Lecture - 34
Design Thinking Methodologies and Tools

(Refer Slide Time: 00:28)

(Refer Slide Time: 00:29)



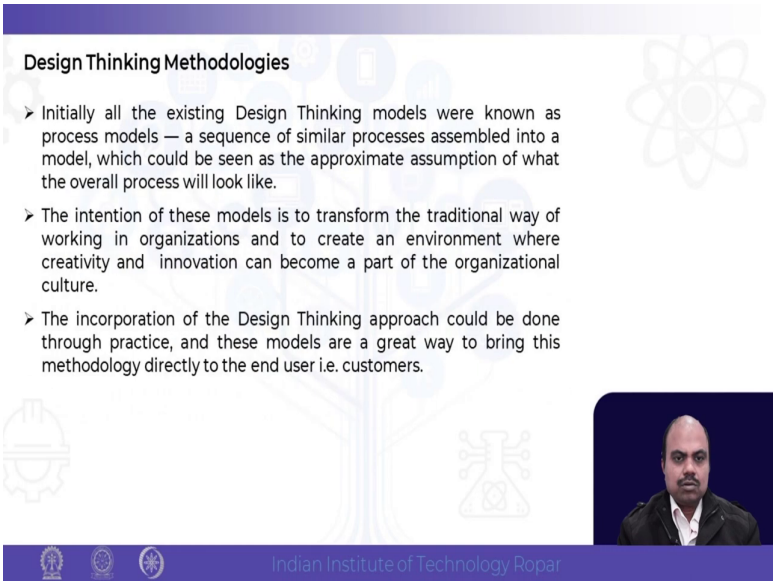
Today, we will be learning about Design Thinking. Methodologies. So, in the last two decades design thinking has come up as a promising and effective way to teach in a way for a especially for innovation good technique it is and in various domains, it has wide applications. In this several new design thinking models has come up some of them and majority of them or most important them we are going to discuss in this.

The toolkits has been developed and design thinking models has been developed these are communicates it ideology to the wider audience. While these model may differ depending on the names and number and stages approach on relationship, but almost all the models actually follow a very similar pattern.

To large extent design thinking methodology or design thinking steps are coinciding or very similar to the design process especially the conceptual design process. So, this consist of

problems finding; first is problem finding and then defining designing, prototype creation, gathering feedback and designing the final product. So, the main goal is to accelerate visualize, improve, creative ideas which are beyond design expertise and include multidisciplinary teams.

(Refer Slide Time: 02:03)

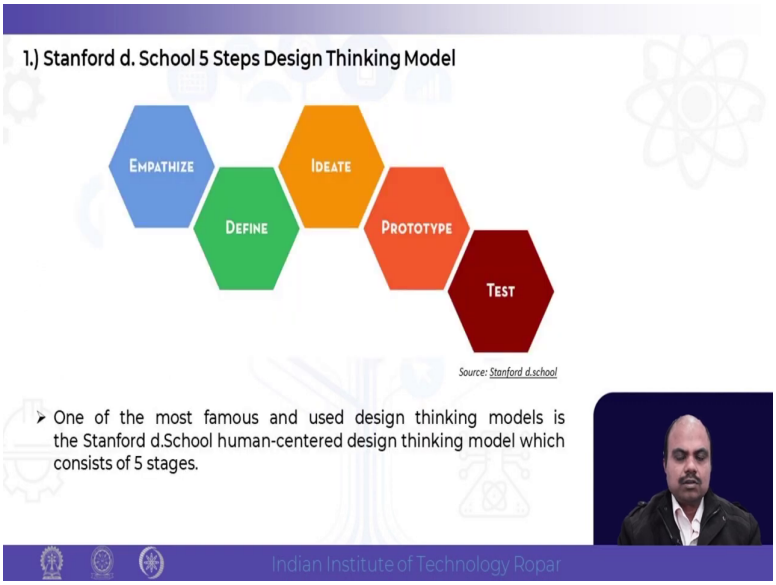


So, initially all the existing design thinking models were known as the process models a sequence which is similarly processed assembled into a model and which could be seen as an appropriate assumption what the overall thinking process or the design thinking process should look like.

The intention of the models has to way to transform the traditional way of working in organization and to create an environment where creativity and innovation is a part of the organization and to culture this creativity innovation design thinking process or design

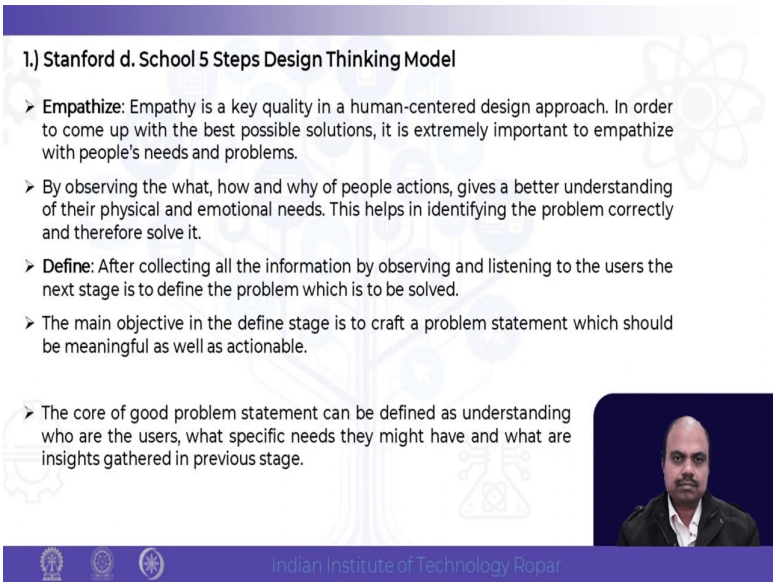
thinking methodologies are very useful. The incorporation of this design thinking approach could be done through practice and these are the models they are helpful to the customers.

(Refer Slide Time: 03:02)



So, the first model which we are going to know about today is the Stanford d School design school model. This is also this first step design thinking model this already we have explained or understood in another lecture. Ideally issue this is one of the very good model and most popular model among the all the design thinking models which are which are there. So, in this model the first step is empathize, second step is define, third one is ideate, fourth one is prototype and last one is or fifth one is the testing.

(Refer Slide Time: 03:40)



So, in the first one this is empathize, empathize is a basically key quality in the design thinking approach and in order to come up with the best possible solution. So, in this case we basically observe we empathize the feeling of the user, why people take this action give a better understanding of the physical emotional need.

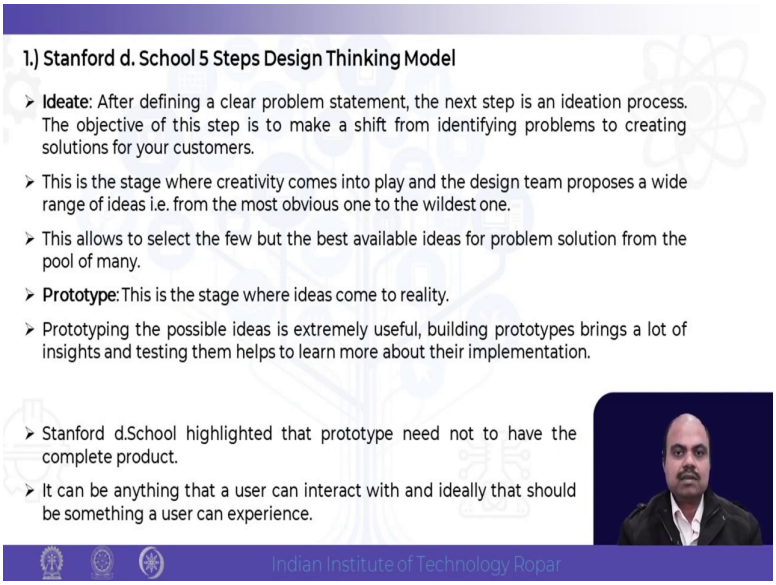
Because this need of these people are different. Same product which is being developed and designed for different kinds of different set of people younger people or older people needs a different. So, often they are not able to tell ok, this is what they need.

So, until and unless we empathize, we feel we not able to understand. So, here is the question where is the idea that we need to empathize their feeling and then understand their issues and then design the product. The next set next step is defining define. So, after collecting all the information by observing and listening to the users next step is to define the problem which

need to be solved. So, the main objective is to craft a problem statement which should be meaningful and actionable.

So, the core of the good problem statement is yeah can be defined and understood and who the users what a specific need and gather all the information and then understand this is the problem exactly it is there and we are going to solve it in the next step. The next step is very important step this is the what is where solutions are coming up, this step is called ideate.

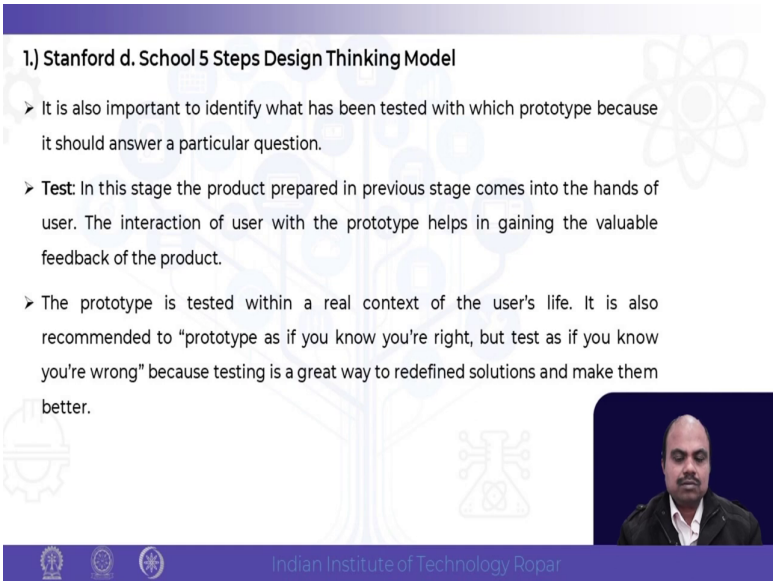
(Refer Slide Time: 05:29)



So, after defining a clear problem statement the next step is an ideation process. The objective of this step is to make a shift from identifying problems creating solutions for the customers. This is the stage where creativity comes into play and where both individual and design team members are important.

Contribution is important for all of them because solution can come from anywhere. A creativity of individual creativity and group creativities are very important to help them to find out solutions. There are wide range of ideas can be there and even the strange ideas can be which is which can give very good solution.

(Refer Slide Time: 06:14)



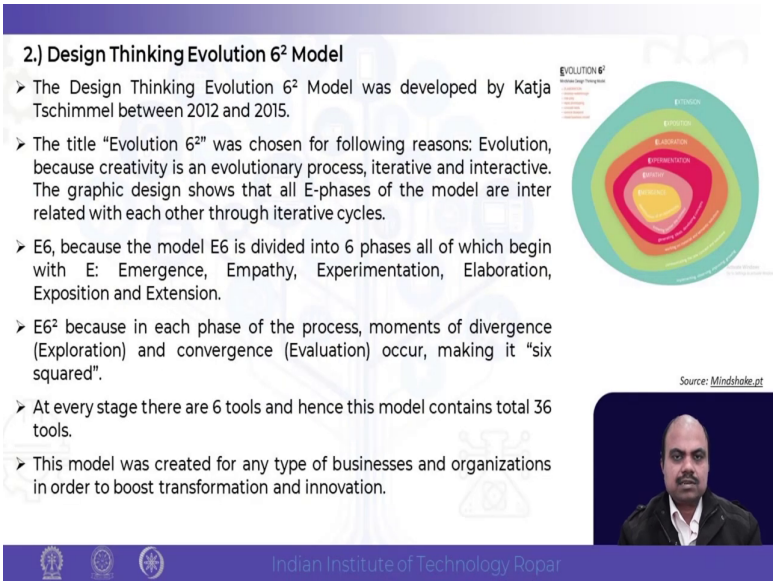
And later on, once we have a pool of solution, we are going to select some of them. One of the best possible solution and then we are going to go to the next step that is called prototype stage. This is a step where ideas are coming into reality. So, in this prototyping this is important the building of the prototypes build a lot of insight and learn them by from the implementation.

And it need not be a complete working prototype, it could be a simulation, it could be a model, it could be, but ideally it should be a physical working prototype. Where the idea is

that the users can interact with the product while interacting can understand, how they are interacting, what are the problems there in this. And it is important to test also in the prototype and that is what last stage is about when we make the prototype, we test it.

So, in this we test the prototype to gain the understanding of the user, feedback is important. And feedback can be given only when we have something to show, something as a prototype. So, in this case testing it is a testing with the real context of the user, it is also recommended to prototype as if you know you are right and test if as if you are wrong. Because testing is a great way of redefining solution and making them better.

(Refer Slide Time: 07:58)



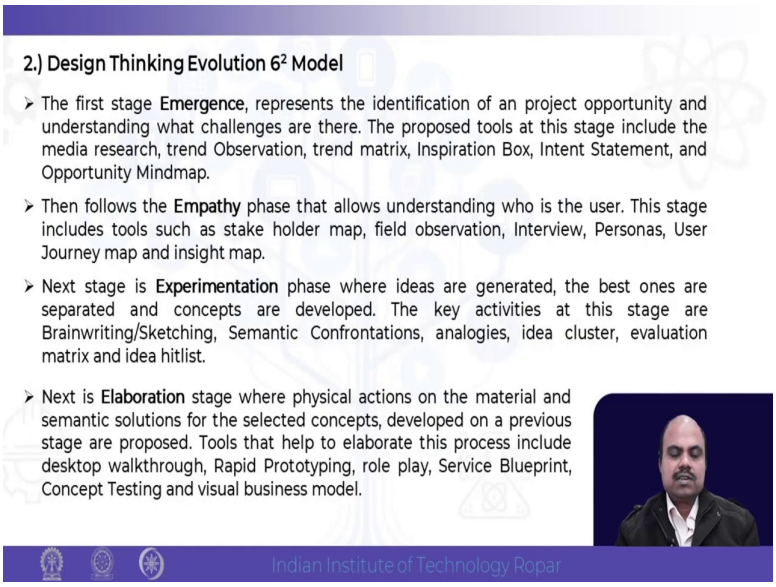
The next model which we are going to discuss today is called the design thinking evaluation 6 square model. So, in this the design thinking 6 square model is were developed by its a between 2012 and 2015.

So, you can see it is quite a new model the evaluation of 6 square was chosen as following evaluation because creativity is an evaluation in process iterative and interactive and the graphic design show which is there in the right side of it can show it is evolving.

So, emergence, empathy, experimentation, elaboration, exposition, extension. So, this is what this model core belief of this model is all about. And this is the phase in this this because the different phase of the process, moments of a divergence, exploration and convergence. So, converge and diverge, converge and diverge.

So, 6 square model this is what we name it, but they what they have named, what the inventor has named. So, at each stage there are 6 tools and hence the model is called 36 there are 36 tools in this model. The model was created for any type of business organization to boost transformation and innovation.

(Refer Slide Time: 09:43)



The first stage is emergence represents the identification of a project opportunity and understanding what challenges are there. The proposed tools at this stage include the media research, trend observation, trend matrix, inspiration box, intent statement and opportunity mind map.

So, some of these already we have learnt specially for mind map. Then following the empathy phase the next phase is that allows the user to understand who the user is. And in this stage, we are going to include tools like a stakeholder map, field observation, interview, personas, user journey map and insight map.

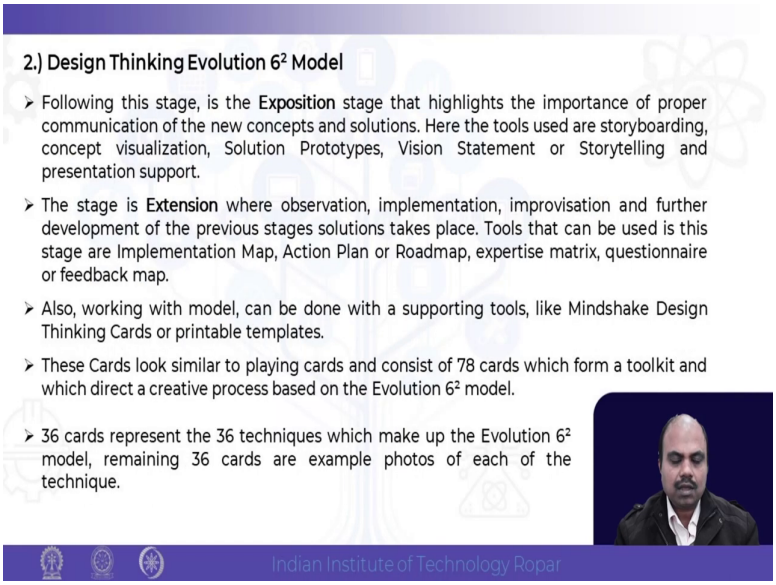
So, user journey map already we have used and that we have seen or you are going to see in a another exercise. The next step is experimentation. In experimentation phase the ideas are generated, the best one are separated and concept are developed. The key activities of these

stage are brain writing, brain sketching, semantic confrontations, analogies, idea cluster, evaluation matrix and idea hitlist.

These are the methods which you can use in this stage. Next, we are going to go to the next stage. The next stage is called elaboration stage. In this stage physical actions on the material and semantic solutions of for the selected concepts developed as previous stage previous stage are proposed.

Tools that help to you elaborate this process include desktop walkthrough, rapid prototyping, role playing, service blueprint, concept testing and visual business design, business model. Rapid prototyping using rapid prototyping that we have already discussed in separate course class. So, this stage is also important where we see a physical form.

(Refer Slide Time: 12:04)

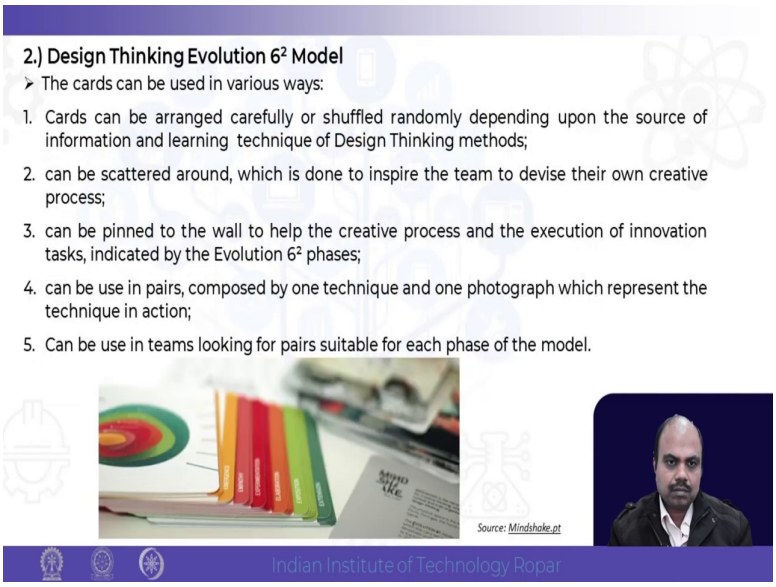


Following this step stage is the exposition stage where the highlight we highlight the importance of the proper communication of a new concept and solutions. Here the tools used are storyboarding, concept visualization, solution prototypes, vision statement or storytelling and presentation support. So, these are tools for this stage.

Next is the stage extension where observation, implementation, improvisation and further development of the previous stage takes place. There are certain tools for this suitable for this phase. This tools are implementation map action plan or roadmap, expertise matrix, questionnaire or feedback map.

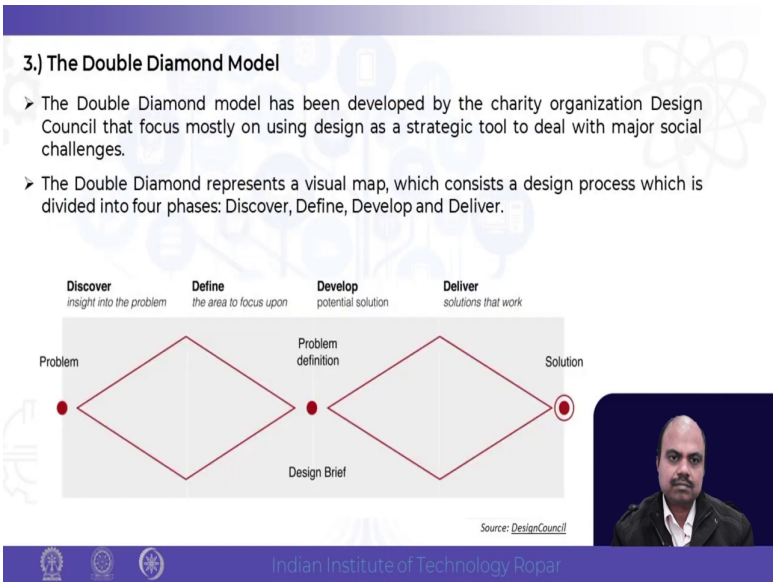
And also working with this model can be done with supporting tools like mind shake design, thinking cards and printable templates. These cards look like playing cards and they consist of 78 cards and which forms a toolkit which directs a creative process based on the evolution of 6 square method.

(Refer Slide Time: 13:32)



So, these cards can be used in various ways, cards can be arranged carefully or shuffled randomly. It could be scattered around also, it could be pinned and can be used in pairs, can be can be used in teams looking for pairs, suitables, there are various ways you can use these cards.

(Refer Slide Time: 14:01)



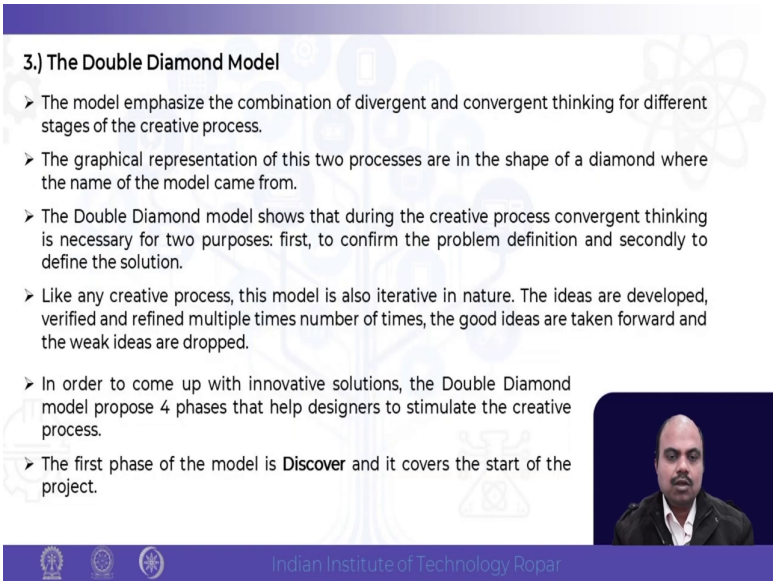
The third method which we will going to discuss today is the double diamond method. This is also a quite useful method. Double diamond method has been developed by the charity organization design council that focuses mostly on using design as a strategic tool to deal with major social challenges. Double diamond represents a social map which consists of a design process which divides into four phases, discover, define, develop and deliver.

So, you can see this model down in this image where we discover. So, we discover means basically we, diverge explore and then define we basically converge, we define to a certain problem. And so, here we getting design brief or problem definition. And then again, we are going to develop potential solution.

Again, potential solution means we can diverge, lot of solutions, we are going to create and then we are going to solve, we are going to find out a suitable solution and then you after

finding out we are going to deliver. That is what deliver is with converging. So, ultimately, we are getting a converging solution. So, problem to problem definition we are going to discover, discover, define and then develop, deliver. So, ultimately it is it is called double diamond method.

(Refer Slide Time: 15:36)



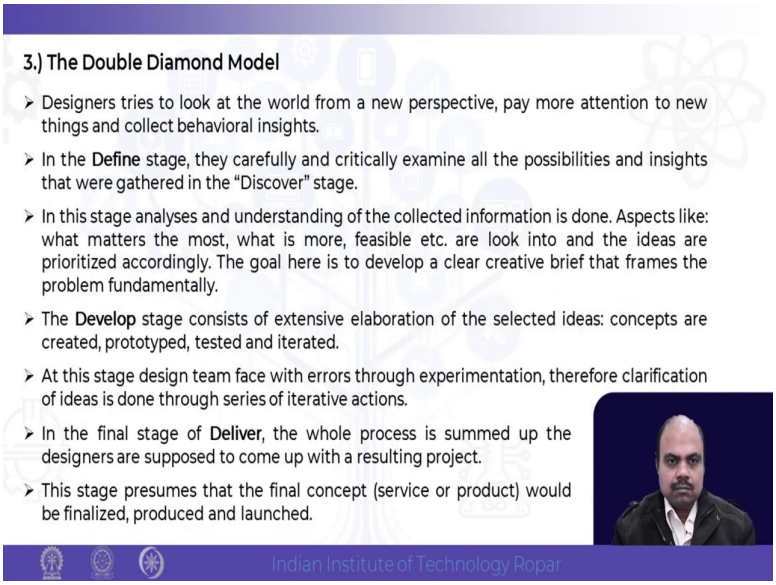
So, in this double diamond method it is a combination of divergent and convergent thinking. For different stages of creative process, the graphical representation of these two processes are in the shape of diamond, of in the process of diamond, which are named by this one.

So, double diamond method shows that the during the creative process convergent thinking and divergent thinking are both important. So, convergent thinking, necessary for two purpose, first to confirm the problem definition and secondly, to define the problem. And

likewise creative process is iterative nature and this is ideas that developed and there are various ways in which we can generate and think about ideas.

So, in order to come up with innovative solution double diamond process method proposes four phases that helped designers to simulate and create creative process. The first phase of this is called discover and it covers the start of the project.

(Refer Slide Time: 16:51)



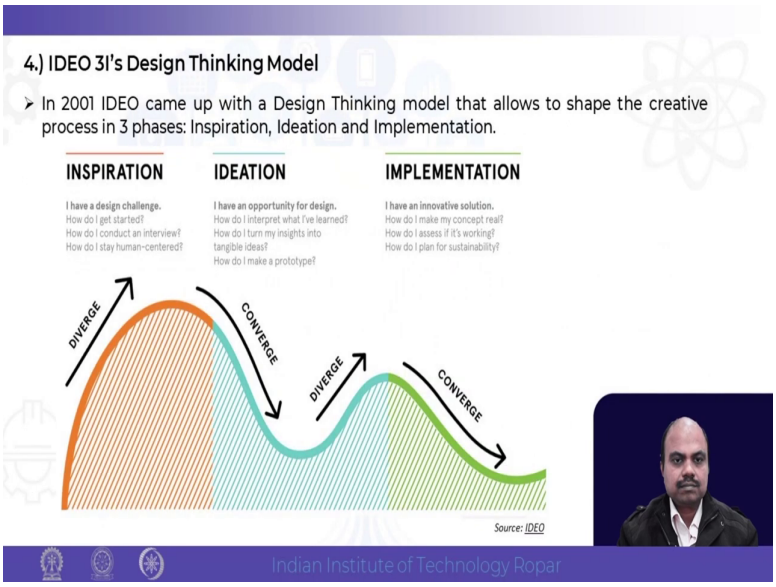
So, in this designers try to look at the world from a new perspective, pay more attention to new things. Next, define the carefully criticized, critically defined and examine all the possible and insight discover.

So, in this stage we analyze and understand the collection information is done aspects like what matters are most and what is more feasible and what is what look like and the ideas are prioritizing, the goal is to develop a create creative, brief and the problem fundamentally.

The next step of this one as already discussed is the develop phase in which consists of extensive elaboration of the selective ideas concept created prototype tested and iterated. So, at this stage design team phase with errors with experimentation, clarification is done and series of iteration action.

When develop phase is completed, we are going to go to deliver phase. So, in deliver phase is basically again as I told is converging phase where the whole process is summed up. And designers are supposed to come up with a resulting project and these stage presumes with the final concept and we finalized and produced and launched.

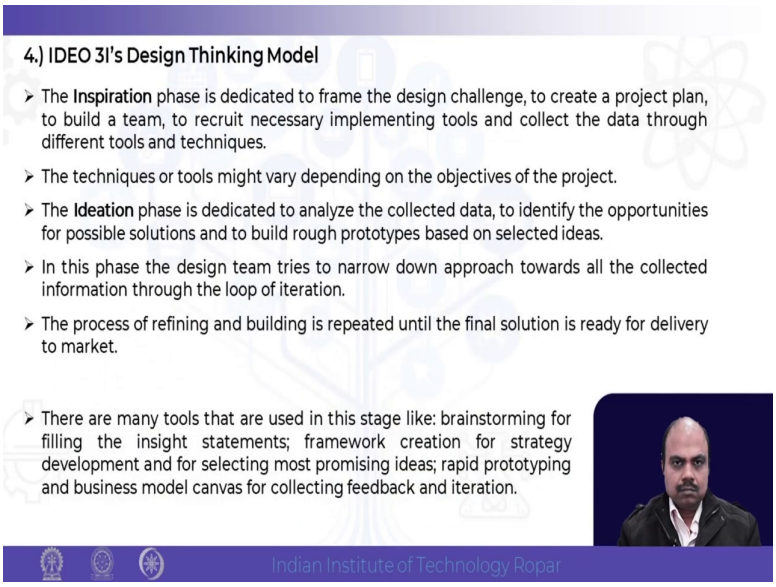
(Refer Slide Time: 18:27)



So, now we are going to learn about the fourth method. It is IDEOs 3I's design thinking model. So, in 2001, IDEO came up with a design thinking model that allows to shape the creative process in three phases ideation, sorry, inspiration, ideation and implementation. First is inspiration, inspiration basically diverging.

So, it is lots of it is it is diverging and ideation we are going to get more idea. So, little bit of converging and again we are diverging. And then implementation, implementation is where we are going to implement the solution which means that again it is converging.

(Refer Slide Time: 19:21)



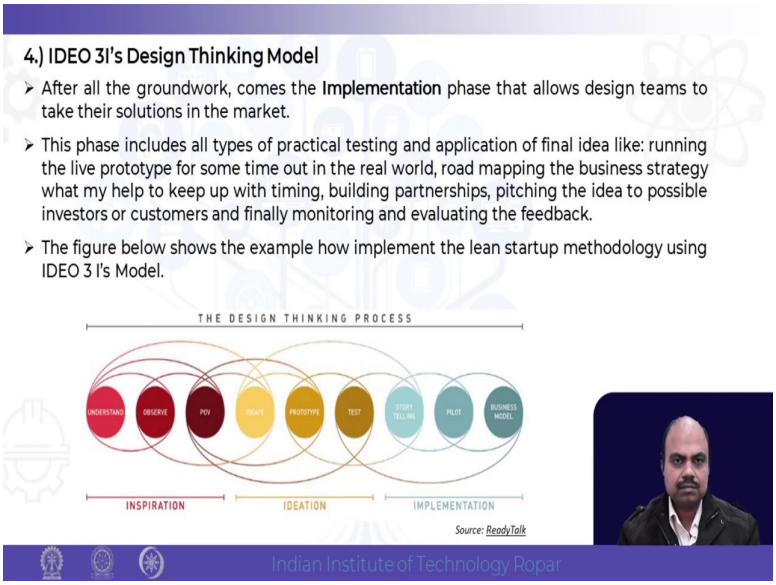
So, first phase of this is inspiration phase. It dedicated to the frame the design challenge to create a project plan to build a team and to recruit necessary implement tools and collect the data through different tools and techniques. The techniques or tools might vary depending upon the objective of the project. The ideation phase is dedicated to analyze the collected data to identify the opportunities for possible solutions and to build rough prototypes based on selective ideas.

In this phase, the design team tries to narrow down approach towards all the collected information through the loop of iteration. The process of refining and building is repeated until the final solution is ready for delivering to the market.

There are many various tools that are there which are used in this stage like brainstorming for filling the insight, framework creation for strategy development and for setting most

promising ideas, rapid prototyping and business models, canvases for collecting feedback and iteration.

(Refer Slide Time: 20:48)



After all the ground works comes the implementation phase that allow the design team to take their solutions to the in the market. These phase include all types of practical testing and application of final ideas like running the live prototypes for some time or to out in the real world, road mapping, the business strategy, what we, but may help to keep up time running, building partnerships, pitching the ideas to possible investors or customers and finally, monitoring and evaluating the feedback.

These figure down as you can see that here the figure shows example of how implementation implement the lean startup methodology using IDEOs 3I model. So, first is here we understand, observe, POV, ideate, prototype, test, storytelling, pilot and then business model.

So, first 3 phases we can say it is inspiration, middle 3 phases we can say ideation and last 3 phases we can say implementation.

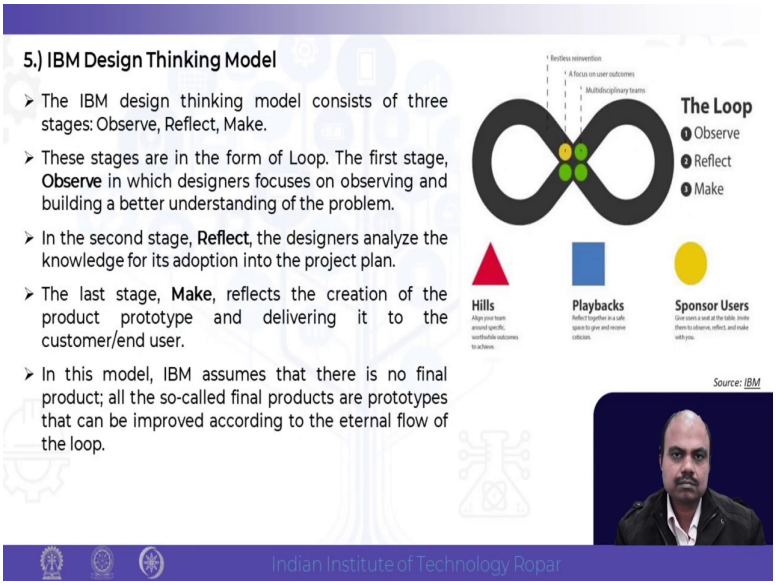
(Refer Slide Time: 22:17)

Now, we are going to go to the 5th model, 5th model is developed by IBM it is called IBM design building model. Sorry, design thinking model. So, it is one of the recently published design thinking model in 2013 IBM started a project to create a design thinking or design driven culture. The project took more than 3 years involving about more than 750 designers and affecting over 10,000 employees in the company.

The project aimed to build a design process that ensures a clear understanding of the customer need and to build empathy. The new model was placed to be remade with the speed and scalability to meet the demand of modern companies. While the previous models were more

biased towards small and medium scale industries that is SMEs, IBM model target a larger scale of companies including large entrepreneurships like IBM, Google, Samsung etcetera.

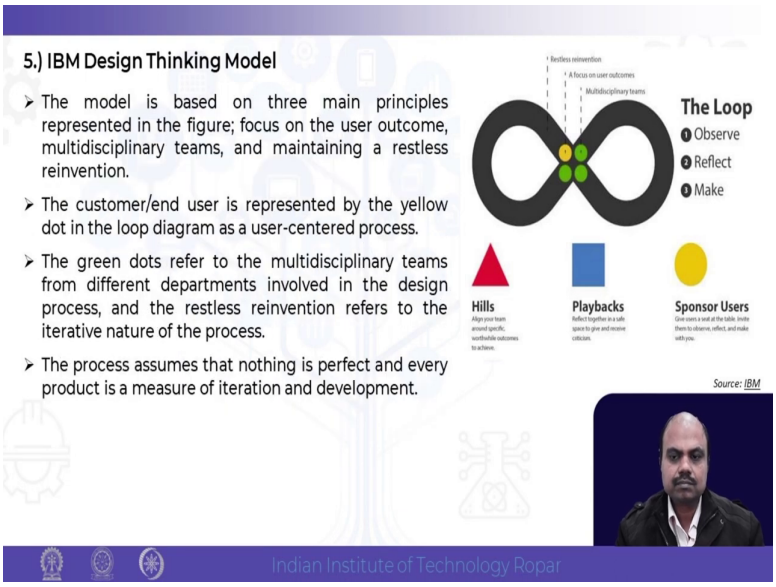
(Refer Slide Time: 23:32)



So, the IBM design thinking model consists of three stages observe, reflect and make. So, these stages are in the form of loop. The first stage is observe, in these designers focuses on observing the building a better, building a better understanding of the problem. The second stage is reflect, the designers analyze the knowledge for the adaptation into the project plan. The last stage is make, reflect the creation of the product, prototypes and delivering it to the customer and end user.

So, in this model, IBM assumes that there is no final product all the so-called final products are prototypes can be improved according to the eternal flow of the loop. So, in the right side of this slide you can see the loop first is observe, next is reflect, third one is made, make.

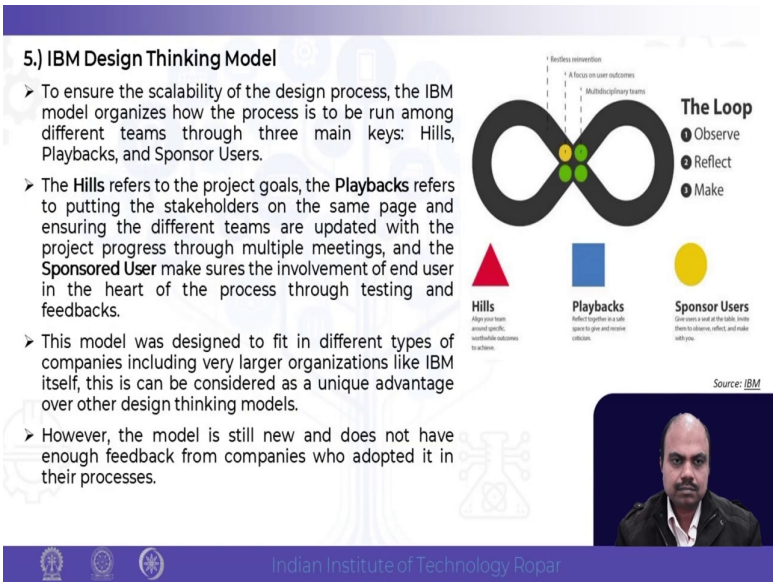
(Refer Slide Time: 24:42)



So, the model is based on three main principles representing the figure focus on the user customer, user outcome, focus on user outcome, multi-disciplinary team and maintaining a restless invention. So, the customer end user is represented by the yellow dot in the loop diagram as a customer or user centric process.

The green dot refer to the multi-disciplinary teams from different department involving in the design process and the restless invention, reinvention refers to the iterative nature of the process. The process assume that nothing is perfect and every product is a measure of iteration and development.

(Refer Slide Time: 25:37)

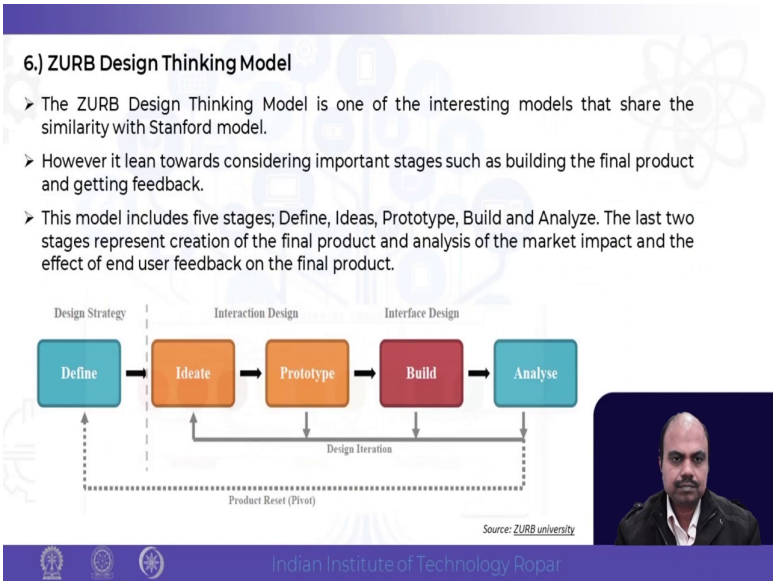


So, to ensure the scalability of the design process, the IBM model organizes how the process is to run among different teams through three key three main keys, one is hills, second one is playbacks and third one is sponsor users. The hill refer to the project goals, the playback refer to putting the stakeholders on the same page and ensuring the different teams are erupted with the progress project progress through multiple meetings.

And the sponsored user make sures the involvement of the end user in the heart of the process through testing and feedbacks. The model was designed to fit in different types of companies including very large organization like IBM, Google and various other organizations and it is considered as a unique advantage over other design thinking models.

So, however, the model is still new and does not have enough feedback from companies who adapt it in their process. However, it will look interesting model even one can think of adapting it here also in bigger companies.

(Refer Slide Time: 27:08)

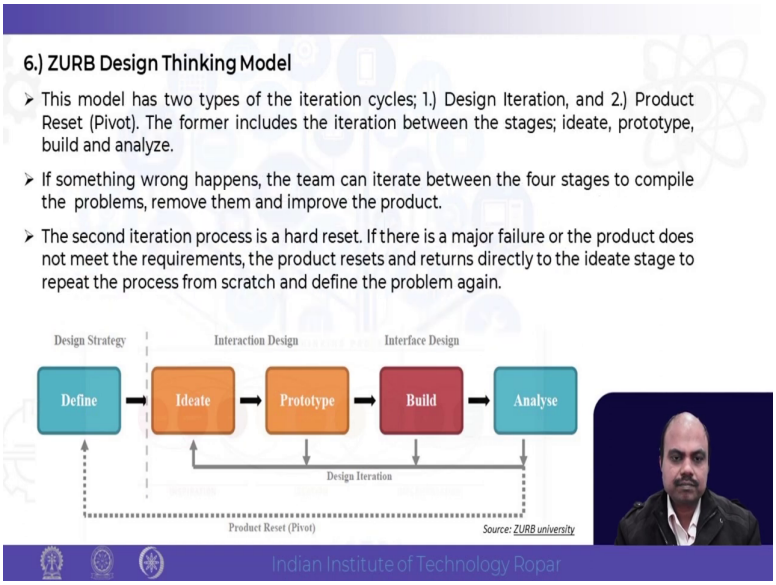


Now, we are going to learn another method. The 6th one is ZURB, Z U R B, ZURB design thinking model. So, ZURB design thinking model is one of the interesting model that share the similarity with the Stanford model.

However, it learned, it lean towards considering important stages such as building the final prototype product and getting feedback. This model includes five stages define ideas, prototype, build, analyze. So, last two stages represent creation of the final product and analyzes the market impact and effect of the end user feedback on the final design.

Progress so first is define, next is the ideate, third one is prototype, fourth one is build and last one is analyse. So, in this case if you see first is design strategy that is called defined under defining then interaction design is a ideate and prototype that build and analyze. So, basically it is a iterative cycle which is also there.

(Refer Slide Time: 28:29)

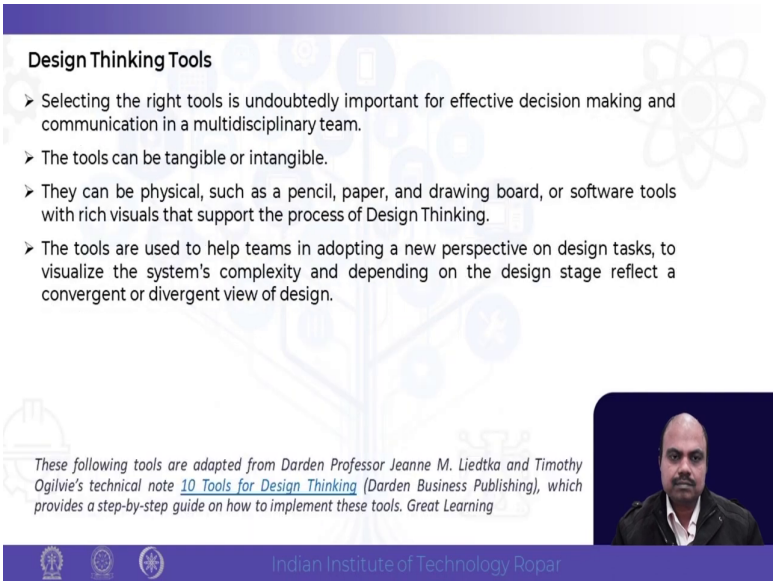


So, this model has two types of iteration cycle; one is design iteration and product reset by work. The former includes the iteration between stages, ideate, prototype, build and analyze. So, if something wrongs happens the team can iterate the four stages of to compile it.

So, it can go back and again fourth problems remove them and improve the product. The second iterative process is a hard reset, if there is a major failure in the product and does not feel the product does not meet the requirements then what is going to happen? That time the

product resets and now return directly to the ideate stage to repeat the process from the scratch and define the problem again.

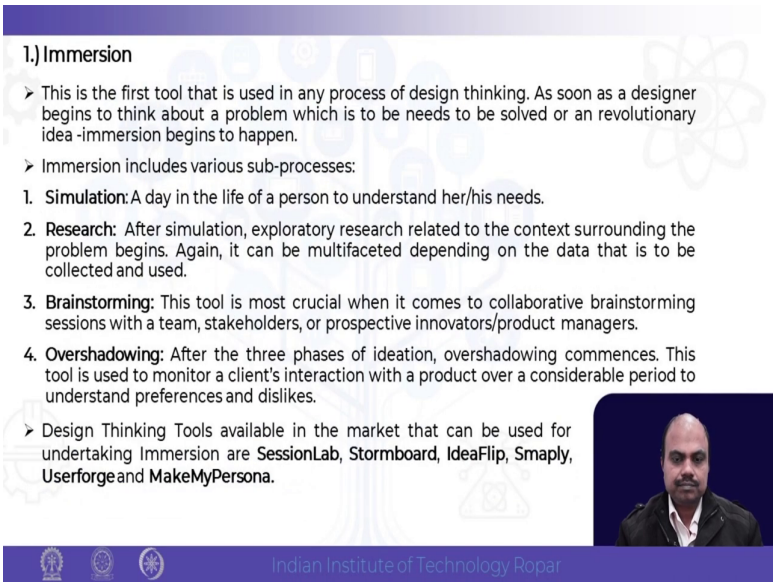
(Refer Slide Time: 29:22)



Now, we are going to learn about design thinking tools. So, selecting the right tools is undoubtedly important for effective design, effective decision making and communicating to a multiple multi-disciplinary team. The tool can be tangible or intangible. They can be physical such as paper, pencil, paper, drawing board or software tools with rich visuals that supports to support the process of design thinking.

The tool are used to help teams in adopting a new perspective on design task, to visualize the systems complexity and depending on the design stage, reflect a converging or diverging view of design.

(Refer Slide Time: 30:19)



So, first one is immersion in first one we see immersion, here this is a first tool that is used in the process of design thinking. As soon as the designer began to think about a problem which need to be solved to be and it will solved or the revolutionary idea immersion begins at that time.

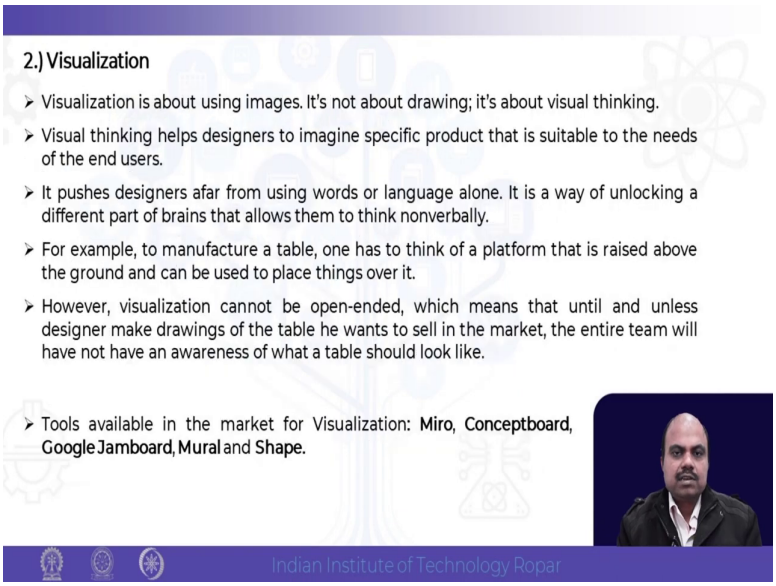
So, in immersion, you are going to emerge. Basically, you think of that design is going to emerge in the problem. So, emerging as a sub step that is simulation a day in the life of a problem to understand the needs. So, here we are going to understand a user from the perspective of a designer, but from they trying to understand and simulate what is the entire life, how the entire day of is going off, going for the user.

Then, is called next is research. After simulation explanatory research, related to the context surrounding the problem begins. Again, it could be multifacet depending on the data that to

be collected and used. Next is brainstorming. Brainstorming, this tool is more critical when it comes to elaboration, elaborative brainstorming sessions with a team stakeholders or prospective innovators and product managers.

Next is over shadowing. After the three phase of ideation over shadowing commences. This tool is used to monitor the client, client interaction with a product, over considerable period and understand preferences and dislikes. So, design thinking tools available in market can be used for understanding immersion such as SessionLab, Stormboard, Ideaflip, Smaply, Userforge and MakeMyPersona.

(Refer Slide Time: 32:27)



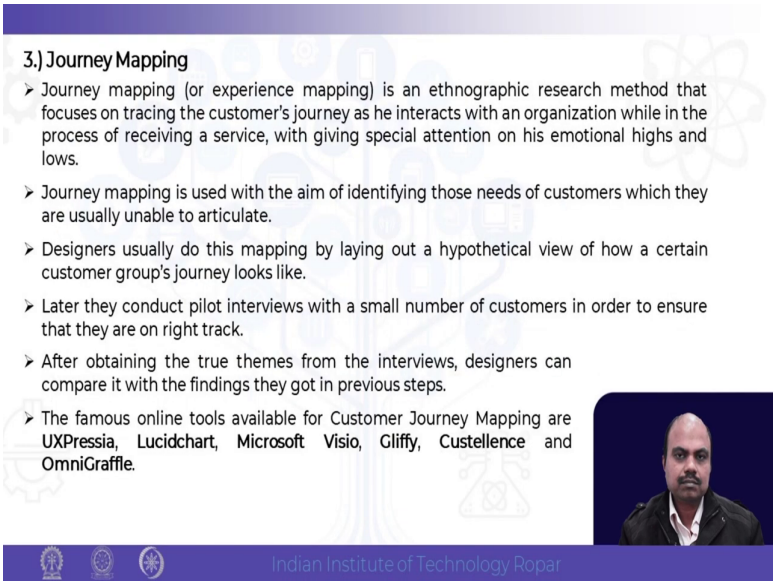
Next is visualization. So, in visualization is a is about using images. It is not about drawing, it is about visual thinking, you think visually. So, visual thinkings helps designers to imagine specific product that is suitable to the need of the end users. It pushes designers afar from

using words or language alone. It is a way of unlocking a different parts of brain that allowed them to think nonverbally.

An example, to manufacture table one has to think of a platform that is raised above the ground and can be used to place things over it. However, visualization cannot be open ended, which means that until and unless designers make drawings of the tables he want to sell in the product, sell in the market, the entire team will not able to understand.

So, here visualizing is not they would know, just thinking, you have to actually make your team, you have to help your team to visualize the way you were thinking, right. So, these tools are available in the as if our visualizations are Miro, Conceptboard, Google Jamboard, Mural and Shape.

(Refer Slide Time: 33:59)



The 3rd is journey mapping. In journey mapping or the experience mapping, it is an ethnographic research method that focuses on tracing the customer's journey as he interact with an organization while the process of receiving a service or giving special attention to his emotional highs and lows.

So, journey mapping is used with the aim of identifying those needs of customers which they are usually unable to articulate. Designers usually do the journey mapping by lying over a hypothetical view of how a certain customer groups journey look a like, look like. So, later they conduct pilot interviews with a small number of customers in order to ensure that they are the right track. So, basically you understand and feel what the journey of a person is with respect to product.

After obtaining the true themes for the interviews, designers can compare with the findings that they got in previous step. The famous online tools available for customer journey mapping are UXPressia, Lucidchart, Microsoft Visio, Gliffy, Custellence and OmniGraffle.

(Refer Slide Time: 35:34)

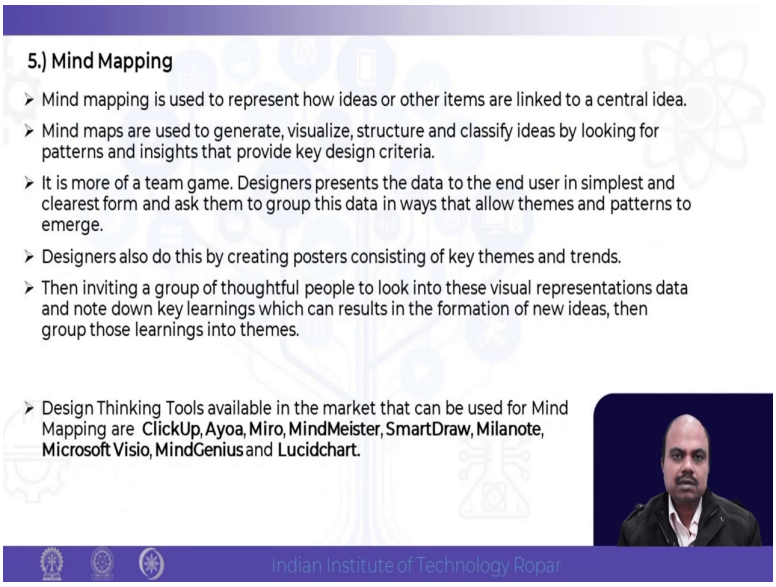
Next is value chain analysis. The value chain analysis is the business side equivalent of customer journey mapping. It is a tool used for evaluating each and every activity in a company's value chain to understand where are the opportunities for improvement, improvement lies.

By conducting value chain analysis, managers can know which step can increase or decrease the value of the final product or services. This gives managers or designers some form of advantage like reduction in the cost or increasing time in R and D of the product. Value chain analysis examines how an organization interact with value chain partners to produce market and distribute new offerings.

So, here basically you understand how the value of the product will be in the market. Analysis of the value chain offers to create better value for the customers along with the chain and

uncovers important clues about partners capability and intentions. It begins by working backward from the value creation for the ultimate end user and then adding the capabilities and bargaining power of other key stakeholders.

(Refer Slide Time: 37:18)



The next one is mind mapping. Mind mapping is used to represent how ideas and other items are linked to a central idea. So, mind mapping are used to generate visualize structure and classify idea by looking for patterns and insight that provide key design criteria. We have learned already mind mapping in a more detailed exercise in a more detailed exercise way.

It is and designers also do this by creating posters consisting of key themes and then these we use mind mapping to visualize. So, there are various tools for mind mapping. Some of tools are the Miro, SmartDraw, Microsoft Visio and others Lucid, Lucidcard Lucidchart.

(Refer Slide Time: 38:18)

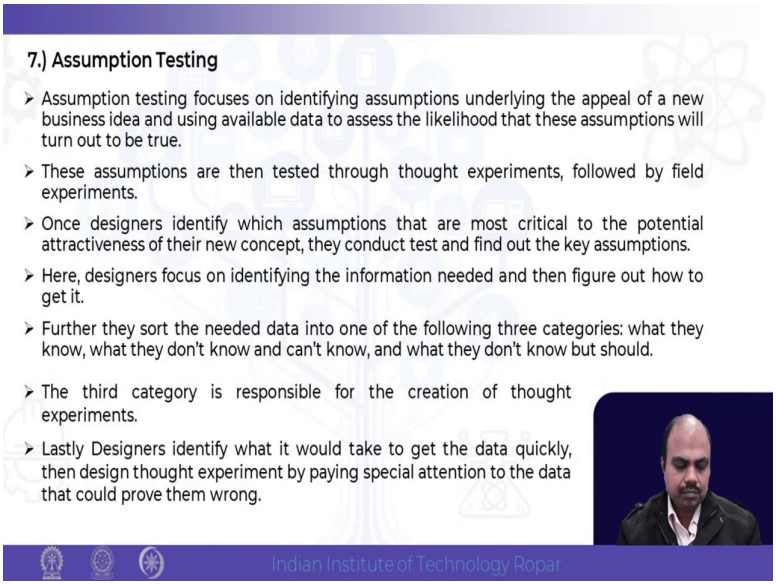
The next is rapid concept development or iteration. So, rapid concept development helps design thinkers in generating hypotheses about innovative product opportunities. In today's fast paced world where competition is tighter than ever, it has become extremely important or essential for the for the organization to adapt quick with ever changing customers need.

In this tough scenario where coordination between people and object from the real world cannot be replicated in office spaces, a quick iteration, iteration design tool process work best. So, therefore, design designers should test their designs quickly in the real world, improve them upon.

So, this is one of the very important method where you can actually make the concept very fast and see the feedback. So, and this keeps on the market open for innovation. So, if

organizations spent too much time solving small logistic problems, the entire chain will be affected. So, here rapid iteration is required and make it very fast.

(Refer Slide Time: 39:35)



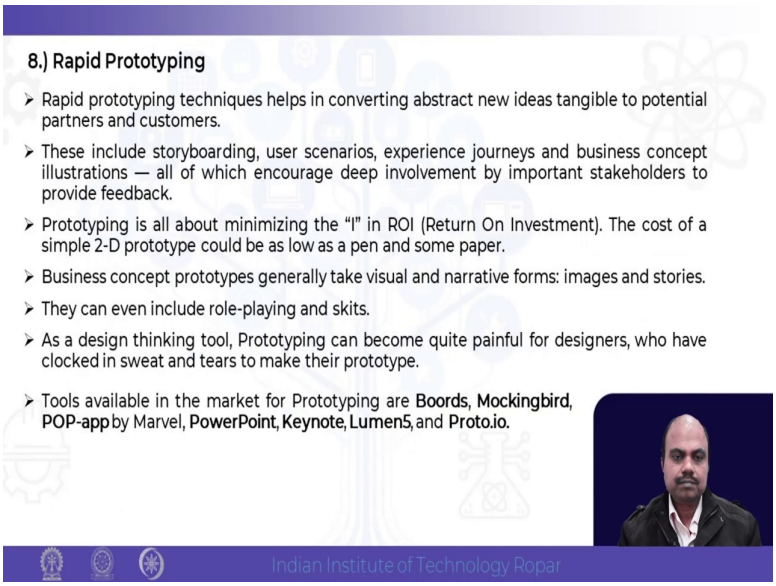
Next is assumption testing. In assumption testing, it is basically we are assumption testing focuses on identifying assumptions. And, identifying the appeal of a new business idea and using a available data to assess the likely likelihood that assumptions will be turn out to be true.

These assumption are then tested through experiments followed by field experiments. Once designers are identifying these assumptions and then most critical to the potential, potential attractiveness of the new products and they conduct the find out the assumptions.

So, assumption testing is very important because maybe I assume lot of assumptions are the designers, right. So, which is important to test whether this will be assumptions is right or wrong, then we need to do something different than what we are doing that is what is important here.

The further they sort and needed data in one of the three categories what they know, what they do not know and cannot know and what they do not know, but should know. The third category is basically the presentation of the creation of the thoughts of the experiments. Lastly, designers identifying, identify what it would take to take to get the data quickly, then designs through experiment by playing special attention to the data and that could play them wrong.

(Refer Slide Time: 41:18)



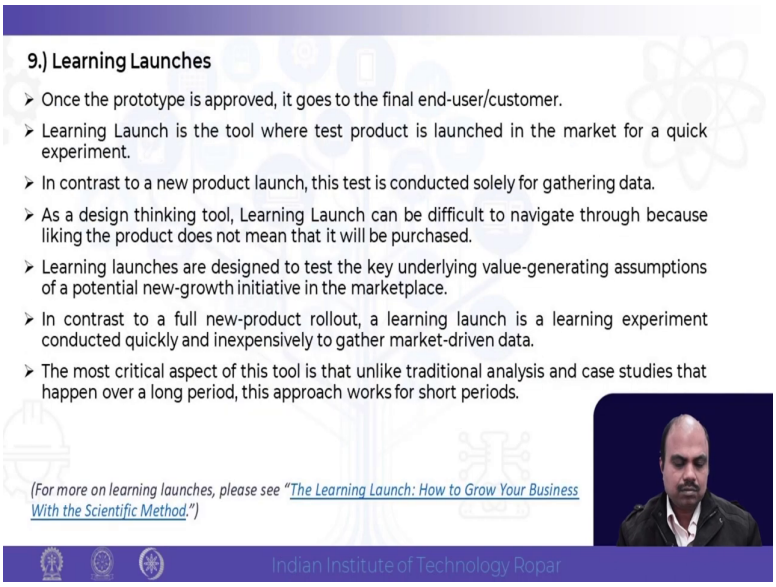
Next is rapid prototyping. This we have explained extensively discussed in different set of slides. So, rapid prototyping techniques is going to help in converging the abstract ideas into tangible. So, here designers can make very fast product using rapid prototyping. So, design, increasing CAD, number 2 STL file and make a make a working product.

So, these include storyboarding, user scenario, experience designers, business concept. So, rapid prototyping not just only a making a physical model, it is also about making some making some scenarios, making some journeys, storyboarding very fast to be prototyped, right. And prototyping is all about minimizing the I and return on investment. The cost of simple 2D prototypes can be as though as pen low as pen and some paper.

So, here concept, business concept prototypes, generally, take visual narrative forms, images and stories. They can even take role playing and skits. As a design thinking tool, prototyping can become quite painful for designers who have clocked in sweat and as well as sweat and tears.

So, these are the techniques, these methods, some of the techniques or some other way for rapid prototyping is going to help designers to see the design process and see the prototype faster. Some of the techniques which are available is Boords, Mockingbird, Popped app, PowerPoint, Keynote, Lumen5 and Proto io.

(Refer Slide Time: 43:06)

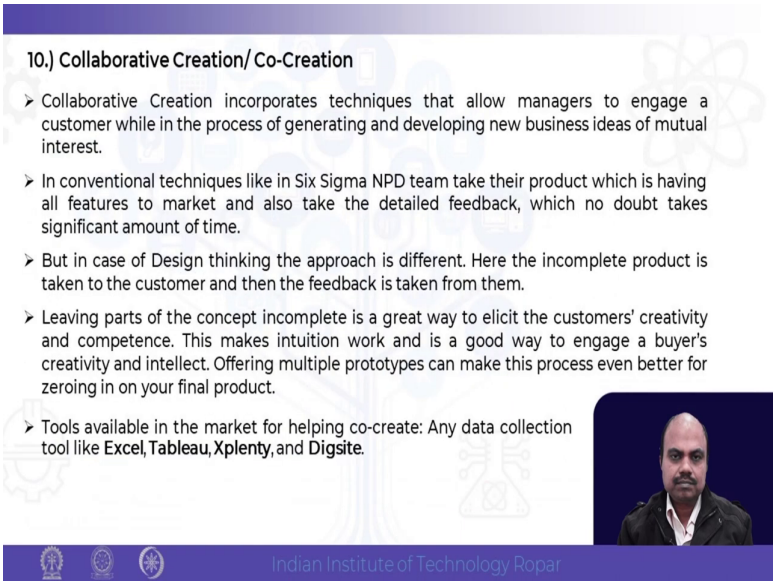


So, now we are going to go to 9th one. 9th one is the learning launches. So, one of the prototype is approved, it goes to the final end customer. So, learning launches is a tool where test product is launched in the market for a quick experiment.

In contrast to a new product launch, the test is conducted solely for gathering data. As a design thinking tool, learning launches can be difficult to navigate through because lighting the product does not mean that it will get purchased. So, learning launches are designed to test the key underlining, value gathering assumptions of a potential new growth initiative in the marketplace.

In the context to a new product rollout, a learning launch is a learning experiment conducted quickly and inexpensively to gather market-driven data. The most critical aspect of this tool is that unlike traditional analysis and case studies that happen over a long period.

(Refer Slide Time: 44:23)



This approach works for shorter periods tenth one is collaborative creation or co-creation. So, this is again very important for especially for bigger companies and multiple people involved in multiple places.

So, collaborative creation incorporates techniques that allows managers to engage a customer while in the process of generating and developing new business ideas of mutual interest. In conventional techniques like Six Sigma NPD, team takes their product which is having all the

features of the market and also take the detailed feedback which no doubt takes significant amount of time.

But in the case of design thinking, the approach is different. Here, the incomplete product is taken to the customer and then the feedback is taken from there. So, in this case, it leaving the part of the concept incorporate is the way to elicit the customer's creativity and competence, see what they feel and what their responses are.

This makes intuition work in a good way to engage a buyer's creativity and intellect. And offering multiple prototypes can make this product process even better for zeroing in an your final product. So, some tools are Excel, Tableau and other tools are also available.

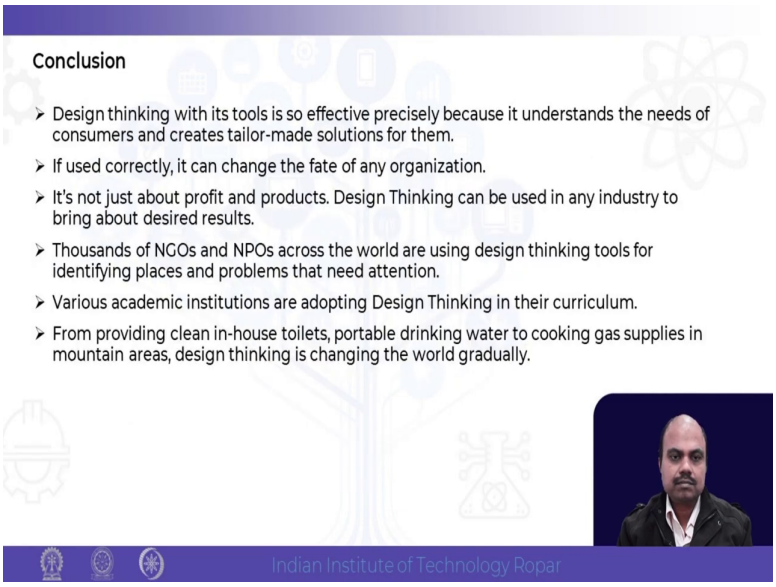
(Refer Slide Time: 45:68)

11th one is storytelling or art of selling. Storytelling has been used in every craft and art practice including business and it is becoming a primary production tool. As a part of design thinking, this tool is not used properly and can say if he not use properly, it can result in returning that phase one immersion. After all, without convincing the customer to buy the product, this is where the whole team of the professional advertisement and marketing come into picture.

So, here we have to tell the customers and tell the story in in the right way, then only the customer is going to give feedback or they are going to buy it, right. So, here we need to also understand what to do while we are doing this exercise. The story narrates about revealing a problem.

So, using metaphors, analogies and data to be driven home your product and key services of nailing the art of selling. So, if you see any successful product, life-cycle of product or services, notice that how it was introduced in the market, made all the differences in bringing about sales and staying in the mind of the customer forever.

(Refer Slide Time: 47:25)



So, in the conclusion, we can say that design thinking with all these tools is an effective precisely because they understand the need of the customers and create tailor made solutions from them. If used correctly, it can change the fate of any organization. It is not just about profits and products. Design thinking can be used in any industry to bring about desired results. Thousands of NGOs and NPOs across the worlds are using design thinking tool for identifying places and problems that need attention.

Various academic organizations are adopting design thinking in their curriculum. From providing clean in house toilets, portable drinking water to cooking, gas supplies and maintaining in mountain area design thinking is changing the world gradually.

Thank you.