Design, Technology and Innovation
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Lecture-12
Collaborative Innovation Methods Part 1

So today's class is on collaborative model for innovation. This is a culmination of all the three aspects of design, technology and innovation. So you will see this particular sort of development happened as a research project of mine while, you know, I worked in industry for nearly seven years and after industry experience, I joined IIT Delhi as a professor and then I started my PhD then, because I realised that innovation needs a different type of skill set and innovation was a very early stages in the country.

We did not see many developments in the country at that time. Even the cars, you know, were very few. If you look at that time you had two brands running in the country. So, in that stage I said let us workout a research program where I, you know, did a PhD theory of collaborative innovation. So, this whole journey I am going to show you, how we built this collaborative model from real case studies.

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Objective

To develop a Collaborative Model for Innovation
that will enable organizations to generate
innovative product ideas.

So the main objective was to enable organizations to generate innovative product ideas. It could be organizations, or it could be students, or it could be non government organizations. Any of

them, if they have to come with innovative ideas. And these innovative ideas need not necessarily be product ideas. See for all of you I am telling you this could be communication ideas, it could be animation requirements, it could be interaction ideas, it could be anywhere but the methodology is the same wherever you take these ideas forward.

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So here we specifically built this using real case studies. Then we actually took them as sponsored projects with students. And if you take them as sponsored projects with students, the industry is a partner to this. So when you call it a sponsored project what happens is the industry pays a large sum of money to the institute so that the professor and the student is part of the team. Ok. So, here, then only it will be called as a real case study, otherwise the case studies are not real. Ok, so that was done.

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Real case studies with industry

- The live case studies helped in addressing the complexities and operational issues related with innovative product idea generation process.

And then these were live case studies which addressed the complexities and operational issues related with innovative product idea generation, because what happens if you are doing a fictitious classroom project, it is called a mock project, you will not get the complexities as clear as you do in a real project. So when you talk about a real project, the most important aspect of the project is that you will get an industry partner, which is the toughest stage. And most of the industry partners who are ready to come to satisfy their current small issues.

They will not come to work on an innovative next generation product using new technology and new materials or new design. They will just say, you know, redesign my product. So we have to find the right partner to do this project. We have to form teams, both in the industry and academia, that is, for example, I have a student, the guide was me and some of the colleagues from other departments who were part of the teaming process.

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Methodology

- Identifying the industry partner and product requirement
- Formation of teams
- Situation analysis & Product brief

Then, where to come up with the product brief then the team would develop ideas and then build it into concepts.

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Methodology

- Concept generation
  - Development of concepts
  - Selection of three concepts
  - Refinement of concepts

The concepts will come up with multiple three concepts. Then these would be refined.

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Methodology

- Final concept: Selection of the final concept collaboratively after assessing the strengths and weaknesses from the point of view of product brief.

And finally the final concept would again go into the network group to see whether innovation can happen or not. So this is the total, you know, methodology be followed for the research. In research it is very critical to have very strict sort of methods because each case study has to follow the same method so that we can actually get them into a particular framework to come up with the model. Then this model will be very effective for everybody.

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Hero cycle case study

So, here we come up with these life case studies. The first case study was the design of a bicycle, next generation bicycle for Hero Cycles. Hero Cycles is the largest manufacturing, you know, bicycle manufacturing company in the country and, you know, we were very lucky that they agreed to partner with us in this journey. Then the next project was a dual chambered bottle for a beverage

company. This company wanted the bottle to be manufactured which has dual chambers. He wanted to supply masala milk and the masala liquid should be mixed just before drinking the milk. If it was mixed before, the aroma, the taste, will all get ruined.

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Dual chamber bottle case study

So that is called a dual chamber bottle. The top chamber will have the masala content and the bottom chamber of the milk so it can mix, and it can be used for various other Indian beverages. So he wanted the bottle design for that purpose.

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Petrol pump design case study

The third product was the petrol pump design. Before I joined IIT Delhi as a Professor, I worked on petrol pumps and the competitor came rushing to us and said we would like to work with you.

So this was a very easy client for us because he knew that we would work on innovation and this was a company called Midco which wanted to, you know, sort of wanted come with an innovative product.

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Hero motorcycle design case study

And the fourth one was from Hero Motors. Hero Motors was manufacturing a moped called Hero Pook and they wanted to sell it urgently in the market and they said we want to really work on the form innovation as well as user convenience innovation for this vehicle.

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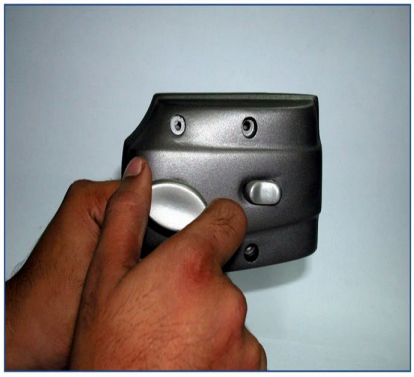
Godrej lock case study



And the last project was from the Godrej locks division in Bombay. They say that we have a lock product which we like to do, you know, redesign at 50% of the cost.

So, each one had a challenge. So from these challenges we started our project. So why did we went ahead with our, you know, real case studies? We had a student who would work on the project earlier like, you know, we discussed this helmet case study.

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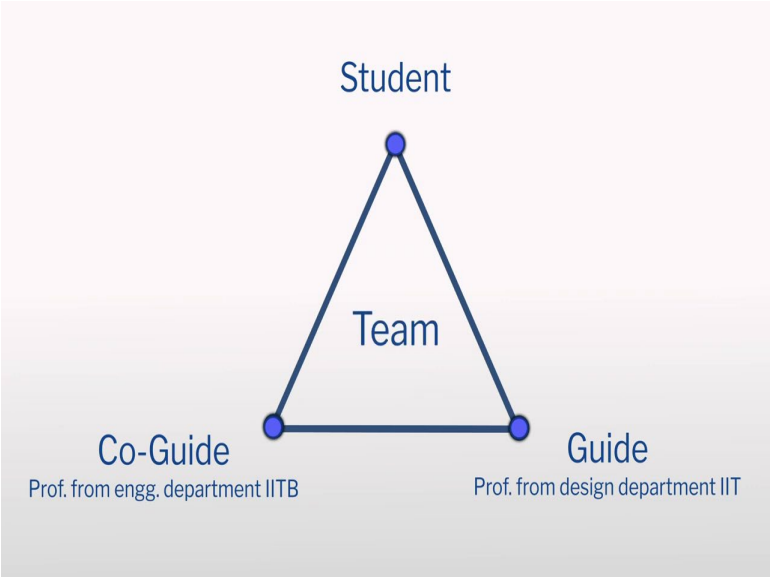

The student is the full team member, we call him as the person who is fully responsible. We had the guide, who was me, who was from design school and we had an engineering professor from another department who would be his co-guide and that was called the team at IIT. Then, we built a team which is at the company level, where the company would then give their person for marketing, one person from manufacturing, one person from supply chain and one person from finance.

That way we have 4-5 people from the Hero Cycles company and in this case, remember I was telling you, all these case studies have to have a particular framework. And what is the framework we used?

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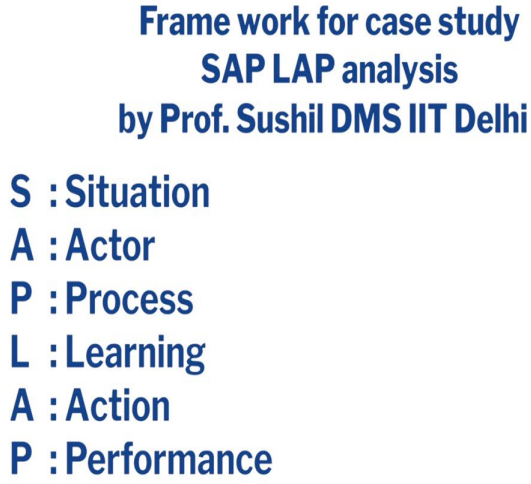

The framework was called Situation, Actor and Process: SAP. Learning, Action and Performance: (LAP). This is a SAPLAP and this was actually done by my professor who was my guide. My professor who guided me in my PhD is Professor *Sushil*. He was from the school of management in IIT Delhi. So he was my guide and he came up with this framework to assess case studies. You do a case study, you apply this framework and analyse, and you will come up with learning so that you can act on the learning. After acting on the learning, you can have your performance, you can make things happen.

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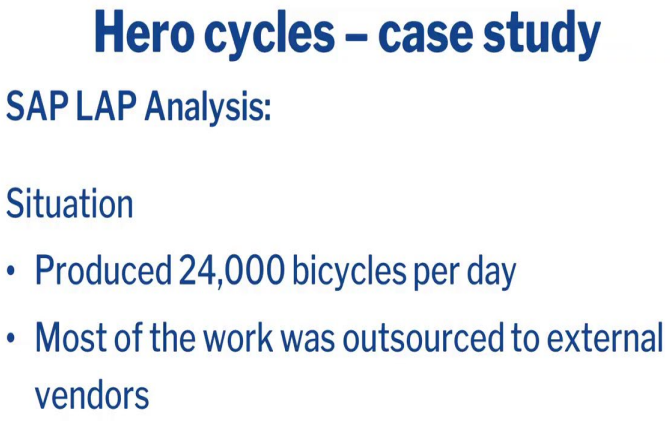

In fact we were lucky. We were at the gates of Hero Cycles and my god, it was like a highway because they were manufacturing 24,000 bicycles a day. That is a huge quantity. Every truck used

to move around 200 bicycles. So if you manufacture so many, how trucks have to move on a particular day. And then on the top of it, if you are a manufacturer of so many bicycles, the parts have to come from all over *Ludhiana*, right?

Hero Cycles was in *Ludhiana*. So it has to come from various locations so all these people, vendors would start supplying the materials in their trucks. So the main gate of the company was like a huge, sort of, gateway of trucks going in and trucks going out. That type of volume they were manufacturing.

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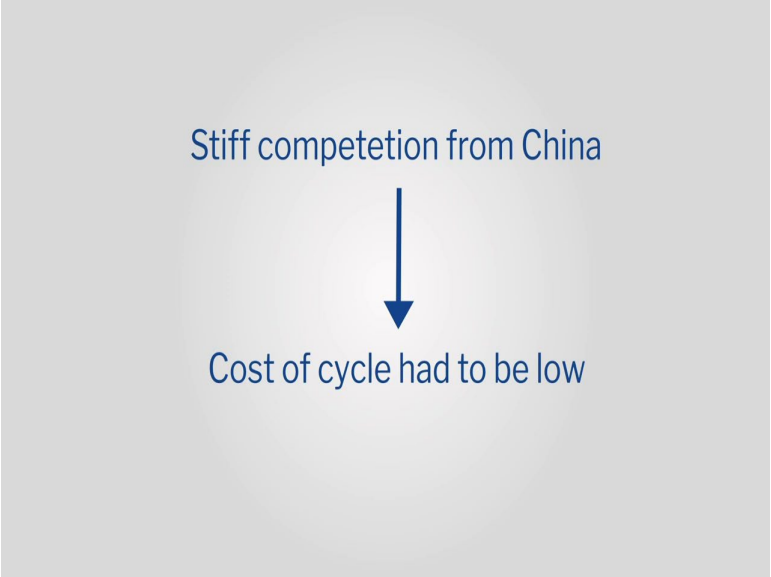

And they were having this stiff competition from China. China was supplying bicycles in India at half the price of Hero Cycle. And Hero Cycles was threatened, they said that if they (China) started supplying in large quantities like, you know, what will happen to our business? So, they were really concerned and that was the assignment they gave us, that you design with your innovation. We want a low cost bicycle. You come up with innovative materials, you do whatever but our cost of the bicycle should be low.

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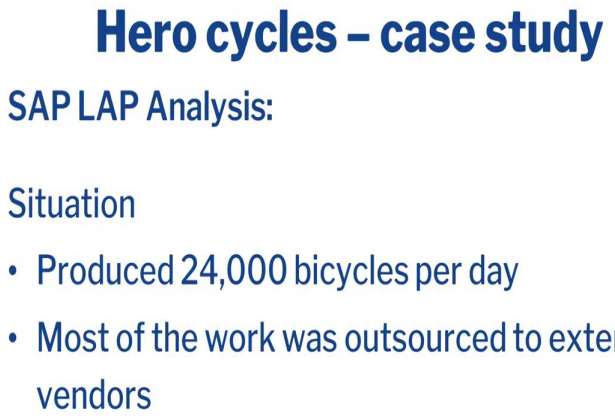

So here we are. Then you have to understand the situation, what all Hero Cycles is doing. They outsource a lot of pipe manufacturing, component manufacturing outside.

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They assemble the bike in the factory. Not capable of producing high quality products that is very interesting. This information was also given by the CEO.

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You know, when you weld a frame what happens? When you weld something what happens? When you weld pipes together, the stresses develop in the pipes, right? And your pipes are never in one line. So your front wheel and your back wheel in all our cycles are never true. If they are highly true, they will be the best cycles. You will have a very little load to bicycle. There will be phenomenal. You will see the difference drastically.

So, here the biggest challenge was getting the pipes in one line and getting your front wheel and the back wheel in one plane in exactly one line. That is the most important test for a bicycles accuracy and cost.

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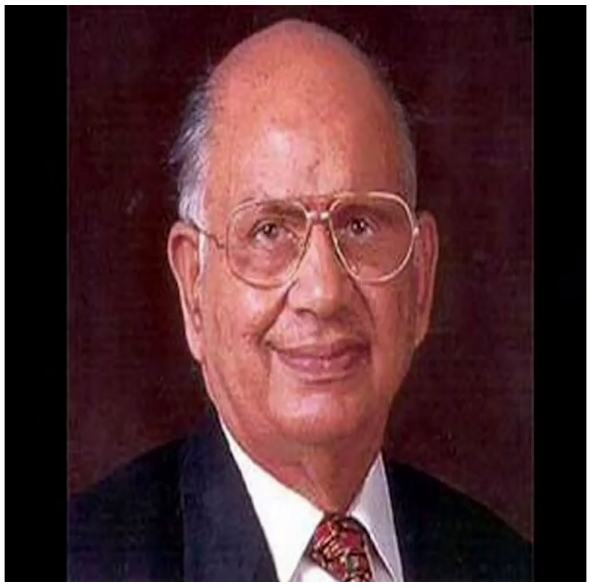

And we were very lucky, *(Brijmohan Lall) Munjal*, he was a senior guy who was around 75 to 80 years at that time. He came and gave us this very interesting one line brief saying that we need to innovate. We need to come with bicycle which can beat the Chinese competition, but also have a form factor, which is different from the current cycle. So very, you know, we were very inspired by him because at that age he could give that type of phenomenal direction to the project whereas all other people from marketing and all were talking about their current problems and looking at that.

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Here the Actors are the student, guide and the co-guide, I told you. The co-guide is from another discipline. For example if I am doing bicycle design, I will take a co-guide from applied mechanics. The professor from applied mechanics was our co-guide in the project. So we were 3 people team. Then the second team was from the company. The CEO, the top management support was very critical. So here we have the CEO coming in very, very closely. Head of design DGM-Marketing and Head of Export Division. This was chosen by them. Hero Cycle also exports a lot of bicycles all over the world.

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Hero cycles – case study

SAP LAP Analysis:

Actors

- Third team: Head of design at Maruti Udyog, Caparo-vendors and experts in deep drawing, Independent sheet metal consultants and two professors from IIT-D, expert in deep drawing and material

And of course the third team were, this third team was built after we started the project and this team included out-of-the-box vendors like Maruti Udyog who were designing products as a vendor to the car company, we had Caparo Vendors who were experts in deep drawing, we had some street metal consultants who came from outside and they were experts in deep drawing, professors from IIT.

So this is a new team, which was built up after we understood that we cannot handle this project without some more additional information coming in. So that was the third team which came up. So we did the data collection. We found out what all was happening and then we came up with a lot of ideas which were important for us to see whether we can merge all this cycle idea. And cycles have been, you know, very very phenomenal in their simplicity and use. So, what type of ideas can we come up was the biggest challenge.

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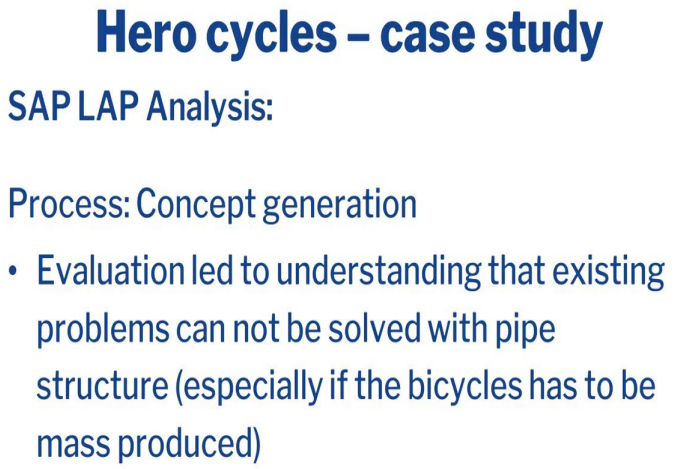

So, we want to solve the pipe structure problems, the pipes were the biggest problem because the welding was getting stuck, all of you know the bicycles.

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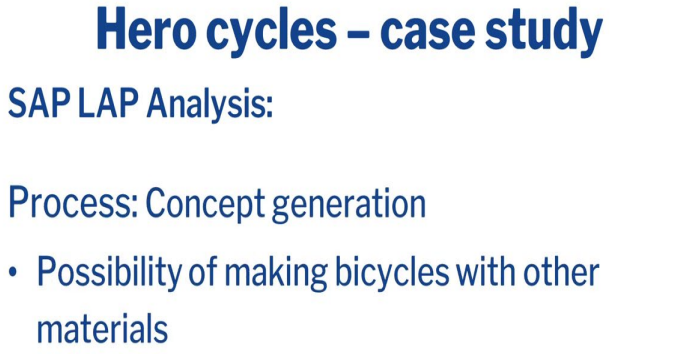

The welding was not proper. The weldings were taking a lot of time. Then we also looked at the possibility of use of other materials.

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How many of you have ridden aluminium bicycles? Aluminium alloy bicycles? Very good. They are very light right? What happens when the cycle is light? It moves faster with lesser effort right? But the aluminium alloy is so expensive that the cycle generally costs 3 times the regular cycles. 3-4 times the regular bicycles, because aluminium is difficult to weld, and the alloying, you know, is a special process.

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Hero cycles – case study

SAP LAP Analysis:

Process: Concept generation

- Use of deep drawn sheet metal for the purpose of manufacturing

The biggest breakthrough came when we did the idea generation for a deep drawn bicycle.

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How they were manufacturing cars? They are manufacturing cars by sheet metal draw, right? The car body is drawn by large presses. You may have seen it on videos. So, when the large press is pressed you get the whole part in one go. So, can we manufacture bicycles rather than pipe welding, you manufacture by the deep drawn process.

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Hero cycles – case study

SAP LAP Analysis:

Process: Concept generation

- Sheet metal does not have enough strength to hold the structure like the pipe structure
- With the help of external experts it was established that sheet can be strengthened by providing ribs and special profile

That is a very big insight and we will show you how that insight went forward.

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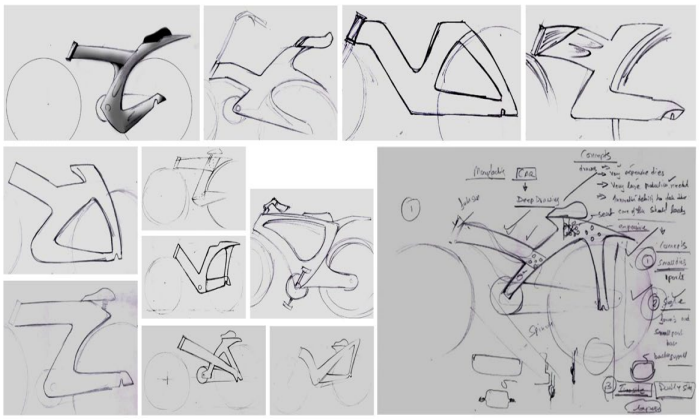

So a lot of ideas came up with, you know, aluminium. Dye cast materials.

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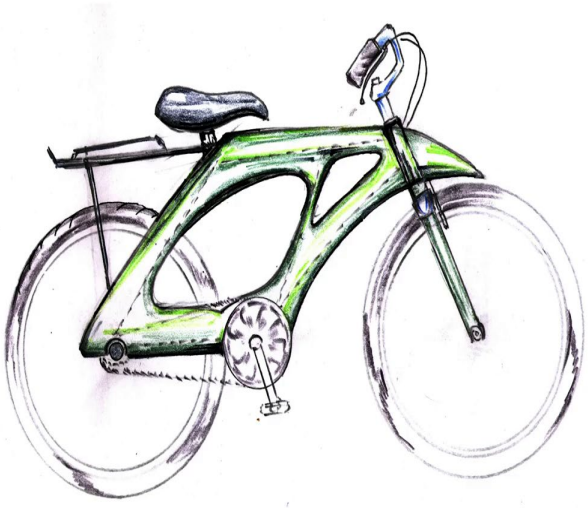

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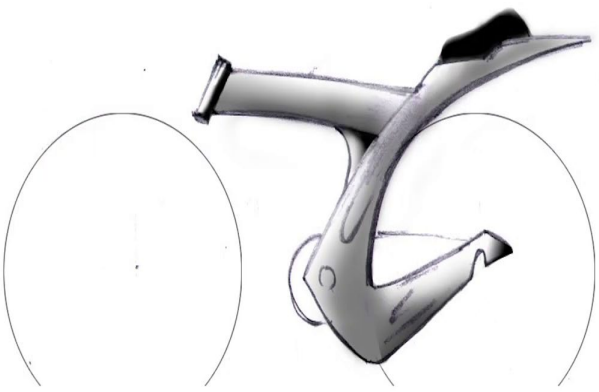

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Aluminium pipe structures, mild steel structures.

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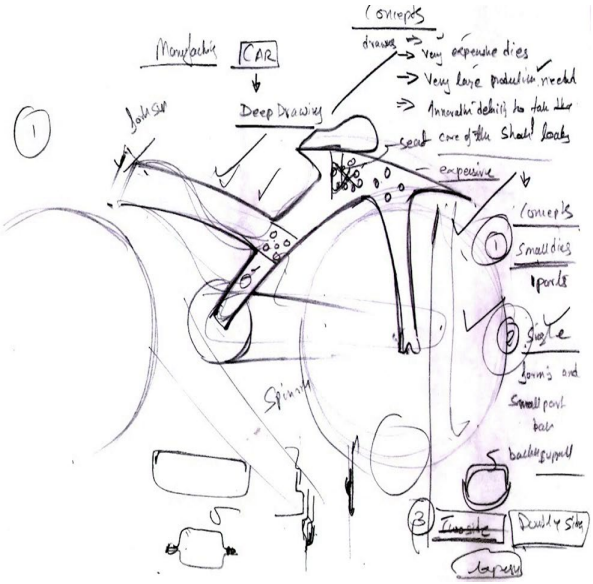

Riveting the structures together rather than welding because that was taking a lot of effort.

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Focus cluster of concepts

And here finally you come up with your focus cluster. Here you have, you know, three focus clusters with three different types of materials here.

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This first concept is a sheet metal drawn bicycle. Isn't it interesting, as soon as it becomes sheet metal, what's happening to the handlebar, it has become very long, because in sheet metal if you gotta get the same stiffness your length of the fork, will have to increase otherwise it will start wobbling. So this is a very interesting characteristic of a sheet metal and all this is drawn at one go in a press.

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So, you get a one single frame bicycle. And this single frame bicycle you can have special alloys to make it very light weight.

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Here for example, you have box pipe frames made up of aluminium. Aluminium box frames are so light weight and cost-effective in welding. Easy to weld. So this is one box frame welding. And here it was again mild steel structural welding which was again being used over here.

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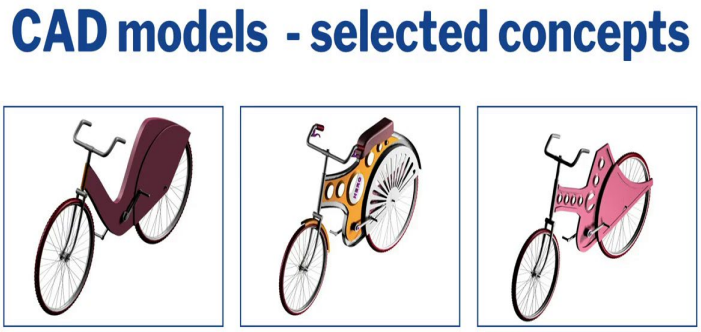

And the sheet metal concept was selected as the best concept, because the advantage of using sheet drawn concept was that it would become very very cost effective. The prices will straight away drop by 75%. Because what happens in a pipe bicycle is pipes are actually sheets originally.

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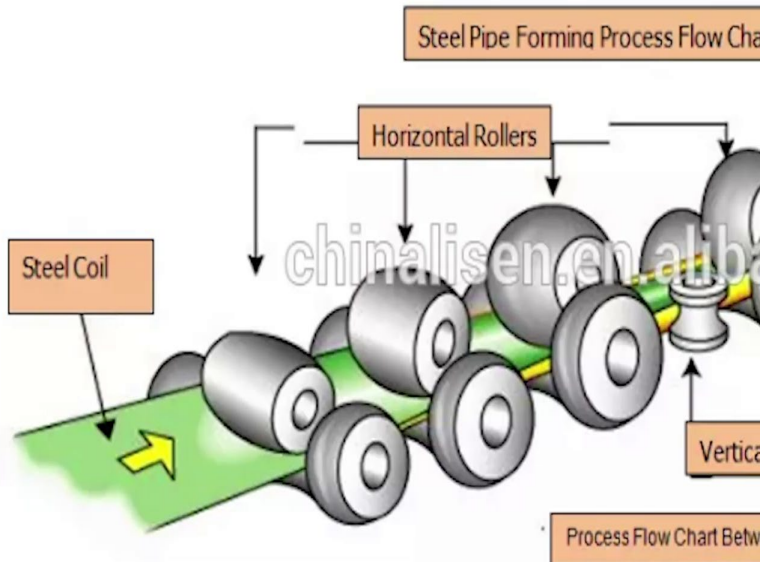

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They cut the sheets, and they are rolled into pipes and that is how pipes are manufactured. Pipes are not extruded. Cast iron pipes are extruded. Most of the pipes are sort of rolled and welded. So just imagine if I directly take the sheet and use it, my cost will be very low and because of the manufacturing process of deep drawn it is a very very fast process.

You get, you get no welding, no cutting. So it will become very, very cost effective. You can see how the whole frame has been built in one go. And then, further development happens.

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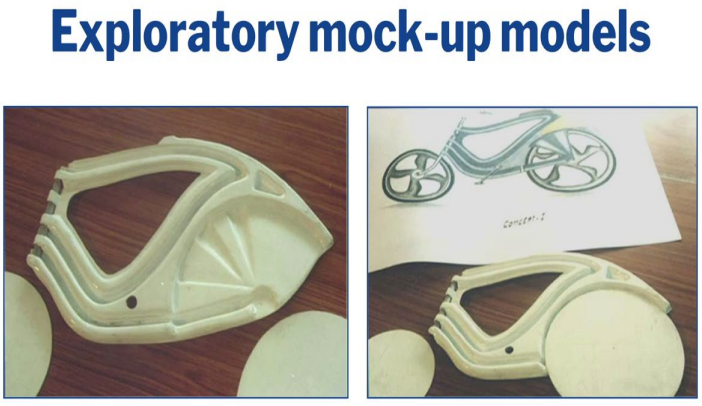

And then in the same process, we have something called the mockup model, remember I always talk about mockup models here.

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So you build mockup models of this to understand how they design would work.

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Full scale mock-up model

And from these mockup models we built one full scale mockup, non-working mockup because, you know, you need special steels to make a prototype.

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Full scale mock-up model

And it was very difficult to procure the sheets at that time and you needed tooling which will become very, very expensive to do. So this became the option for us to show to the company. And of course, the company was very thrilled to see this product because the cost was actually finally 75% of the current cost of material. Whatever material they were using. But the biggest challenge here was the tool cost was very high. So they have to invest around 50 lakhs in tooling produce this bicycle which will be 25% cheaper.

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Hero cycles – case study

SAP LAP Analysis:

Finalization of concept

- Interaction of the first team with the team of experts was iterative in nature
- In the concept detailing stage one concept was preferred over others

So, what did we learn from this journey was that interaction with the first team, with the team of experts was iterative in nature. So, this interaction with the experts who were doing the sheet metal drawing and all became very iterative and the concept development happened with experts from

the manufacturing sector in sheet metal. The concept detailing stage 1 concept was preferred over the other. In all the concepts why the other concepts were not chosen because of the focus. The main reason for our journey was that we needed to start with the low cost aspect whereas all other concepts were not low cost so we chose the concept which would result in low cost production. So that was the reason.

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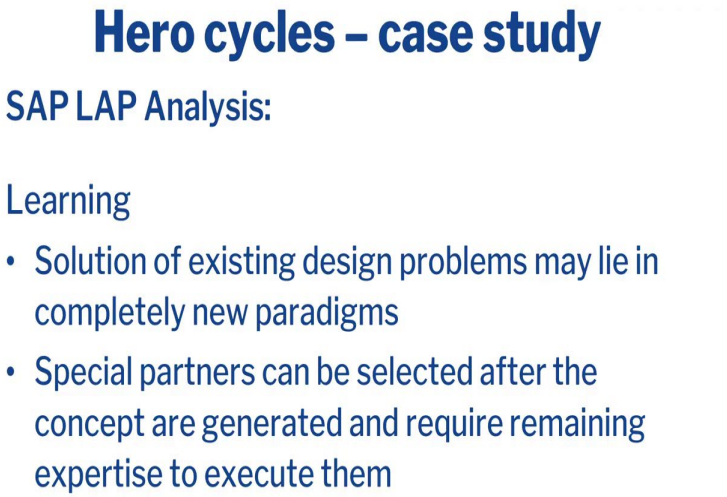

And the main learning was, solutions to existing design problems will lie completely in new paradigms. What is the new paradigm? Car manufacturing. A car paradigm of deep drawing and cars are cheap only because of deep drawing and because of the large manufacturing base, which they have. And special partners that can be selected. What is the learning for us, for the collaborative team? You have to select special partners, like the people who are experts in deep drawing, the people who are professors, experts in alloying of sheets.

So I need to produce, I would have to go to Tata Steel and request them to produce the special grade of steel which can be deep drawn and which will be stiff, because your bicycle cannot wobble right, the sheet has to be stiff, right?

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Of course the form factor is there, we made the form which is the rib, so that it would be stiff but the materials also have other properties. So that was the major, you know, the learning in this case study that you need to really bring experts into the field during the design process.

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So here, this is a dual chambered bottle. The same journey. A lot of ideas were built.

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After a lot of ideas were built and each Idea was taken from a creative analogy. So the first idea was, if my opening is like the shutter of a camera. There is an opening and closing, right? So if you take inspiration from the shutter, the dual chamber, for example, the top masala can get mixed with milk by moving the shutter, right? So I have taken the analogy from a camera to design my dual chamber bottle. So, here you have the shutter in this and you move this lever and the shutter opens and only when you want to drink the masala milk you're mixing masala with the milk.

So here we have this, second idea, was taken from these dispensers, the tubes for ointments, where there is a layer of silver foil and you press with the end of your cap, the ointments. You reverse the cap and you press and punch a holes. **(Refer Slide Time: 17:23)**

This was like a puncturing like mechanism, you have a foil here and you have a button. So this content will get in by puncturing the foil. So this is a puncturing mechanism, which cannot be reused of course.

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And the third option was inspired by traditional soda bottles with the ball. So this soda bottle you press the ball out of its location, it goes and settles somewhere else and the channel becomes open for you to drink.

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So here, for example, you move this ball and automatically a channel opens, because the ball is elliptical and then the channel opens, the top masala will, liquid will mix with the bottom. This

was a live project. The beverage company was on our back. He wanted a patent for this. When you want a patent for such a product. You would, you have to go and look at your patent thing. We found 500 patents for a dual chambered bottle and my student went, you know, haywire, he said, 'Sir, how can I make one more which is good.

But that was the beauty is here. For example, we found out that the need was very critical here. The client said that this particular bottle should not be more than 10% more expensive than a regular beverage bottle like a pet bottle which is used for Coca-Cola or Thumbs Up. If those bottles are costing you 10 Rupees this should be equal to 12 rupees, not more than that.

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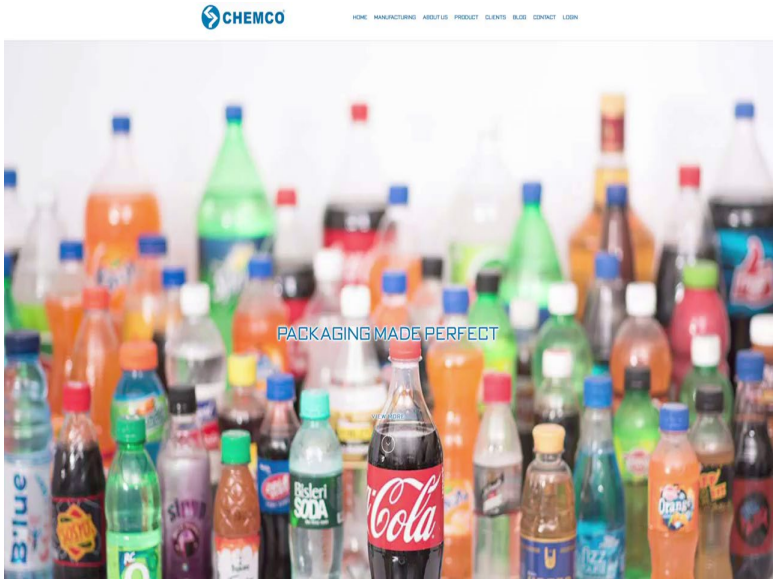

And when you went to the web to see how many patents were there, all those bottles were for different, different purposes. They did not have that type of, you know, cost aspects. As soon as it came in, the pet bottle, we talked to the pet manufacturers straight away. And he said, he told us that we are coming up with a new material which is 10% cheaper than the current material. So you design with a new material you will be able to come down to your cost by 10% and then you come with your other designs which can work.

So those bottles you put them together and finally the whole team decided that they would like to go ahead with the shutter one, because that is more simple and more easy to operate and more cost-effective.

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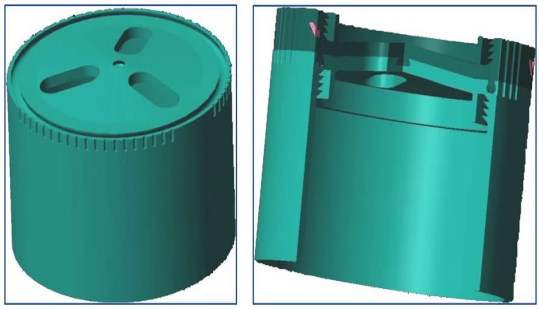
CAD models for details



And then the actual work started off of detailing. So here how will the shutter work?

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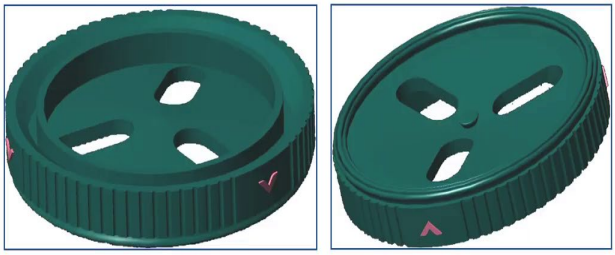
CAD models for details



Here you have this, you know, a very interesting slope given. Without the slope what happens is your sealing is not perfect. So you have the shutter, when this turns in these locations, it is closed and when these two match it opens, a very simple mechanism. But the biggest challenge here you should be leak proof. That is the big challenge. Where do we get the inspiration for leak proof you tell me? Have you seen these leak proof taps, stainless steel taps with the rod.

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What happens in them? It is just a taper, right? And in that they put a brass receptacle. It goes, because of the taper, it goes and locks. There is no rubber there. So, we took that inspiration from that design and we used this taper over here. So this is no longer flat. This is tapered like this, so when you lock with the taper, you get a very good waterproof design. so these got designed. And then finally it goes, you know, implemented in the bottle and the bottle, you know, was actually just 15%. It was not 10 of course, 15% more expensive than the current bottle.

Because, this piece of the plastic is what is extremely low cost. So the bottle had the turn in the middle. So you hold the bottle, turn the whole ring, the ring on the top, this ring and top content will get mixed with the bottom content. And the dual chambered bottle was ready. So, the client was wanted to get a patent, so we got it patented and after that we really do not know what has happened with the product. We are hoping that he has manufactured it.