Social Innovation in Industry 4.0
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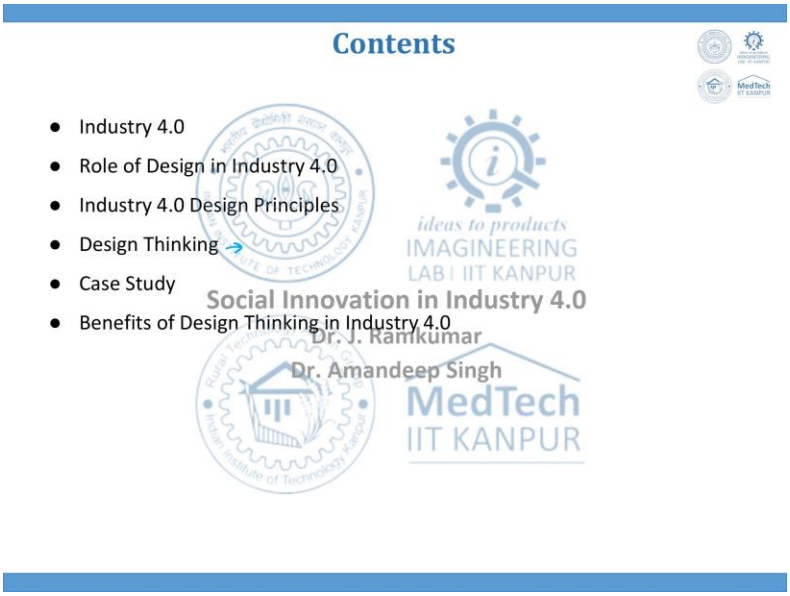
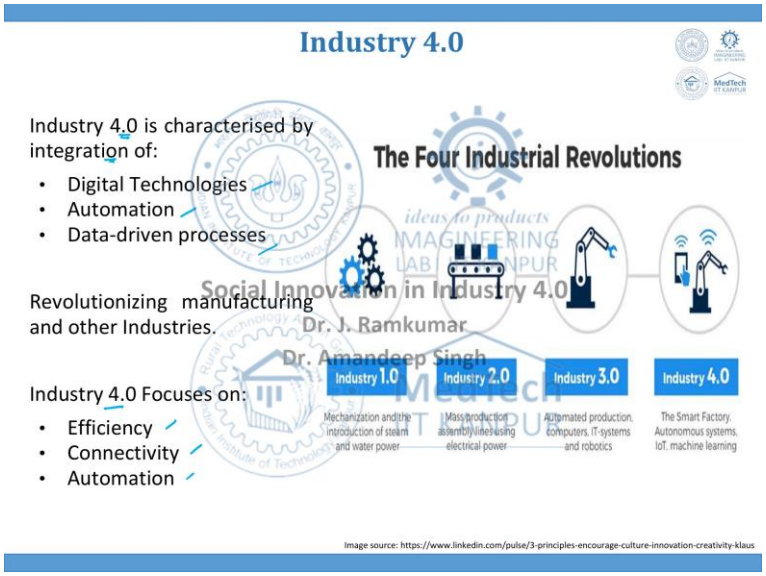
Lecture 18
Design for Industry 4.0

Welcome to the next lecture on Design for Industry 4.0. We have been discussing more on Social Innovation, characteristics of Social Innovation, how do you identify the problem, and all such things. But now, we have also supposed to understand the other half of the course is Design for Industry 4.0, because Industry 4.0 is going to make the scalability, repeatability and reliability of your solutions.

Social Innovation, it can be product form, or it can be process form, or it can be service form. So, when we are looking for product, process, or service, Industry 4.0 plays a very very important role.

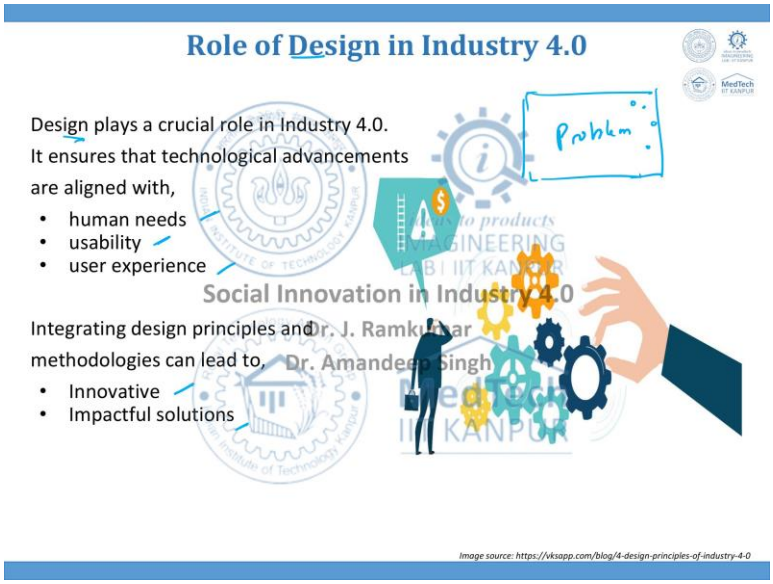


Let us look into the content of the slide. So, Industry 4.0, then Role of Design in Industry 4.0, Industry 4.0 Design Principles, Design Thinking, which I have been covering on and off little bit, a small brief about it, then Case Studies, Benefit of Design Thinking in Industry 4.0.



Industry 4.0 is characterized by integration of digital technology, automation and data-driven processes. You are trying to digitize the data collection, you are trying to digitize the data analysis. So, digital technologies is very important. For a digital technology to come into you always try to integrate a sensor which runs 24 by 7, so that you try to automate it and try to get the digital.

And, moment you have a digital data, you try to do analysis of the digital data. So, all the three things are very important and Industry 4.0 integrates all the three. Revolutionizing manufacturing and other industries has happened after Industry 4.0 coming into existence. So, it has improved the efficiency, connectivity and automation in the start-up eco culture.

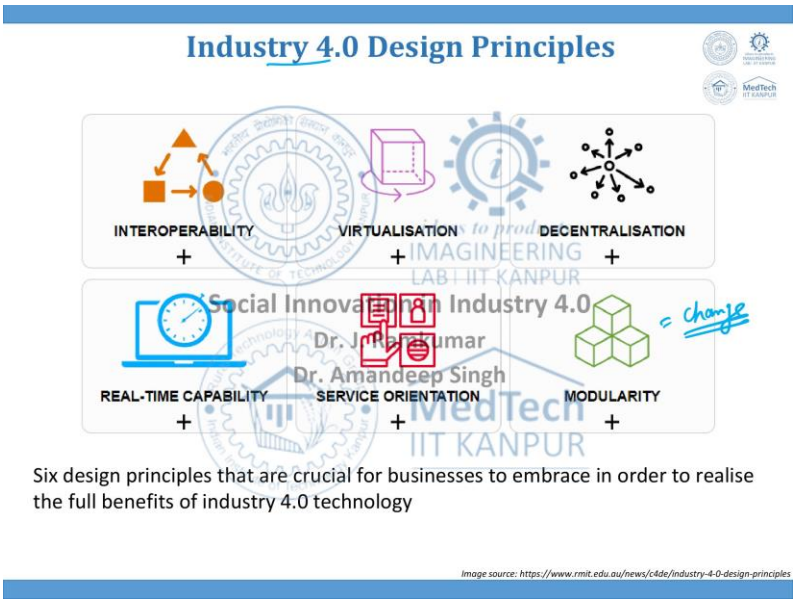


What is the Role of Design in Industry 4.0? Design plays a important role. Design process starts with customer need identification, and from there we go up to the end of the project after validating, testing and implementation. So, design plays a crucial role in Industry 4.0.

It ensures the technological advancements are aligned with human needs, usability and user experience. The design whatever we think in the engineering perspective is, you are being given a problem, then in that problem you have been given with constraints, you work on this constraints and try to get an optimum solution for the given defined problem. But truly speaking, the design starts from understanding the human needs.

The definition of the problem is the biggest challenge. So, you identify the human needs, your usability and user experience, all these things have to be aligned in the design process.

The integrating design principles and methodologies can lead to innovative and impactful solution. When you align all these things, what are the things, this factor, like human needs, usability, user experience plus the digital technology, automation. So, here if you can integrate digital technologies, automation and the data-driven, along with human needs, usability and user experience, you will see a solution for it.

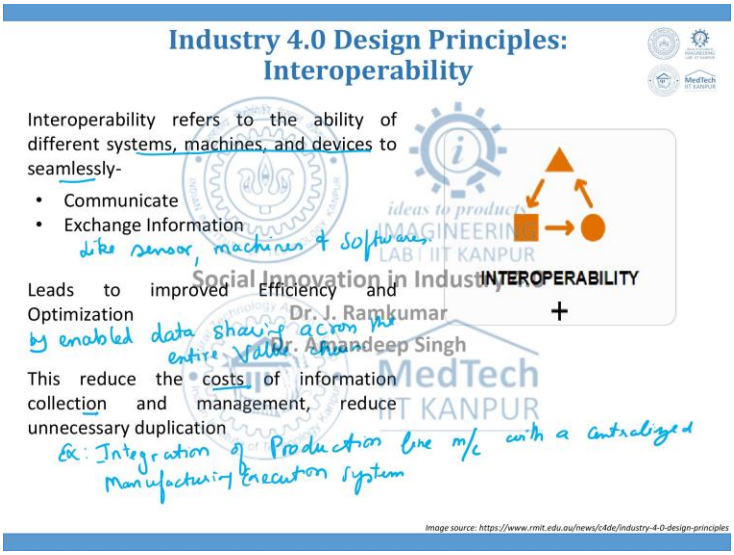


The Industry 4.0 Design Principle works on 6 Design Principles. We will see individual principles in the forthcoming slides. So, interoperability is the first principle, virtualization second principle, decentralization third principle, real-time capability fourth principle, service orientation fifth principle and modularity is the sixth principle.

When somebody says that I am implementing Industry 4.0 the design principles are going to be this 6. So, the 6 Design Principles that are crucial for business to embrace in order to realize the full benefits of industry 4.0 technology is given here.

The 6 principles are basic. It can be a single principle or it can be 2 principles or it can be 4 principles put together. So, it can be interoperability, virtualization, decentralization. Decentralization is you are basically empowering.

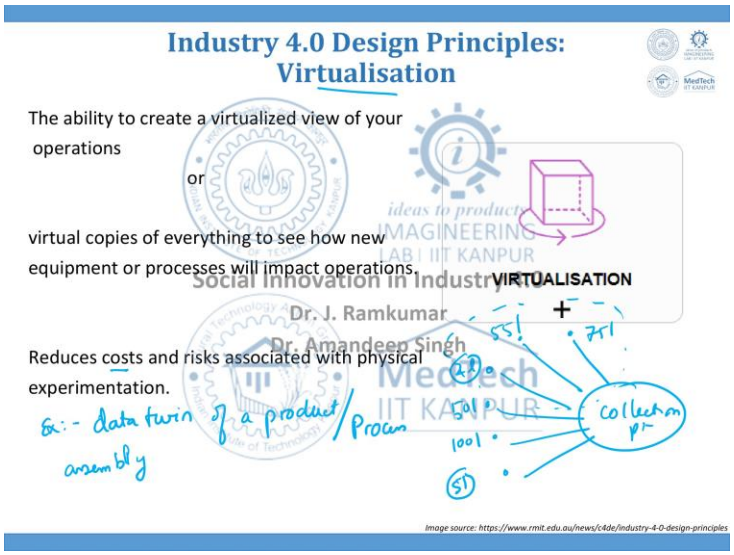
Decentralization, real-time capability, then service orientation and modularity. Modularity leads to change. If you have a base module and if you can keep changing it to meet out to customer demands, then that becomes modularity.



When we talk about interoperability, it refers to the ability of different systems, machines and devices to seamlessly communicate and exchange information. Here, we use sensor, we use machines and software.

So, a seamless connection between systems, machines and devices is interoperability. which leads to improved efficiency and optimization by enabled data sharing across the entire value chain. This reduces the cost of information, collection and management, reduce unnecessary duplicacy.

For example, when you try to integration of production line with centralized manufacturing execution system, then the real-time data sharing will be available and between machines can be done and the downtime also can be analyzed. So, the interoperability principle is basically to communicate and exchange information seamlessly when you do this, it tries to improve efficiency, and it also tries to do optimization, which reduces the cost of information collection and reduce unnecessary duplicacy. So, this is the principle for interoperability.

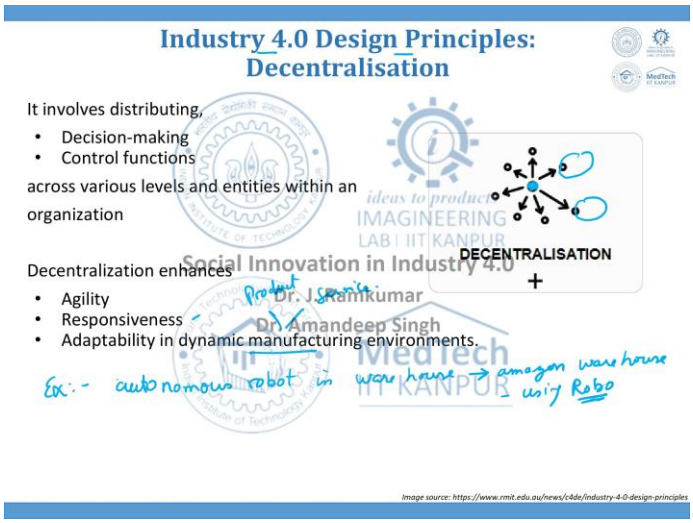


The next one is going to be virtualization, the ability to create a virtualized view of your operation. For example, you are trying to see, ok, there are people who are living in different parts of the community, and they all are trying to produce milk, they produce milk. So, it is maybe 5 liters, then 100 liters, then 50 liters, then 2 liters, then 55 liters, then it is 75 liters. So, here is a collection point.

So, now you know what is the distance and you know the traffic factor. So, then you can try to calculate what will be the time it is going to take moving from here to here and here to here. So, this will try to tell me how many vehicles should I operate, such that I try to get the yield, and second thing is should I at all concentrate on this 5 liter and 2 liter, because it is at a far off distance and the output is too low should be considered.

So, all these things can be before simulated and then you can start your business. The ability to create a virtualized view of your operation or a virtual copy of everything to see how new equipments or processes will impact operation.

So, this is virtualization. So, this will try to reduce cost and risk associated with the physical experiments. So, example here is, creating data twins of a product slash process assembly, before we do the experiments physically. So, reduced cost and risk associated with physical experimentation are part of virtualization.



The next one is going to be decentralization. It involves distributing decision making and control functions. So, rather than a single system trying to take a decision, we try to decentralize. Moment you try to decentralize, the decision happens much faster and the percolation of information goes much faster and it can be taken at a local standing.

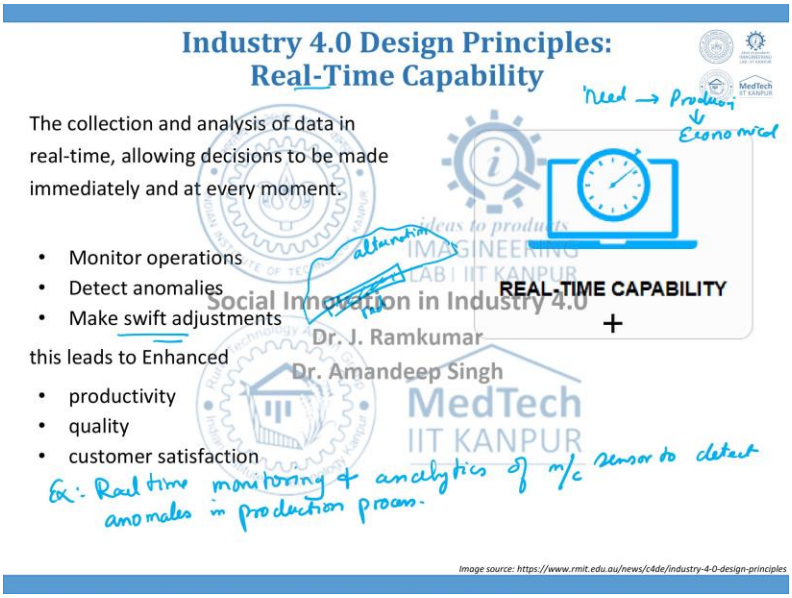
It involves distributing, decision making, and control functions across various levels and entities within an organization, it decentralization is also part of Design Principle Industry 4.0.

Decentralization enhances agility that means to say, how quickly you can change to meet out to the requirements, responsiveness and adaptability in dynamic manufacturing environment. So, for example, if there is a demand getting 0, now what would you do is, you will immediately go, tell the society of people or a group of people.

You change to another cluster or change the product, such that the requirements can be many. Agility is quick response to the market needs, responsiveness and adaptability in dynamic manufacturing environment. Manufacturing here, it talks about product, it also talks about service.

So, example here is, implementing autonomous robots in warehouses. They go around the warehouse, pick the item, and then they try to give it, and it occupies a minimum floor space area and other things. So, you can look at Amazon warehouse using robots, you can see that. So, that will give you lot of information, how is a robot, how does a robot move inside, how does it move at depending upon the requirements you do on the

agility, depending upon the requirement of the customer, what do you do, everything is given there. So, decentralization becomes the third important principle in Industry 4.0.



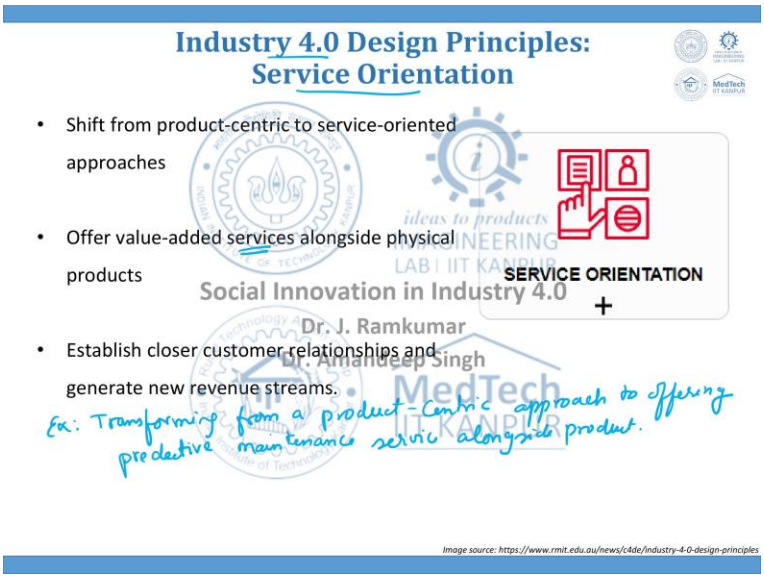
The next one is going to be real-time capability. The collection and analyzing of data in real-time allowing decisions to be made immediately and at every moment is real-time capability. In real-time capability the agility of the system is very much checked, how quickly you can change to customer requirements and keeping a system quad dynamic is also going to be a server intensive, and it needs lot of models which is very difficult to establish, mathematical models which is very difficult to establish.

For example, all your share business goes under real-time capability monitoring. So, the collection and analysis of data in real-time allowing decisions to be made immediately at every moment is the real-time capabilities.

So, monitoring operations, detect anomalies, and makeshift adjustments are done. For example, when you are using a Google map, you see, there is a complete red line here, then the Google says all alternative routes. So, it is almost makeshift adjustment. If there is a limitation because of flood transportation is not possible, then the alternative arrangements can be done immediately by the real-time data. So, this real-time data helps in preventing lot of societal damage.

This leads to enhancement in productivity, quality and customer satisfaction. Here example is, you use real-time monitoring and analytics of machine sensor to detect anomalies in production process. See, in Social Innovation, moment you identify need, then you have to start producing, and in the production we have to make it as economical

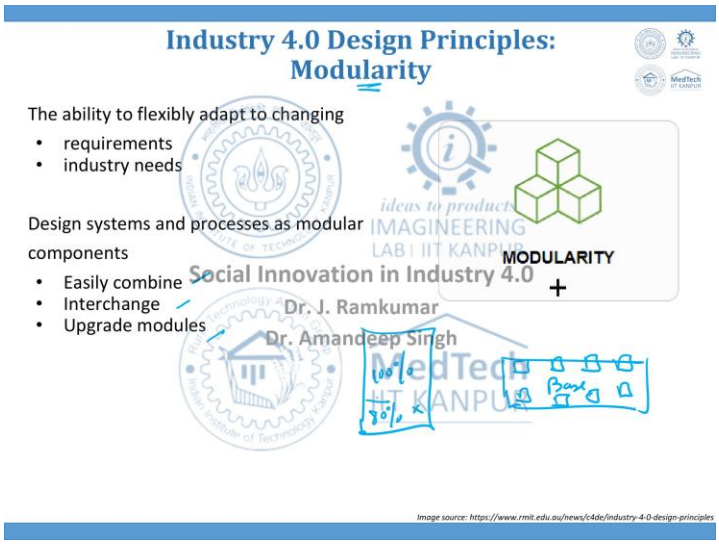
as possible. So, all these real-time information plays a very very important role.



Next is, service orientation. Shift from product-centric to service-oriented approach is one of the principles of Industry 4.0 design. Offer value-added service long side physical product. You deliver a physical product, along with it also try to give a service with it, then establish close customer relationship and generate new revenue streams.

So, this is also there. For example, you try to transforming from product-centric approach to offering predictive maintenance service alongside the product. This is possible. Transforming a product-centric approach selling only product, you also trying to do offering predictive maintenance service alongside the product. For example, you have sold a product, and then you are trying to trap the product, what is its performance.

Assume that I buy a car from you. Now, you keep on tracking the car and all the subsystem parts and what is its performance. And then, what you do is, you sell a car, you also try to sell a service saying that I will keep tracking your car and whenever there is an anomaly, I will try to immediately alert you, and I will try to help you in changing it. So, this is what is establish closer customer relationship and generate new revenue streams. Again here, IoT of sensors and other things will be used and that will try to help you to do a predictive maintenance service.



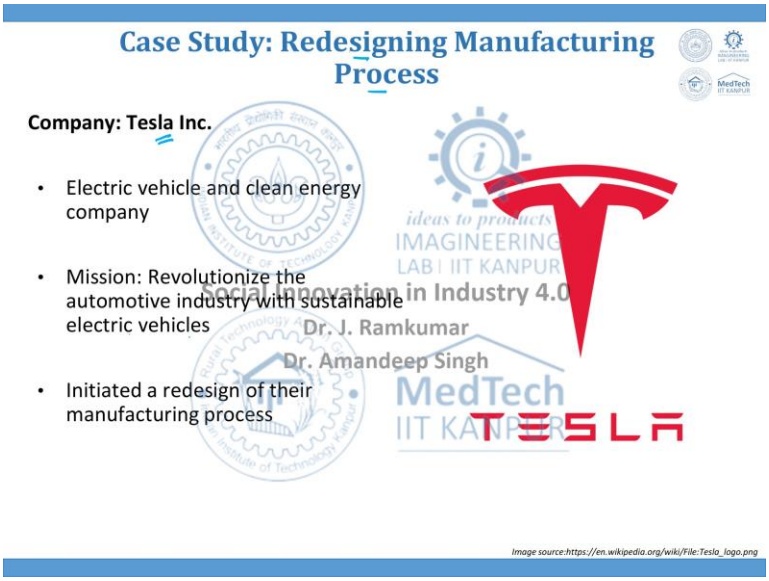
So, the last one is going to be modularity. Modularity is the ability to flexibly adapt to a change. You have a breadboard and now this breadboard is the base, and on the breadboard at several places, you keep adding features to your products, such that it can meet out to the market requirement.

For example, I buy a car the car is given without an AC, without a audio system, without a power steering, without the automatic gear. So, you can have the base model, and then you can keep adding it to the base model, so that you meets out to the customer. Same way in product also, whatever you do, product or service, whatever you do, you try to develop modularity.

In several of the software companies they say that here is the 100 percent version of my software, I give you 80 percent version at an X price, then you try to pay something more, I give you 100 percent. So, this is again, they follow the concept of modularity. Ability to flexibly adapt to changing requirements and industrial needs leads to or pushes us to modularity.

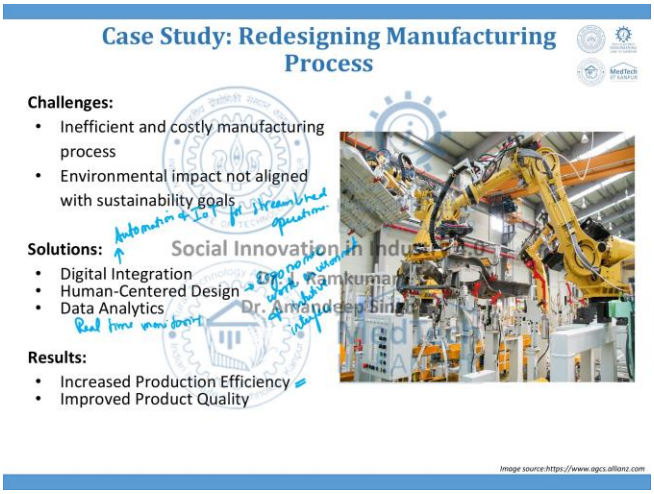
Design systems and processes as modular component, so that you can easily combine, you can interchange or you can upgrade. So, this is the next principle of Design Principle of Industry 4.0.

So, we saw all the 6 principles. These 6 principles are very important, when you are trying to implement Industry 4.0 in Social Innovation or Social Entrepreneurship. So, when you do that interoperability, modularity, virtualization, decentralization, real-time capability, monitoring and service-oriented. So, all these things have to be incorporated into the design principle while deciding Industry 4.0 for your Social Entrepreneurship.



So, let us see some of the case studies. Redesigning manufacturing process. Tesla is a company which has completely redesigned its manufacturing process. So, electric vehicles and clean energy company is the motto of Tesla. The mission is revolutionizing the automotive industry with sustainable electric car, then initiated a redesign of their manufacturing process.

So, all these things was done, basically, to improve their productivity, and making the cost effective. So, revolutionizing the automotive industry with sustainable electric vehicles is the mission which is done by Tesla. And, that is done after implementing this IoT or Industry 4.0.

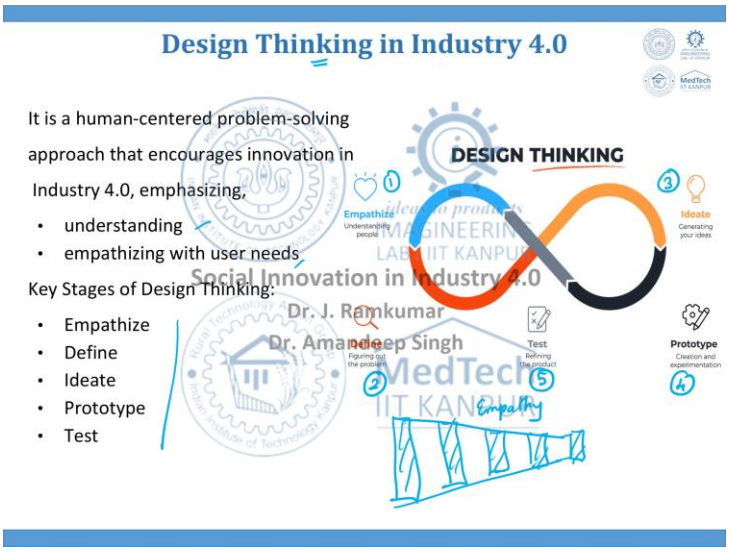


So, challenges faced by it are inefficient and costly manufacturing processes were involved, Environmental impact not aligned with sustainability goals were used.

So, these were some of the challenges which was faced and the solutions were digital integration. Digital integration is automation and IoT for streamlined operation, then human-centered this thing. So, we are trying to work on ergonomics, then you will have work environment and intuitive interface.

So, this is human-centric, that is why human machine interface is talked about, HCD is talked about. All these things have to be there at the back-end, such that your front-end delivery to the customers is effective.

Data analytics is real-time monitoring. So, all these things led to a result of increase in productivity and increase in product quality. When you try to automate it, when you try to have more amount of data, then production efficiency and product quality also improves.

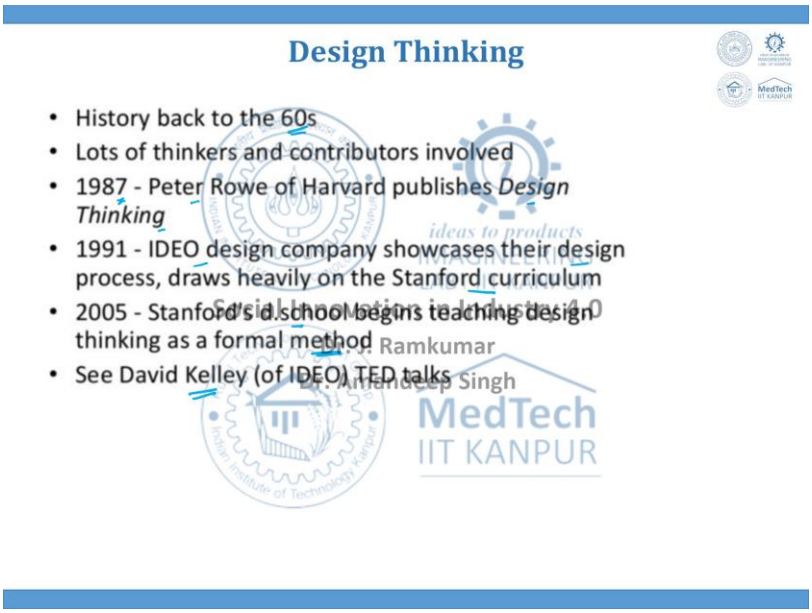


The design thinking approach in Industry 4.0 is the bus word which is used. So, design thinking is also used for Social Innovation or any innovation to happen.

It is a human-centered problem-solving approach that encourages innovation in Industry 4.0, emphasizing understanding and empathizing the users need. What are the key stages of design thinking? The key stages of design thinking are empathy study which is 1, then do definition of the study, 3 is you try to do ideation, 4 is try to do prototyping, and 5 you do testing. And, it is not a end of it, after you do testing, the figure of 8 continues, and you start doing one more round of empathy study.

So, it is like this, your empathy study starts like this, and at the next step your empathy study starts like this, and then it starts like this and this, and finally, when you do an empathy study of the fifth round or the sixth round, it becomes very focused.

Now, the entire definition of the problem, the ideation, and prototype development and testing, all becomes easy. These are different runs which is done for the empathy study.



So, these are the 5 stages. So, let us see stage by stage. Design thinking is a very powerful tool which was started in 1960s. Lot of thinkers and contributors were involved, but in 1987 it got a new shape which is Peter Rowe of Harvard published design thinking as a tool or as a publication.

Then, in 1990, IDEO design company showcased their designing process, draws heavily on the Stanford curriculum. Then, in 2005, Stanford's d. school begins teaching design thinking as a formal method in their school. Then, see in this TED talk, if you see David Kelly's TED talk of IDEO, you can see, he has nicely presented about it.

So, these are some of the examples of innovative thinking. So, you can see here, a candle and a candle stand is used. So, the innovation of this project is, you have a thread which runs all along this. As and when you burn the candle, it seep the other side, now you swipe it, so, the other side candle becomes ready for burn.

So, it burns, it settled down. So, then this part is removed, and then you have a next portion to burn. So, this is a innovative approach, it is a sustainable approach, it tries to reduce the wastage, and it is very efficient, a design thinking approach.

Here is another design thinking approach, the design thinking approach is the pillow, nothing else, it is a pillow, where in which you keep your iPad for doing operations.

This is a design innovative thinking approach. So, here why do not we have soap as a soap tablet, and we try to take each tablet for one use, wash it, and then use it.

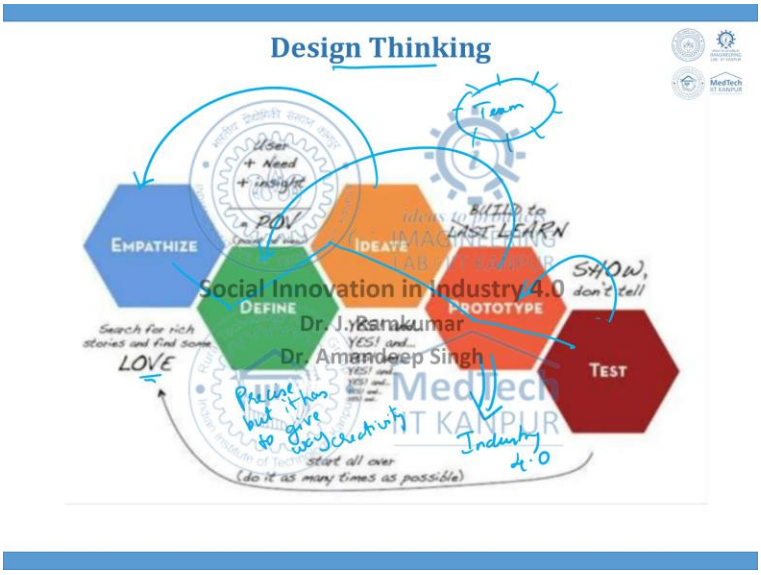
So, each soap tablet comes for rinsing of the complete body once. So, maybe you will have a soap tablet where in which you have 50 tablets, which can be sold in one chiclet box, and then you can try to use it as and when. So, here the reuse of the soaps are avoided, and the soap material whatever is used is minimized and you get the best out of it. So, here the wastage is reduced, it is a sustainable goal.

The other innovative product is a heater getting attached with your knife which helps you in scooping it out. So, this is also an innovative approach a Social Innovation, because it tries to reduce the waste and it tries to use the energy very efficient.

So, this is another innovative approach where in which a wiper is used to wipe the glass

mirror as and when you take by the steam gets accumulated here. So, you use a mirror like what is there in a car and clean the surface. So, exactly the focus of a person comes here only that portion is cleaned. The other innovative product is these pods where in which the cable passes through it, so that you can get it attached with it.

So, you reduce the time of fixing it and entangling it. So, these are some of the innovative products, and almost all these innovative products used an approach called design thinking approach. Here, it is not a particular example with respect to Social Innovation, I have put it for all the innovation. From here you can try to understand this design thinking approach which is a design tool used for innovation. So, as I told you these are the 5 steps.



These steps need not be linear, that means to say, after doing first step you go to the second step, you can go to the third step and then you can come back here.

After doing the fourth step you can come back here, you can come back from here, you can go to prototyping. So, the design thinking approach is not linear, it follows a non-linear approach. It has 5 stages, it moves from every stage to the other stage.

At each stage, you will have to do a proper work, such that, ultimately, you try to get a final output. The empathy study is search for rich stories and find some love that is part of empathy.

So, you are trying to find more and more a deeper understanding of whatever is getting, what is to be identified as a customer need or your unmet demand. Then, based on the unmet demand, you try to go to the next stage which is called as definition stage. In

definition stage, you will have a POV (Point of View), you will have a user need and insight then you will have a POV. So, based on that you will try to get into a definition stage.

The definition has to be precise, but it has to give way for creativity. For example, if I say the definition of the problem is, I want to be a rich man in the next 10 years. So, this is a definition of the problem.

So, now in this definition of the problem I have to be precise. So, what is the precision in the next 10 years? I want to become a rich man. So, rich man has to be converted into some quantum of money, and then I also have to say, how do I do it.

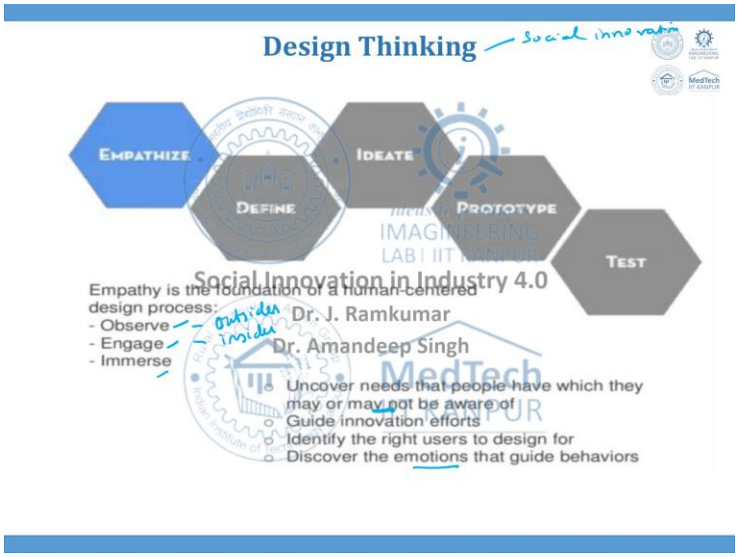
So, I redefined the problem I say I would like to be a millionaire or a trillionaire in the next 5 years, where in which I make money very professionally. So, now time is given, amount is given and the way to go is also given. I have not said which way, I have said professional. Here, I precisely define 3 points, and I also give way for creativity to happen, that is what I said professional manner.

So, from here, I try to move to the third stage which is ideation stage. In ideation stage, we always try to do brainstorming, and we try to understand all those needs. So, now it is very clear, once I do brainstorming, it is always required that you should have more participants.

So, the participants can be your colleagues, can be people from the needy, or it can be anybody else, or it can be a specified team. This team members are all having complementary knowledge to each other, they work together, and then they do a brainstorming session, that is called as ideation.

After you ideate, you try to make prototypes. So, you try to build whatever you want, and then the built one, you try to show it to the customers rather than talking about it to the customers. So, you show and do not tell what is the product and how are they going to look at it. So, then, it tries to get into the phase called as testing phase. So, these are the 5 stages.

Empathy study, definition, ideation, prototyping and testing. So, this approach is used for Social Innovation, this approach is used for Industrial 4.0 also. So, in the prototyping stage, we try to use exhaustively Industry 4.0, and in the regular manufacturing also, we try to use Industry 4.0.



So, what is there as part of empathy study? Empathy is a foundation of a human-centered design process where in which we observe, we engage and we immerse. So, observe means I do not get into the situation, from a very far off situation I keep observing.

For example, in many of the counseling service today, what they do is, they come to your house, and stay in your house as part of a family member, and watch what is going on in your house, such that you have very frequent turbulence, or inefficiency is happening in your house.

House means your residence where in which you are 4 members and there is always a negativity in the house. So, we call an outside member to observe, when you do an election we call an outside member to observe.

So, this observer tries to do the job of seeing whether everything is going right, or what is all the pitfalls, such that it can be done. The next one is you become part of the team. So, you become an outsider.

Next one is, you become an insider, that means, to say you also be part of the family, you also try to do along with the part of the family, and then try to understand what are the difficulties, that is engage.

Immerse is you get deeper. Engage is superficial, immerse is deeper. So, you get into the 3 things. So, empathy is a foundation of human-centered design process where in which

you try to observe, you try to engage and you try to immerse. So, by doing so, what happens is, the uncover needs that people have which they may or may not be aware of, will be clearly seen by you.

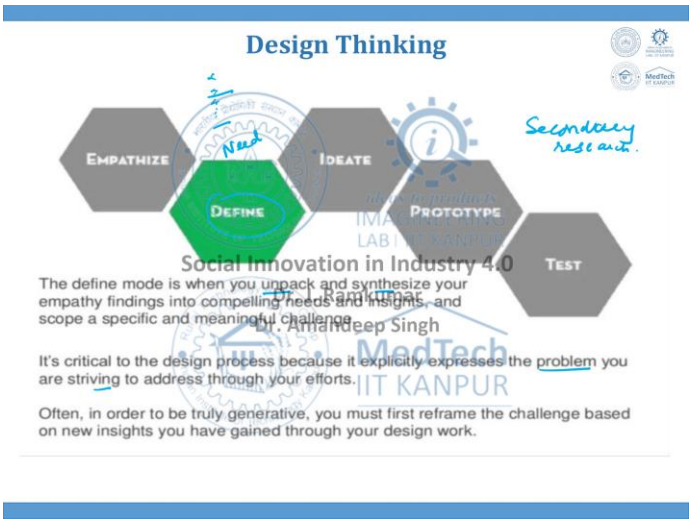
See, many a time a child cries, the child cry is not because of its want, because of some irritation in the body and this irritation is because of some metabolic imbalance. So, if there would have been a proper balance in metabolism, then the stress or the kid disturbance will not be there, it will not cry.

So, the kid will not be able to express and say that I have this problem because of this I am crying. So, some of the time the people may know what they want, and sometimes they might not even know what they want. As a designer, as a social innovator, as a creator, as a problem solver your empathy study you should try to do this, try to understand what are all the unmet needs and what they want, they say and they do not say.

Then, guide innovation efforts is happening in the empathy study, then identify the right user to design. You cannot design a universal product which can be used by anybody, anything and anybody can use, no, it is not possible.

You always have a focus group, for that focus group you try to develop a solution. It can be for a small society, the society size can be little larger, but for that particular society people, only you do it. So, identify the right user of design when you start doing an empathy study, then, discover the emotions that guide the behavior, this is very important, this is where they do not say, emotions are there. So, discover the emotions that guide behavior.

So, all these steps are done in the empathy study which is part of design thinking, and this design thinking is used for Social Innovation and incidentally it is also used for implementing 4.0.



Next one is, the definition states. The definition states is when you unpack and synthesize your empathy finding into compelling needs and insights and scope a specific and a meaningful challenge is, what is definition. Interesting you see unpack, you unpack because while you did an empathy study, you have noted down, you have packed it.

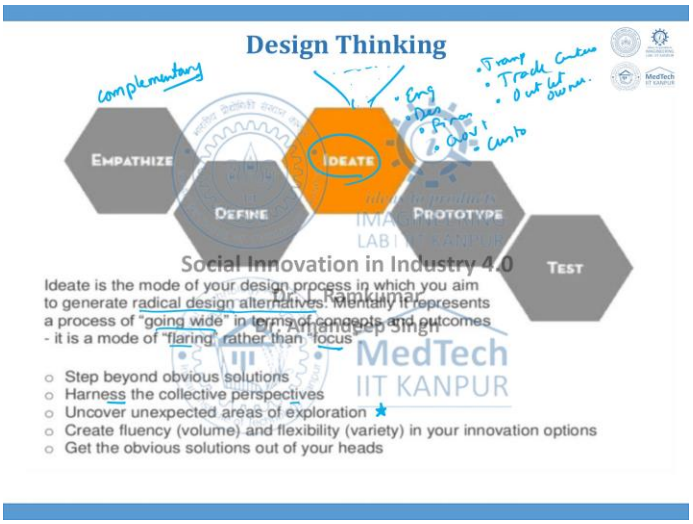
Now you open it, unpack, then you synthesize. So, you have so much of data. So, now you try to synthesize and pick which is the relevant data, synthesize your empathy finding into compelling needs.

So, basically you are writing a need statement here and insight, and scope a specific and meaningful challenge. It is critical to the design process because it explicitly expresses the problem, you are striving to address through your efforts. This is what, we have been time and again repeatedly saying unmet need identification and converting into a definition of a problem.

So, it is critical to the design process because it explicitly expresses the problem you are striving to address through your efforts. Often, in order to be truly generative you must first reframe the challenge based on new insights you have gained through your design work.

Basically what happens is, you are supposed to do secondary research first, and identify the problem whatever it is, and then with that hypothesis you go do an empathy study. Now you see, how is your hypothesis and what you studied is going in line, or completely different, that is what is said here. The hypothesis has to be tested by doing an empathy study. That is what we say, often, in order to be truly generative, you must first reframe the challenge based on new insights.

From the hypothesis, you try to get a new insight, you have gained through your design work. And, through this, you try to define the problem statement.



The third one is ideation. Ideation is a mode of your design process, in which you aim to generate radical design alternatives. You try to develop multiple designs, multiple designs you try to do, multiple processes you try to do, multiple products you try to do, multiple services you try to do, that is what it is, ideation.

Ideate is the mode of your design process in which you aim to generate radical design alternatives. Mentally, it represents a process of 'going wide' in terms of concepts and outcomes. It is a mode of 'flaring' rather than 'focus'. You go expand in your thought process, and then what you do is, you start ideating.

So, with the same theme, but you try to have multiple alternatives step beyond the obvious solution, you know, for this problem this is a solution, do not stop here.

Try to look at an alternative solution to the obvious solution. Harness the collective perspectives, then uncover unexpected area of exploration very important. Then, create fluency and flexibility in your innovation option. So, keep on we doing it and then finally, get the obvious solution out of your head. As soon as you know, this is what is going to be the solution.

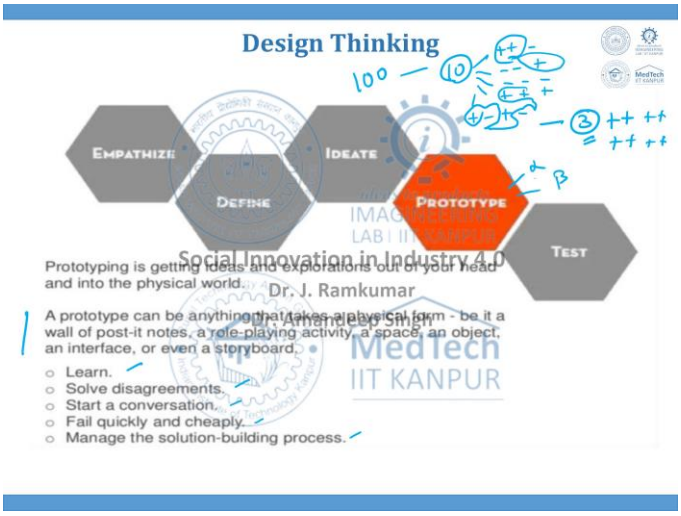
Now, put that out of your eye, put that out of your box. For example, if somebody is crying, you can always go bully him and say shut, it will keep shut, that is a one alternative, one solution. But going deeper and understanding why does he cry, is it a time phenomena, is it a food phenomena, is it a climatic phenomena, why is that. Get the obvious solution out of your head. So, these are some of the important things which is there.

So, ideation means keep yourself as open as possible, and try to allow all the thought process to come. So, all the thought process cannot come from an individual, right from empathy study, try to involve a group of people who are complementary to each other, very important, complementary.

Complementary knowledge is very very important because one is an expert, the other one also is an expert in the same area, then lot of subtle points will be missed out. So, you should have people with complementary knowledge, so that they all sit together and do an empathy study, and after that the definition also complementary team works, then ideation also works.

For example, few engineers, few designers, few finance people, few government people, few customers, few transport people, few trade centers, few outlet owners. If you involve all of them, then in the initial stage itself, you will try to have multiple ideas. Each one of

them will try to give you the best practices which you will try to culminate and come to a final solution.



Next is prototyping. Prototyping is getting ideas. So, whatever you got from here ideas, you might get some 100 ideas. Out of which, 10 ideas are feasible. Now, the 10 ideas, each one will have plus, minus. Minus, minus, 1 plus. It will have minus, minus, minus, then it will have plus, plus, plus, then it will have plus, minus, plus, minus,.

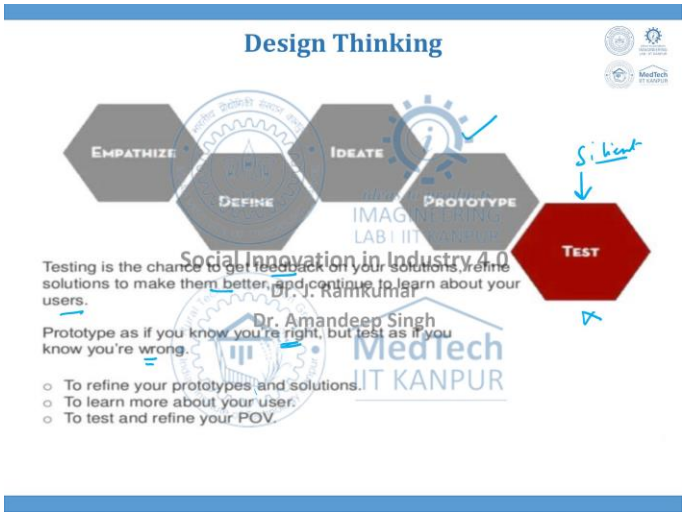
So, suppose if there are ideas. there might be positivity in the idea, there might be negativity in the idea. So, now what do I do is, from 10 ideas, which I shortlisted from 100, I will move to 3 ideas, where in which I try to have maximum plus, plus, plus, plus. So, what do I do? I do cut and paste across the ideas, such that I try to get the best out of it, something like this. So, now the prototyping is getting ideas, whatever it is, exploration out of your head and into a physical product. So, I take all the best ones and now I have 3 best ideas, these 3 best ideas will be prototyped.

A prototype can be anything that makes a physical form. Here, it can be virtual, it can be physical, or it can be a service. A prototype can be anything that takes a physical form. Be it a wall of post-it note, or your role-playing activity, a space, an object, an interface, or even a storyboard.

So, all these things can take a physical form. So, you use a storyboard. Storyboard is very very interesting. Storyboard is, you connect every time with you, you try to say, I went to a village, where, there are a lot of poverty people, there I say, Ram is a character, which was there in the village Ram was trying to struggle.

So, you know Ram, you know the struggle. Now, the connect of the story comes very nice. You make a storyboard and that will be helped in developing solutions. Prototypes, here we learn, we solve disagreements, we start a conversation, we fail quickly and cheaply, we also try to manage solutions building process, in the stage of prototyping.

So, when you do prototyping, again, alpha prototype is there, beta prototype is there, when we start every prototype, it fails, and then the failure will try to reiterate, and then we start going further. So, alpha prototype, it can be there.

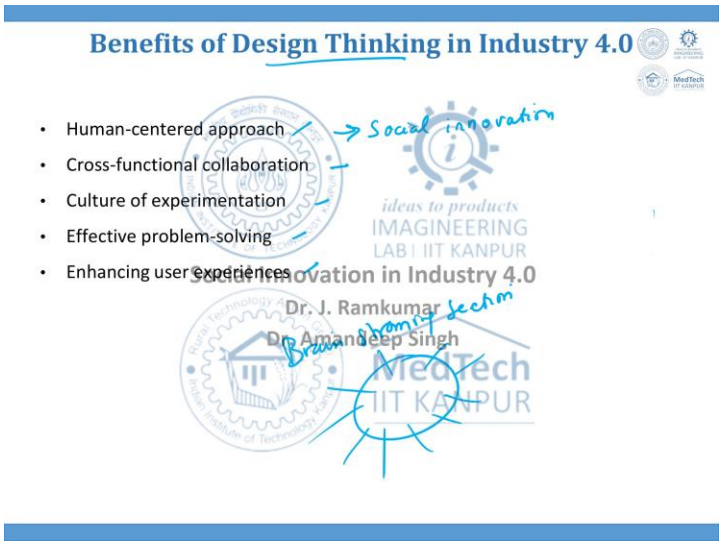


So, the next stage is the testing stage. Testing is the chance of getting feedback of your solution, refined solution to make them better and continue to learn about your users.

So, testing always happens for it. First is, get feedbacks understand your customer more, and you always try to look for better solutions, that is all happening in testing. Testing, please be silent while testing, do not keep talking about your product, throw your product in front of the customer, and allow him to explore, exploit, give a feedback. So, prototyping as if you know you are right, but test as if you know you are wrong.

Prototyping will say, yes, it is a wonderful project, keep moving. But testing will say, no, it is there. This will be yes, and this will be no. So, this is a thought process which comes to you. To refine your prototypes and solutions, we try to do testing.

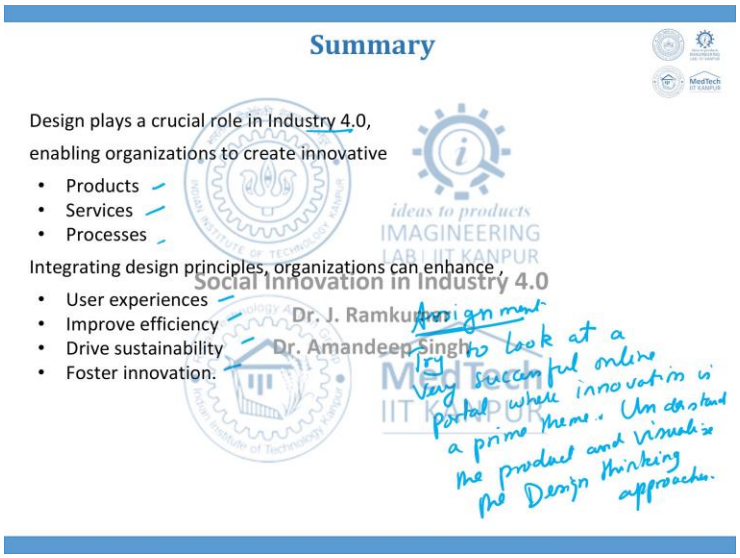
To learn more about the user, we try to do testing. To test and refine our point of view also we try to do testing. After doing testing, again, you will go back, and start doing your empathy study, and now your empathy will be more focused towards a particular point.



Benefits of Design Thinking in Industry 4.0, it is going to be it is human-center which is also required for Social Innovation. So, use design thinking for both Social Innovation, and for implementing Industry 4.0. So, you can also have a cross-functional collaboration, that is happening, because when we try to have a brainstorming session, you will try to have more customers, more stakeholders.

So, it is a cross-functional approach, then culture of experimentation is a benefit. So, what I am trying to do in this stage itself, you see, I am always pushing you to do prototyping, I am pushing you to do prototyping. Then, it is effective problem solving because I made prototype, I made a user testing, now I found out what my mistakes are, I will reiterate and I will go back to the empathy study and get it done.

So, effective problem statement can be done, then enhancing user experience will also be the benefit of design thinking. So, user experience whatever I am enjoying now. So, now, I am going to have an enhanced enjoyment by using the product or the service.



To Summarize this lecture, design plans a crucial role in Industry 4.0, enabling organization to create innovative products, service and processes. Integrating design principles, organizations can enhance, user experience, improve efficiency, drive sustainability and the foster innovation.

So, in this, I give you a small assignment. Try to look at very successful online portal where innovation is a prime theme. Understand the product and visualize the design thinking approach. Try to do this assignment. You can choose any site of your choice which are very good successful site. And then, this site should be having innovation as a prime theme.

Then, you start visualizing what all would have gone through the cycle in developing this portal. And, you should try to use a design thinking tool for visualizing or understanding the entire process. For example, empathy study where would they go, how would have they would have done it, how have these things come in the portal without that, or how something else is still missing which you can use it by doing design thinking on the particular portal. All these things you can try to visualize, and this will try to enhance your design thinking approach.

So, this will be very useful when you complete this assignment. So, these are the references which I have followed. And, I would like to thank you for your patient listening.

Thank you.