Design, Technology and Innovation
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Lecture-2
Jaipur Foot - A classic innovation Part 2

Then what is beauty of this is that they have used very, very high technologies in this and the hit on the nail was that again D R Mehta's brainchild of making it completely non-profit. It is a very, very complex phenomenon. You cannot just take a cast and, you know, put a pipe. You need to have special laser machinery, so the laser measurement measuring devices were brought in from Germany. So, as soon as the patient comes they make him stand on a wall and the laser measures his, you know, whole body and his gait position and then they would take the dimensions from the laser-guided points and then make the prosthesis.

Because even a small five millimeter difference in the way, you know, you work on the prosthesis can be very detrimental to the comfort and to the walking style.

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So, you know, thanks to all the visitors and the promotion which happened with the Jaipur foot.

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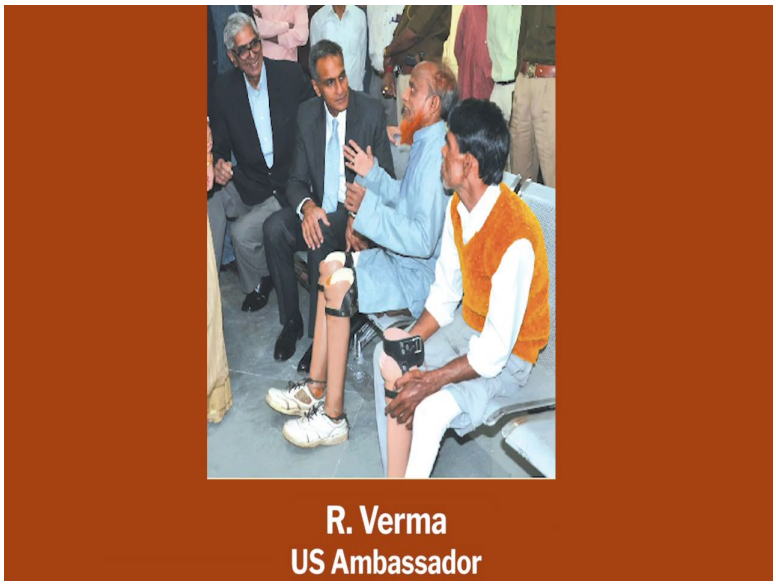

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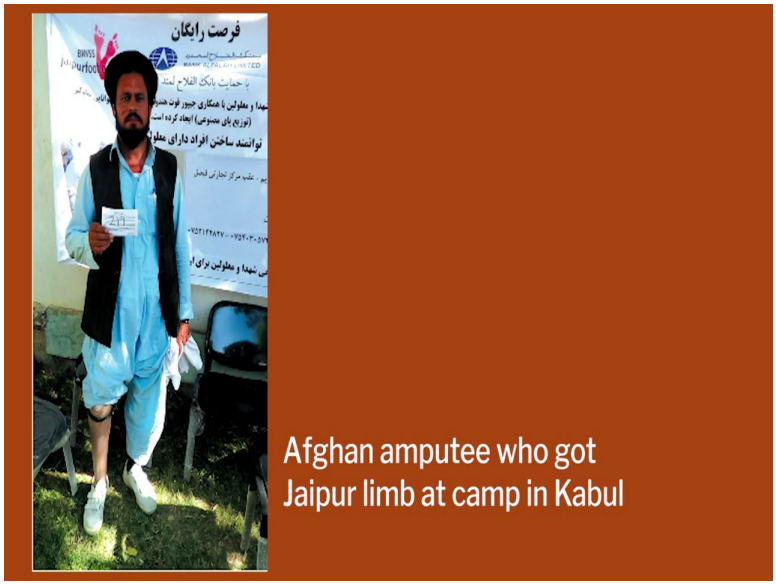

And then because of accidents in Afghanistan and other places, land mines and all, they have set up huge Jaipur foot organizations across the world now and this is the innovation part of our whole course. Till the benefit does not reach millions of users and delighted users, we cannot say innovation has happened.

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BHAGWAN MAHAVEER VIKLANG SAHAYATA SAMITI

DETAILS OF FITMENTS AND OTHER AIDS AND APPLIANCES PROVIDED TO DISABLED PERSONS

FROM 1975 TO 31.03.2016

Years	Limbs	Calipers	Others	Tricycles/	Hearing	Surgery	Total
2010-11	21943	16931	16804	4718	1426	71	61893
2011-12	23005	15453	16592	6963	1966	32	64011
2012-13	24418	15306	15127	3189	2465	9	60514
2013-14	23681	14811	15370	3951	2412	10	60235
2014-15	22848	12509	12370	5409	2619	77	55832
2015-16	26587	18652	16357	8563	5923	0	76082
TOTAL	513806	409944	462867	105774	34921	7472	1534784

JAIPUR LIMB FITMENTS IN CAMPS AT FOREIGN COUNTRIES

AFGHANISTAN	3738	PHILIPPINES	3000	PAKISTAN	987
BANGALADESH	1617	PAPUA NEW GUINEA	170	IRAQ	882
DOMINICAN REPUBLIC	500	RWANDA	500	SRI LANKA	2373
HONDURAS	400	SOMALIA	1000	SENEGAL	607
INDONESIA	1398	TRINIDAD	200	FIJI	300
MALAWI	250	VIETNAM	600	LIBERIA	271
NIGERIA	500	ZIMBABWE	250	MAURITIUS	734
NEPAL	200	SUDAN	1800		
NAIROBI	500	LEBANON	381		
PANAMA	400	ZAMBIA	121	TOTAL	23679

You can see how many countries the Jaipur foot has, you know, gone to the limbs itself has gone to more than 5 lakh 13,000 people and 20,000 people across the world have set up offices 2016 figures.

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And then, you know, lot of professors like Prof. C K Prahalad showcase this whole innovation as one of the best innovations for the bottom of the pyramid.

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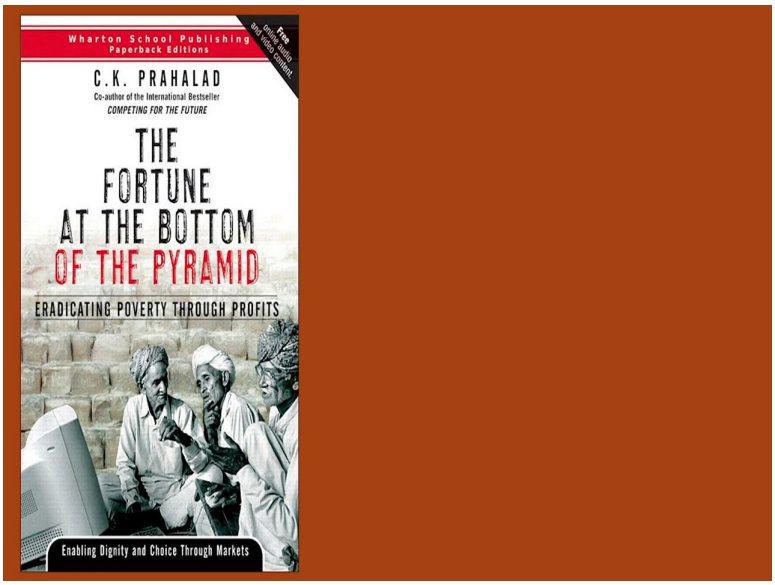

He calls his book 'The Fortune at the Bottom of the Pyramid', so here we very clearly see that every year, you know, 16000 prosthetic fittings are put in. It's a huge number to, you know, work on and take it forward. So, the video I am going to show you now is done by C K Prahalad, his student, a lot of his students and staff came down to India studied the whole phenomenon very effectively and what I like about it is it captures, in a very short video, it captures the complete, you know, whatever I have been talking till now, all the aspects of the Jaipur foot very well.

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So there we are, we you know, saw this film made by C K Prahalad and his project team. When I visited, you know, there I found one person who came with the screws which have come off.

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From the shank, the screws had come off and he had nailed it. So, what happens when you nail a plastic? It will crack, this is the most important part.

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So, then we did a project in IIT. Worked for six months to design the screw. Can you now guess the screws going through how many materials? Skin colored cosmetic rubber which is, you know, the vulcanized rubber compound and the wood and the foot and the plastic shank. So, what used to happen is through the screw water used to seep into the wooden part, through the screw, through capillary action and the wood will start getting soft. So the screw get loose and it would come off.

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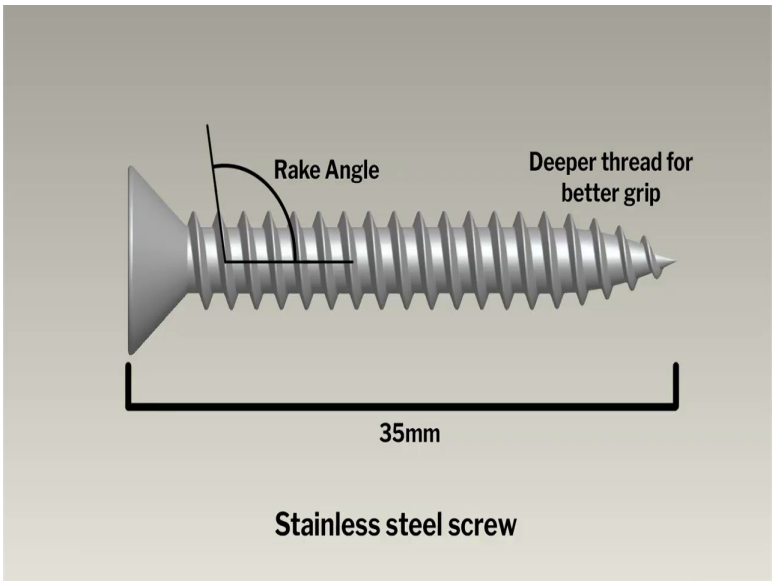

So, then we found out, you know, this best screw that we researched, we found out the correct rake angle talking to our mechanical engineering professors. We came up with a stainless steel screw. We gave the right drill hole so that the stainless steel screw will fit right into all the 3 parts and then we also gave a sealant, that is once you drill a hole you put a sealant drop so that the wood gets sealed over there before I drive the screw in.

And we supplied that to Jaipur and they tried testing 200 of these, you know, screws which we sent and if that works then we would put those screws everywhere. So, every small, you know, maintenance issue can be taken in a very good way so we need to be sending that and that is a small contribution into this large project.

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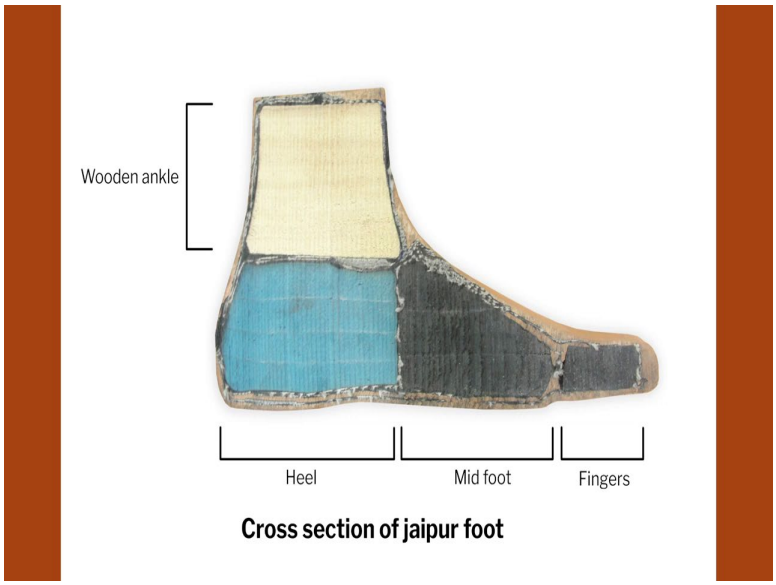

Cross section of jaipur foot

The 3 sections here: the Finger section, Mid foot and the Heel. So these 3 sections are separate where, you know, construction also is like the foot. So, the beauty of this design is it can bend. It is beautiful, the type of load, it can bend, it can take all the shocks of jumps and, see how it is bending.

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So, we saw that the affordance is happening because it is reaching, and it's the way it is manufactured, the whole structure of strategic management happened because of the, you know, officer.

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And then it is maintenance free because it is single, there 2 pieces: the single piece foot and the shank. So the maintenance is very, very low.

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You saw that stocking which is there on the stump, the stocking is specially double woven, you know, cotton stocking which actually gives all the cushioning to the stump it plays a very very vital role and that also I believe comes from Germany because of donations from German counterpart who wants to, you know, give those stockings to Jaipur.

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This is irrigation pipes most probably HDPE so these pipes are extremely strong because they use for piping water for agricultural applications, so that is a very important component of the design. Is this high-tech? What is the high-tech aspect of this?

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Very good. Material. Which material is high-tech here? Of course the microcellular rubbery is high-tech. Why? Because it went through all that research to be produced and, you know, available in large sheets which are used for large applications outside in car industries and other industries as, you know, suspension bushes and other places and here you are using the best research from automotive to use it in Jaipur foot, but you are using it in a customized way. Excellent!

What are the other high-tech things in this? High-tech materials?

Student: The socket.

Very good. The socket again is extremely critical. It comes from the best polymer, largest companies, very good strength, very good moldability. It is a thermoplastic material so you heat it and you very nicely shape it right so that is one, you know, excellent input.

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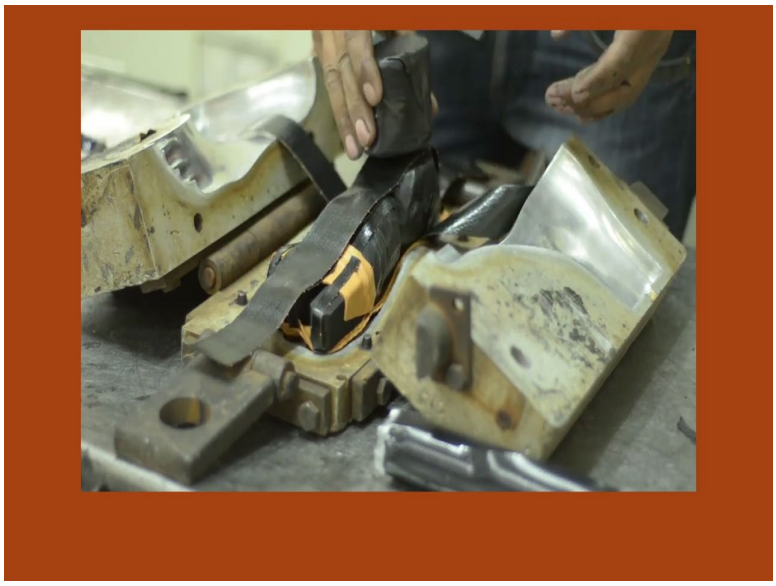

But the third interesting aspect is the rubber cord and the vulcanizing paste and the rubber which is used, comes from the tire industry. And can you imagine how much research the tire industry would do to generate these raw materials? Very, very high quality raw materials. So, I am using the high tech aspect in this is all in the raw materials.

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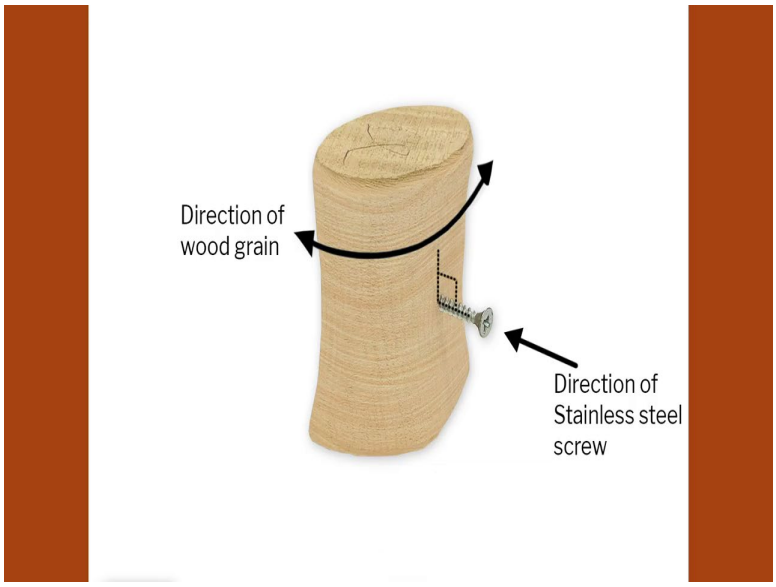

Including this wooden block, the grains of the wooden block has to be in the right orientation so that the screw will not come off. Wood can give you tremendous amount of shock absorption at that level. And what else? The joint. It can give you very good compression for putting the screws in and locking it. So, that is the beauty of putting, you know, all the aspects of the, you know, high-tech into this simple product.

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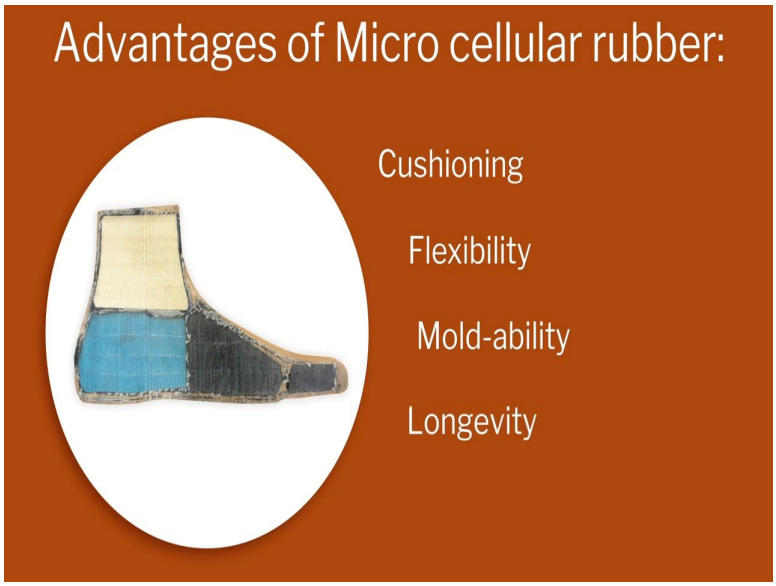

So every aspect in the Jaipur foot has multiple advantages, not one advantage. Microcellular rubber, what all it's doing? It's giving me cushioning, it is giving flexibility, it is giving it moldability, moldability now I mean building the model and it is giving me longevity, because microcellular rubber is non-perishable. Here, see it is all skill, skill of the people who are getting the job done. So, the final fitting and the final design they actually do it very customized to the people who are there.

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You saw they were actually heating on the, you know, heating on a heater to, you know, get the shank into the rubber. So, there is a joint there and it actually they fully fit it in as per design they

have an area that goes fully in and they drill the hole after they fit the shank, through and through. So, they completely fit it, drill the hole and then pull it together. So, their size is already measured. They know the sizes and they do it and that is the whole reason that they do not have too much of standardization. There is another problem of accurate design.

So they are working on that, how to modular design so that they can really close in on the, you know, inaccuracies if they crop up in the design. But this is all again hand skill which is coming into play.

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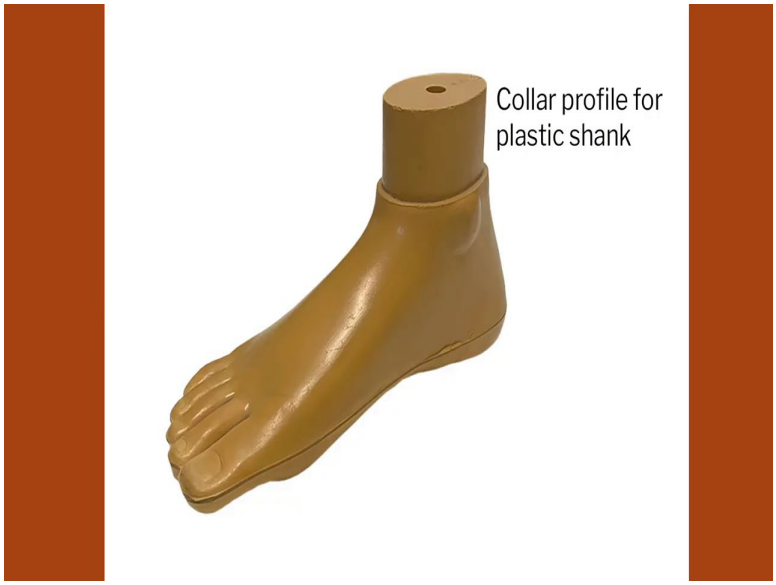

You will have to come up with some design so we came up with a design which is like a collar, so you push the pipe and it goes and rests on a collar on the foot so we made a collar here, it is still not implemented we gave that design where you made a collar, so when you put the shank it exactly goes and sits like a socket like a tiffin box.

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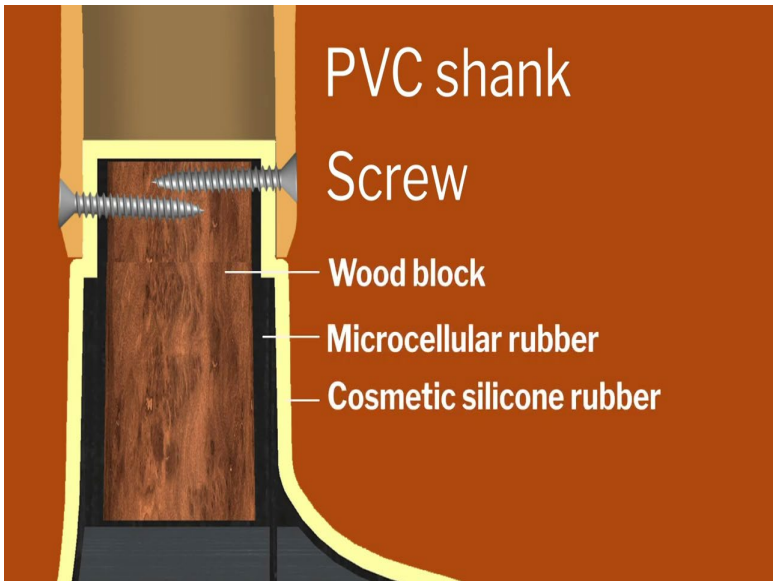

So, we made that, you know, so that there is no sort of dimensional problem because sometimes it is heated more it can't go in. So, we worked 4 months on that and we sent the design. And what is interesting in all this is, it is like again Abdul Kalam now, I sit in Bombay and send in design. Will it get implemented?

It is a large organization right? It is a large training. So, it has to be an activist mode. You have to be there, you have to train the people, you take things forward then only things get implemented. So, we are planning to take it up, you know, in the next sessions and get the whole, you know, thing implemented.

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This small finger blocks microcellular rubber, they were cutting with their hand. It's a very tedious process.

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So, we want to help them out and he said ‘we’ll give them punching machines to cut exactly the size of the fingers’ so that, you know, input was given by us so we are working on that also to support the production aspects of the design.

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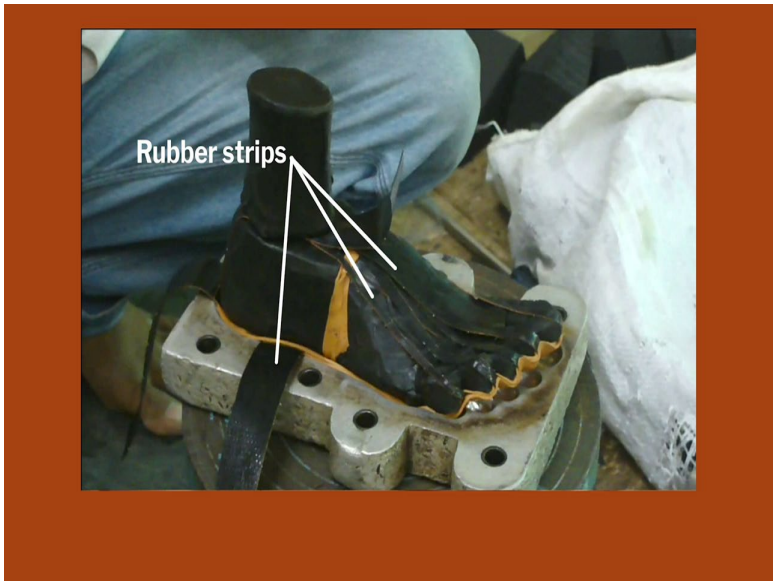

Nylon rubber cords again from tire industry provide strength and resilience. You are telling how will, by weight, it will come back? Look at the way the tire is designed, it is the same way the foot is designed, look at the strings which are, and all these are placed, you know, in the right orientation

so that you can get the type of resilience you want. They are coming, all of them are coming on top of those, you know, finger blocks so, then it gets molded with the cosmetic rubber it all gets sealed and this actually generally is 20% larger size, 10% larger size then the actual tool. So, when the tool presses it the whole thing gets compression and then the rubber flows in all the directions and you get a very, very solid piece in hand.

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And basically no skin color, now they are also trying to get little darker and lighter shades. What happens with all these organizations is when you have inventory becomes very difficult to control, and the type of population which comes over there, you know, they are happy to get a foot. They are really not bothered whether the color of their foot match, it is that type of, you know, sort of requirement. So, we have to really understand the demographics. But if we can give colors one of the best, it is quite good.

I am now coming to the last section of her lecture. So, we saw the whole innovation journey. How the whole manufacturing, how the whole materials and how each material has multiple roles, multiple advantages.

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Blade Runner' Pistorius
2012 Summer Olympics, London

And do you think there are different designs all over the world? Using blade running prosthesis which is developed in, you know, one of the best universities in the US and, you know, it's program, it's got the best materials. So, there are innovations at every level. Will you call this innovation? It is of course innovation. It uses all the ingredients for that context. It could be for one user or two users, but it is happening at that level.

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Can we apply that to our context? It is very difficult, because the whole ecosystem does not work, the cost will come too much, we do not have the type of resources. If we had the resources why not, but if the resources were not there then it is very difficult. So, we need to understand financial

implications, but if you look at the other angle of administration and cause and running, that is where your innovation can never reach scale.

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Similarly there are micro processor controlled prosthesis, and a lot of work is happening on the C leg .

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Fabulous designs, fabulous technologies, you know, very good case studies on the, you know, YouTube of how these are developed and again saved up a passion, the designers and the teams are working on for a different context which is working very well.

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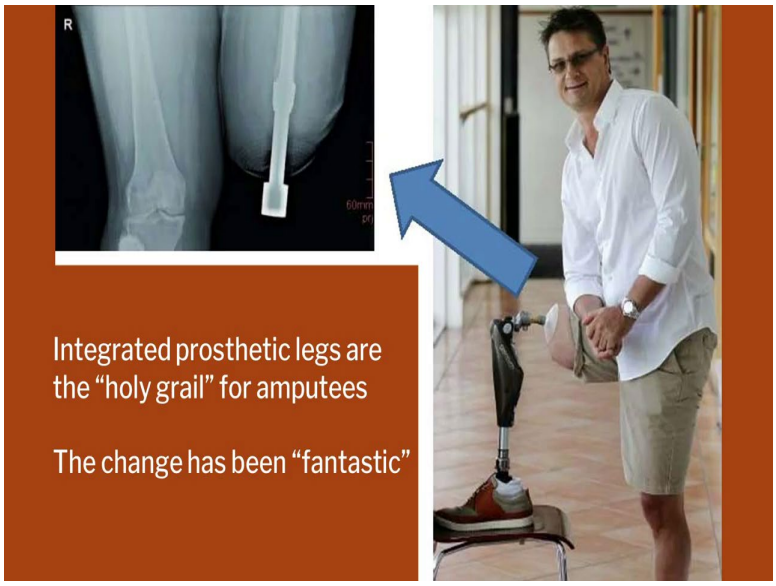

These are again in integrated prosthetic legs. Surgically they have implanted. So you have one part of the prosthesis which is an implant into the bone. Then what will happen? All my outside problems remember I was talking about customization and all, that is gone right? It is already into your bone, and all your gait will be perfect. Your orientation will be perfect and that operation also has to happen very effectively and then you can attach the best, you know, computer-controlled, numerical controlled prosthesis.

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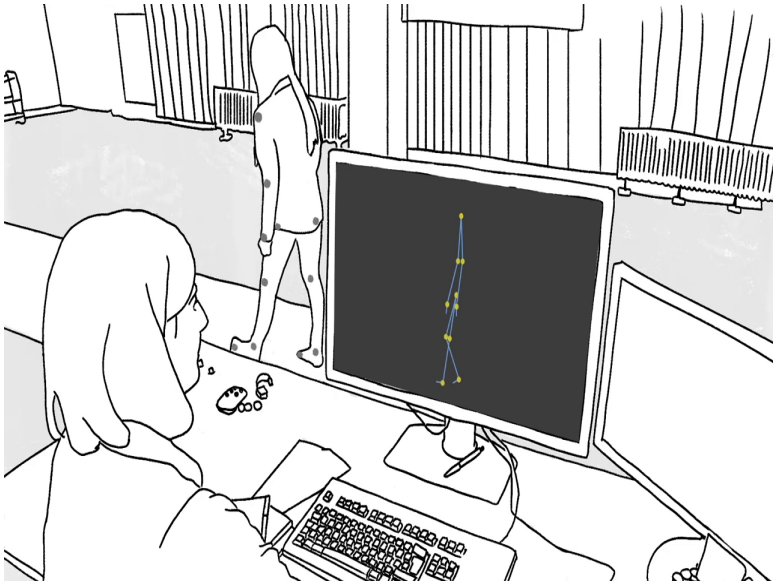

To control your gait it will learn how you walk and program itself to give you the best gait and you cannot even make out that you do not, you know, if you are having an artificial limb. So, the technology and research has gone to that level.

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And we have a lot of examples of this, you know, a racing driver who had an, you know, accident and he has both his legs of that caliber. And with that I'd like to close and we now very clearly know what happens in the journey of design, the technology, technology can be materials and manufacturing, and the innovation, and innovation comes from the complete domain of understanding the user, understanding the strategic implication and the whole vision of the person who is running the show which is D. R. Mehta of : What would I like to do?

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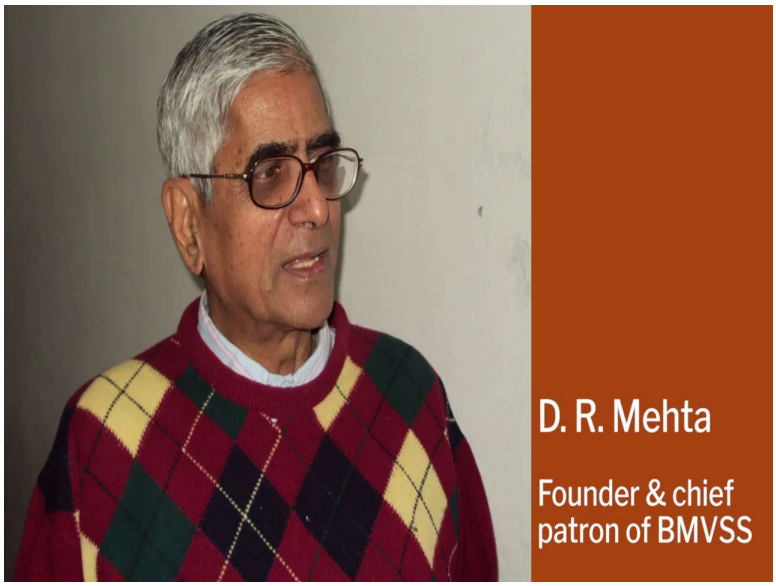

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How will I like to make it completely philanthropic? How will I like to make it a social design? And take forward the largest sector innovations? This is one of the best examples of innovation in the country. So, I thought we will start with this for our whole design and technology, you know, course.