Design, Technology and Innovation
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Lecture-1
Jaipur Foot - A classic innovation Part 1

So, good afternoon all of you and welcome to the course design, technology and innovation. This course is a combination of three large sorts of areas, not even disciplines where we need to see you know how we can come up with innovation using design and technology that is our major focus.

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So, for today's class we will consider the Jaipur foot as our case study. Important aspect of the Jaipur foot is that it is prosthesis. The prosthesis are different from ones which are put inside the body.

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These are which are artificially they're supporting the body from external aspects when there is an amputation or in some deformity in the legs or in the hands.

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So, this Jaipur foot is an extremely unique design and according to me one of the best innovation examples in the country.

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This was started very interesting collaboration between a craftsman called Ram C Sharma who was you know basically building polio calipers for children and he observed a bicycle on the road and said why can't I make a foot as strong as the bicycle tyre from these.

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So, he started building wooden mock-ups because he is already working in the SMS medical college in Jaipur.

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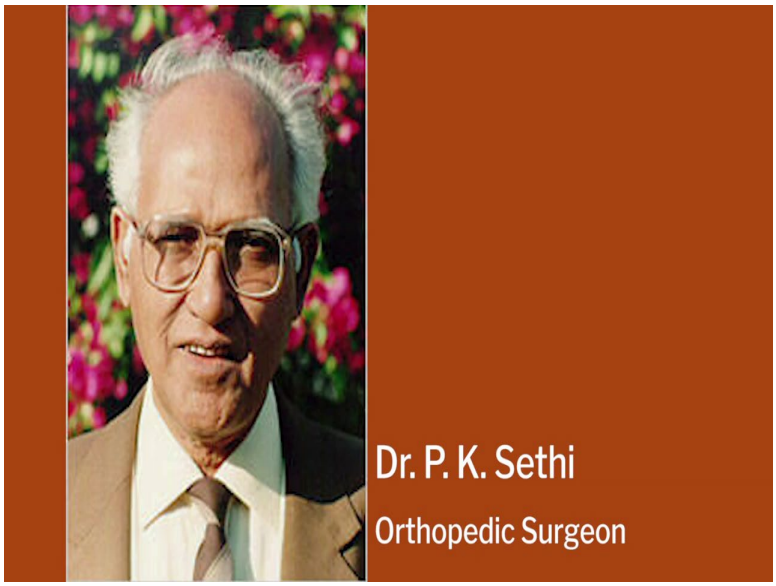

He had this orthopedic surgeon Dr. P K Sethi, so he would go to the doctor and say I am working on this.

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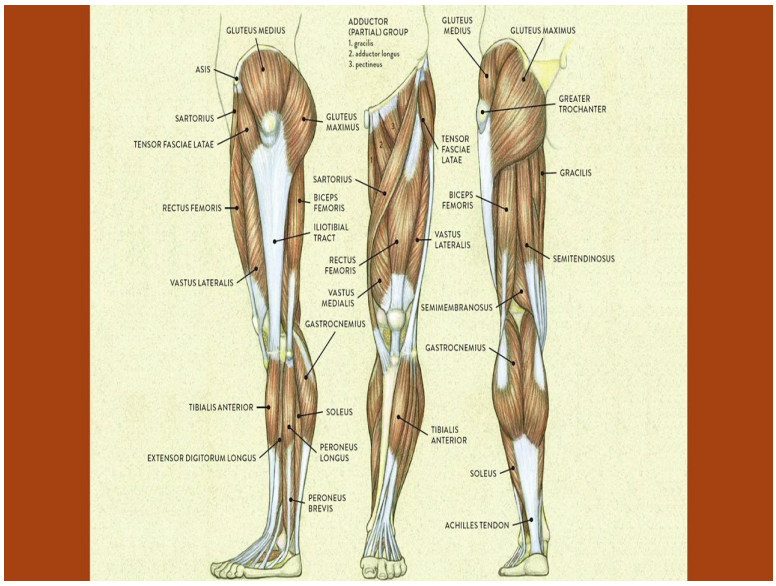

So, the doctor would give him all the anatomical details: what type of system should be done, what type of gait the leg would have.

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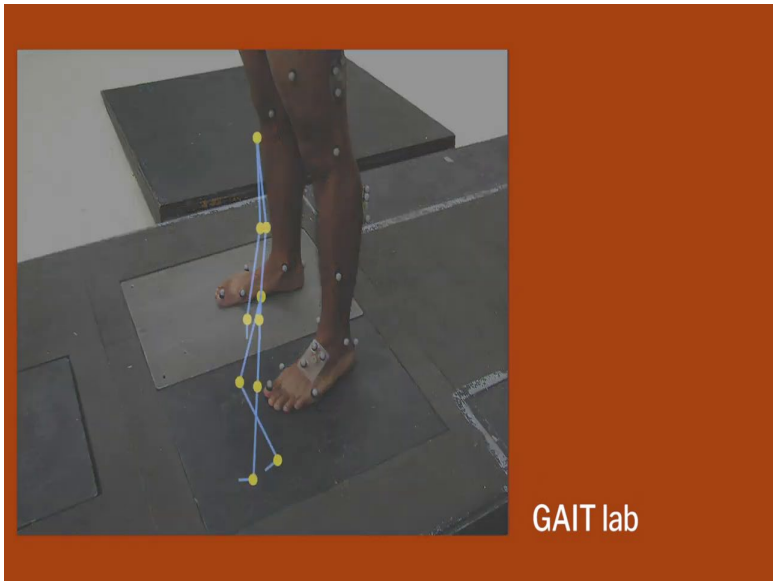

So all those details he would provide.

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And both of them together built multiple samples so there is an initial node development which happened. So, basically the Jaipur foot will have three major components.

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The prosthetic foot is the most critical one in this design.

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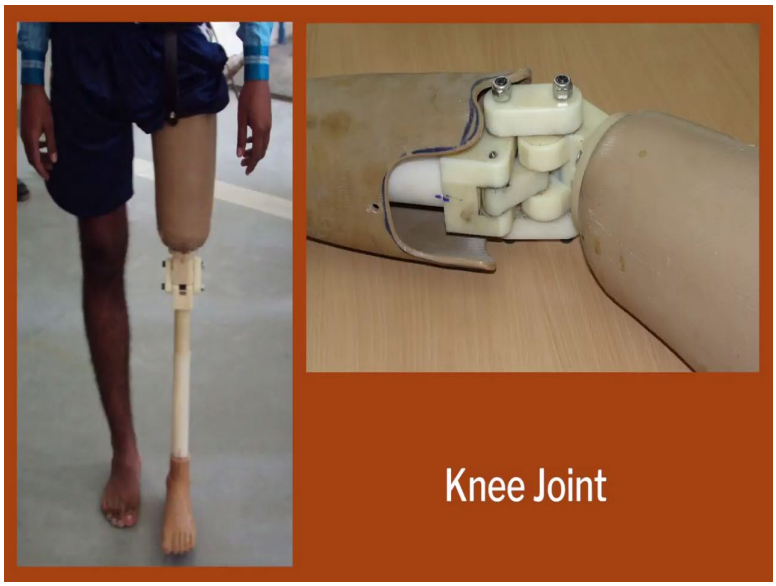

The knee joint if it does not you know upward amputation the above-the-knee amputation you will have a knee joint.

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And a socket and shank to fit the thigh areas;

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So, below the knee prosthesis, you will just have the foot and the shank which will fit into the leg. In 1969 they started, but it was not going forward. They were doing some 10 or 20 prosthesis for various you know patients who would lose their limbs and it didn't you know really scale up.

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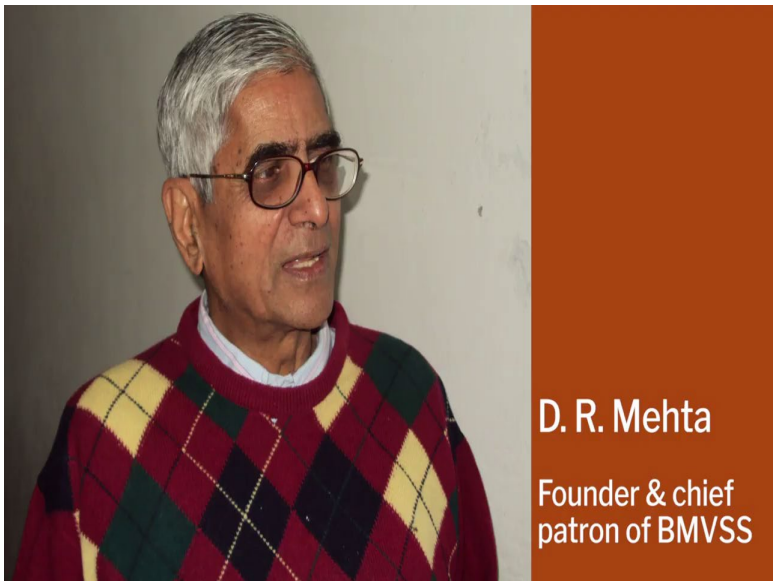

So, the scaling up was done by Dr Mehta who was an IAS officer who took special interests in the Jaipur foot.

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And he has to, he had to pick it up from the hospital and make it into a society and he said 'I am going to provide this Jaipur foot free of cost and the quality will be phenomenally good', and then since then you know with this has been a revolution. So, interesting situation is that the doctor and the craftsmen team kept the Jaipur foot at a very low volume level, not because the Jaipur foot did not have the potential, just because of the human tendency of not understanding how you can scale up whereas an IAS you know, an Indian Administrative Service, you know retired professional would actually talk about scaling right, talk about reaching more number of people. So his whole

strategy was how can I make this reach across the world you know across the country to all the you know people who were handicapped.

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We have the dancer from you know Andhra there was a movie called *Nache Mayuri* and she actually danced in a program and there was a large movie and that made it very popular. Everybody got to know about it and you know a lot of people started coming to Jaipur to get the foot. So, that is how the whole journey started and our interest in the product came up.

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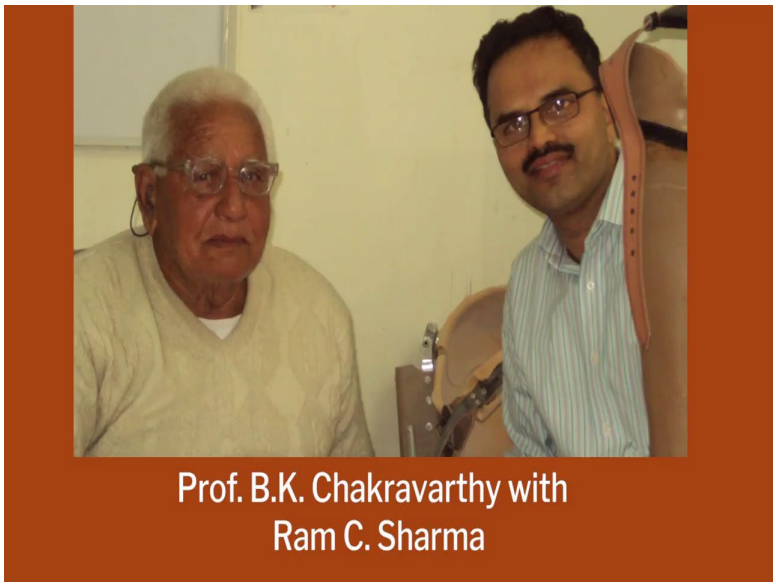

And I visited the place; I got a phenomenal insight on how this Jaipur foot was helping the poorest of the poor in the country.

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The people who get amputated generally are farm laborers, truck drivers, salt pan workers.

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Tell me why would a salt pan worker have an amputation.

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Salt panning, making salt, infection from any cuts or wounds in his leg while being on the sand. So, that infection can cause gangrene and then they would need to amputate the leg. Lot of people are like that. So you know that is a very good case for us to consider salt pan workers where else you see you know standard cases of amputation.

Student: Heavy machinery.

Sir: Heavy machinery, very good, heavy machine generally, you have amputated arms, legs in heavy machinery little, little less but it is there. And truck driving and you know accidents are more common you know for the leg amputation.

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So, here you can see the person walks in. He gets the prosthesis.

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And he goes back the same day walking.

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Unbelievable;

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All this is done because of the association: The Bhagwan Mahaveer Viklang Sahayata Samiti.

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So, the vision of BMVSS you know is that, you know, they want to actually give both the physical, economical and social rehabilitation. The whole organization which build that type of system because the people who come, is very important, the people who come are extremely poor, in fact, most of them who come do not even have their breakfast. So, when they come they give them food. For the everlasting credit of D R Mehta, that IAS officer he said 'Chakravarthy did you observe that these people who come do not have one disability. They have three disabilities'.

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One is amputation. The second is they are extremely poor, because why they got amputated I believe, they were out of work for six to seven months while they were recuperating with the operation or with the leg and they would their, all their finances would have dwindled and then the

third disability is that they were illiterate. They only had a skill. The large number of people who would come 90%, 95% of them.

So, I need to tailor make the design to suit the design of the complete system to see those type of people. If I identified only one disability as handicaped then I would do anything in the world. Let me give a small example over here.

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We had Abdul Kalam who was the very senior scientist at the defense metallurgical Research Laboratory much much earlier.

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He went to the Jaipur Center, Jaipur foot center and he said my god this Jaipur foot is very heavy because I am coming from the context of metallurgy and fiber reinforced plastics and polymers and all those things.

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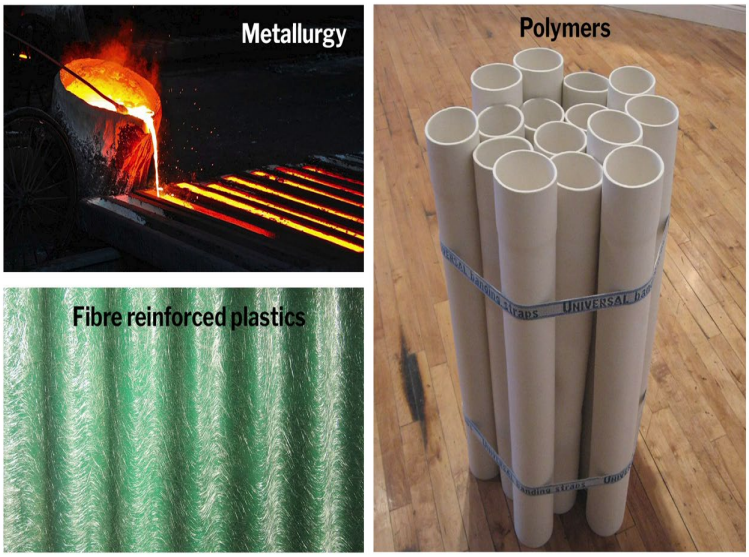

So, he said 'I have all these technologies in Defense Metallurgical Research Laboratory (DMRL), why can't I use it for the benefit of the people?' Very noble thought, ok? So the project was given to DMRL.

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So DMRL came up with this fabulous carbon-fiber shank to be mass manufactured in the factory, then made the foot design, the best possible rubber and that's it. And it is in the showcase of DMRL

even after 25 years now. I'll tell you what happens there. It is very interesting that it is not just technology or research or value proposition, it is about the combined effect of the situation for which the product is being made.

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Every small component in the product from the cost, from the customization, from the delivery, from the mechanism, from the deployment, everything is very important. Just imagine that prosthesis was costing thirty thousand rupees and the Jaipur prosthesis was just two thousand rupees. D R Mehta would said 'I would actually fit with two thousand, I will rather fit fifteen people rather give one to one high-end prosthesis to one guy. So, I will save fifteen lives rather than saving one life'.

So, he didn't pick up the technology. So, this is the interesting study where I am trying to say that you should not come from your perspective for any of these types of very interesting studies of innovation. You need to very, be very focused from the perspective of the end-user. Whom are you know working for? So, that is the issue about, the social rehabilitation for the disabled.

So let me show you a video on how the thing is manufactured. You all observe it closely of how the whole aspect of the you know aspect of the details I told you about customization, about finishing it off one day, type of manufacturing, what all is happening you know I like to run this video for you. So, this is the centre in Jaipur.

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They come in. They are sort of, they are taken in one by one. Everybody comes in you know to take their cards and a very simple process of using a plaster cast to get the exact mapping of the stump. Then you make a knee cast out of the female thing and you have the stump which is your exact replica of your lower knee prosthesis. And then you use, you know, the process of plastic forming and he is now adding the leg part to it so you add the PVC to fill plaster in that, so they get the complete leg part.

So these are those high-end or you know of no polyethylene pipes which are heated. When you heat plastic, thermoplastic, to a temperature they become malleable, they become moldable. So you know get the size into shape and then you come down to the bottom parts where single single plastic, you know, small small parts, various, you know, fingers are put together bound by rubber and then you know put into the dye and then pushed into the vulcanizing machine which is the oven.

And here you have you know after the vulcanizing you have your foot piece ready. So, once the foot piece is ready so you got the whole pipe ready and then it is fitted onto a human body and then you know the person then goes home with the leg. So, this whole process happens in a day because the BMVSS has done all the planning of keeping all the parts ready, manpower ready, who know how to, you know handle these types of large numbers of people and take the thing you know forward. So, there are a lot of things happening, a lot of tests happened, the whole world stood up to this innovation thinking that there is something great about this part because this leg, the prosthesis was better than the imported prosthesis in multiple ways.
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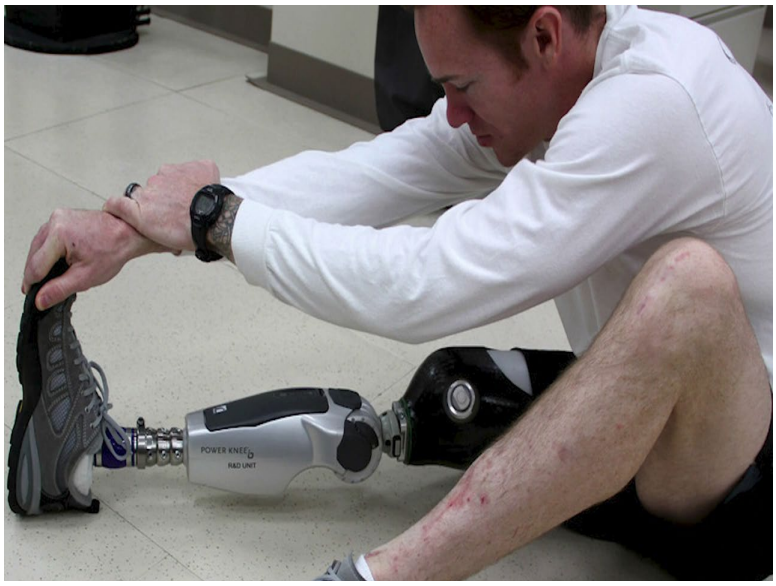

Tell me one thing if this prosthesis was costing two thousand (rupees) and it is better than the prosthesis from Germany's Ottobock or the American prosthesis, what do you think is the reason?

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Any guess?

Student: Sir, one is that it looks like a human foot.

Sir: Very good, one sure short thing is it's exactly the human foot, but that doesn't give you that type of advantage.

Student: It's cheaper so more people can easily get it.

Sir: More people can get it. That is also a very very good point.

Student: It's customized for the person.

Sir: Very good. Hit on the nail. The top mark is for customization, what happens in the International prosthesis they make sizes: Small, Medium, Large, XL.

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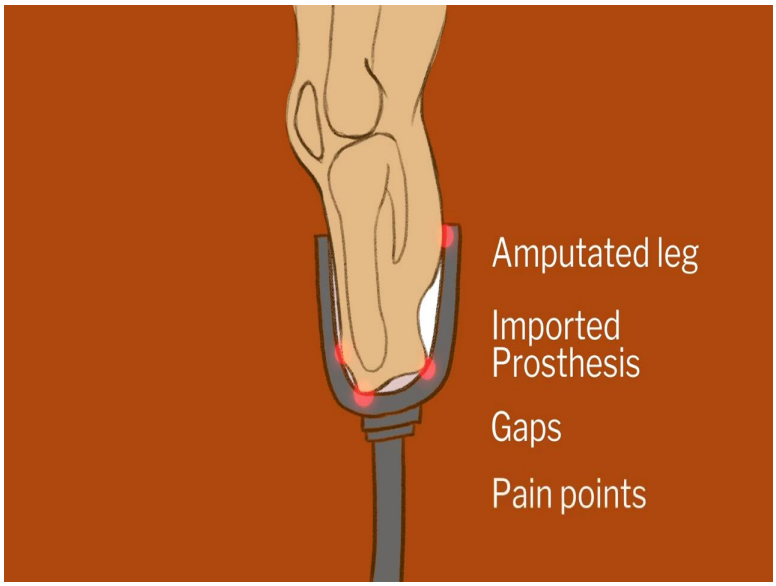

And whatever sizes you make when you put on your stump it will be loose. It will never fit exactly to the size of your stump. So, what happens. This is a prosthesis. Walking, so much of movement, so the scaling happens on your stump, you get sores on your stump. With that problem, get further component they stop using the thing. And if you get a swollen stump you cannot use your prosthesis it is extremely critical.

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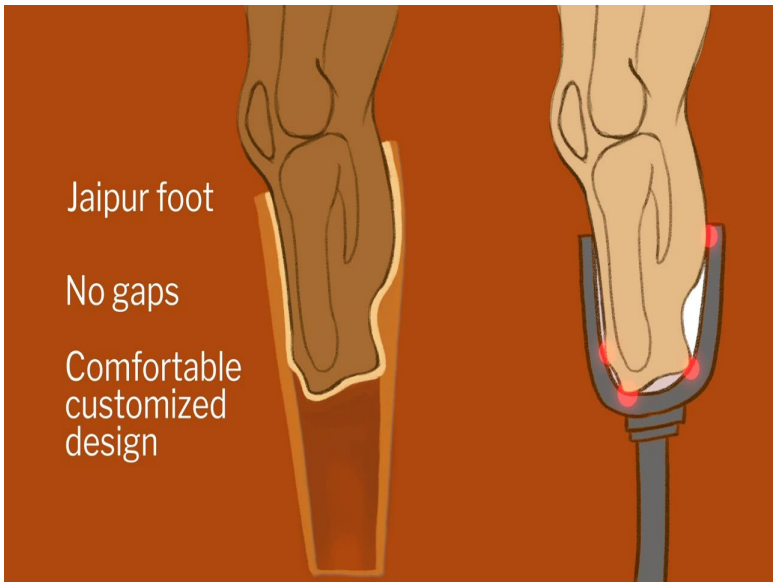

So, look at the beauty of the design. This design with the limitation and the hard work of bringing all the people together, rather than sending the prosthesis to various locations you bring the people in, right? It's completely reverse of an international, you know, supply chain activity. So, by doing that you are getting something which is highly valuable for a product like a prosthesis.

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If I trade off, I would trade off mass production to customization, got it?

Student: Sir, so you said it was custom made, so is there any part that is pre-made, the part that is not attached to the stomp?

Sir: Very good question. It is customized but the customized part only is the stump, stump. Whereas the foot parts are all readily available. Whereas the pipes are formed as per the heights of the people. So, only the customization part is the; is it pipe assembly. The formed you know stump assembly, okay?

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So today, you know, it's the most widely used prosthesis, people run, people play. In performance it is more closer to the natural foot.

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Because here when you do a standard prosthesis you cannot bend your leg. The amount of bending you can do in this leg. Okay?

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So, here we have customized fitting of the leg, better than the imported prosthesis, the biggest advantage comes that you can work in your salt pan lake, because it is completely sealed. Look at the bottom it is rubberized silicone rubber so you go in a salt pan lake nothing happens to it. The top is highly chemical resistant, polyethylene pipe so that is also you know very, very good for your use.

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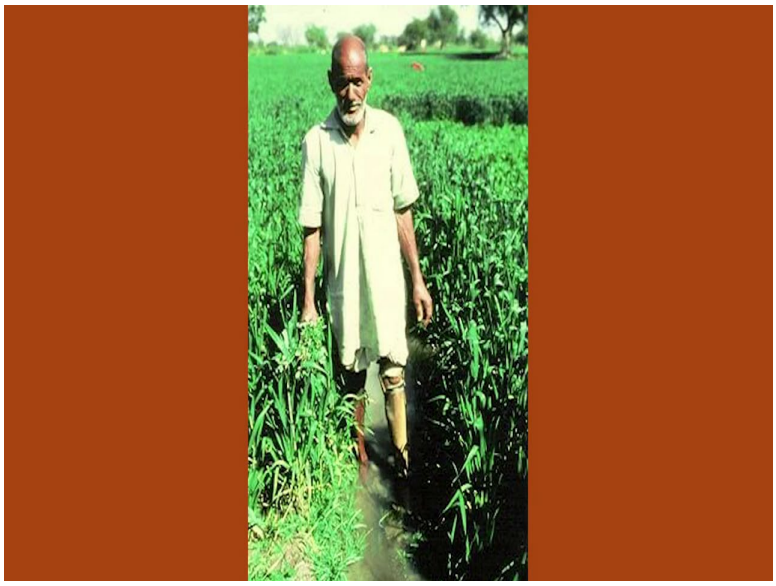

And then, you know, people can work in agricultural fields, paddy fields and there is no issue at all. And the best part is that you know you can go barefoot. So, it culturally matches our requirements of sitting on the floor, going to temples, you know and multiple aspects, which made the costs go down drastically.

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And the production happened at large scale.

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Tell me when it is nonprofit, lot of people donated, huge amount, organizations donated. Even our Minister of Welfare Government, came back and said, ‘Wow! you did a great job, can I give you money?’ So, you know, that way there was a lot of service to the underprivileged and the handicapped people. And the key to the success in all this was meeting a common goal. Remove the three disabilities, I was saying, meeting the three disabilities in the best possible way.

Tell me, how will I meet the disability of being extremely poor? What will I do there? It's low-cost but he is not spending money. So, they thought up till that level, they said ‘My god this person is already was in the hospital, he has finished all his resource, so he sold his one acre plot, he has got nothing to do.’ So they thought about all that and actually they rehabilitate them by giving them cycle rickshaws, this is most probably for the, you know, people with the hand amputation.

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They work with them also while they manufactured the Jaipur foot they would manufacture cycle rickshaws and also give them.

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They set up a separate factory to give them the rickshaws for you. Once you have mobility you could have a lot of work and you know they can pedal and take it forward.

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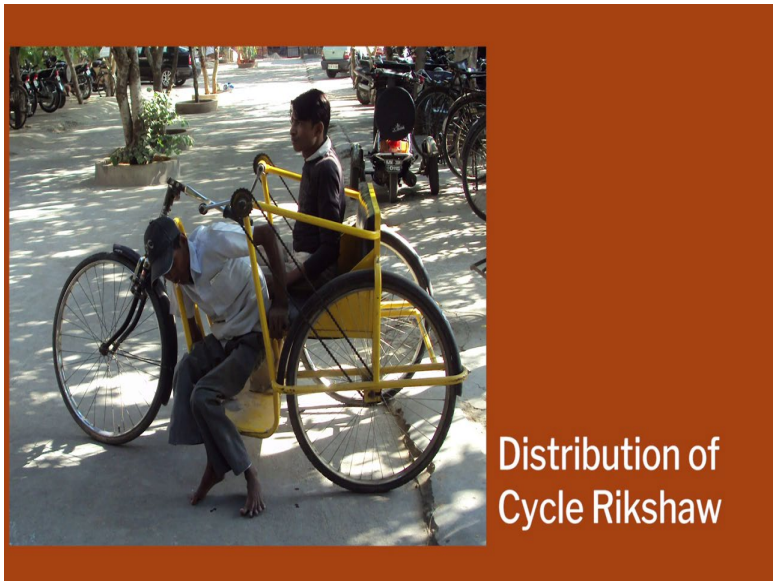

Giving them job training and women would be you know given sewing machines.

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And some of the men would be given the tea shop kit.

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I was completely sort of you know floored when I saw that while they were going out they were handed over these you know kits which just would cost 2,000 bucks or thousand rupees in the whole and you know they would go out empowered to lead the life as it is is very traumatic, the whole family is depended on this one breadwinner and you know he is now the whole family you know takes in to the next level.

Every organization like this, when I have been working with Jaipur foot for the last 10 years, a lot of IITs, a lot of large institutes, large companies start coming in very, very heavily.

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They have some of the best gait labs set up at Jaipur in the, you know, center for prosthesis and orthotics.

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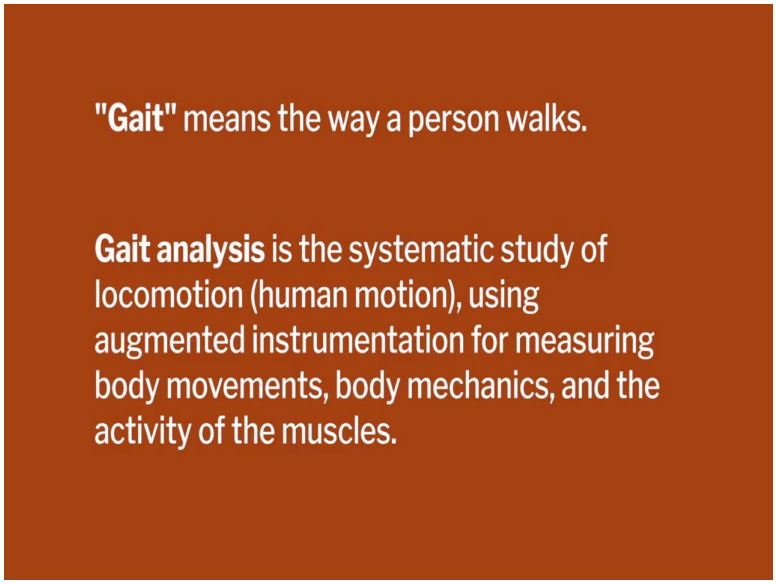

People have donated heavily for, you know, study of various aspects of below the knee and above the knee prosthesis.

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And then, as usual you know, we had lot of philanthropists you know, Ratan Tata, then then the US Secretary of State commerce: John brass

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A lot of these interesting visitors would come and because of that what happened the visibility increased and more and more technology started getting used.