Design, Technology and Innovation
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Lecture-23
Smartcane for the Blind- A Success Story Part 2

I may do much, let us say, a detailed business model or detailed modelling of the finances or a market may be at a later stage, but I should have a little knowledge very early even when I am doing research kind thing. Because the market is a filter for many of the products.

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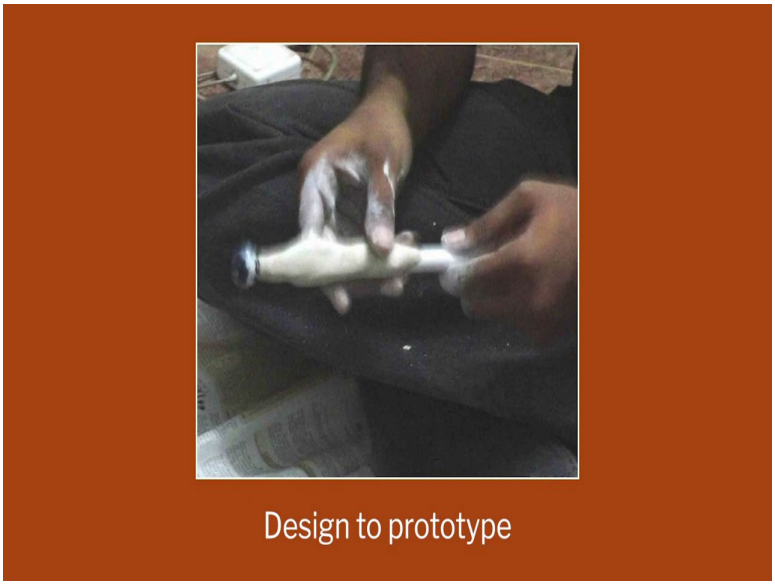

As I said a lot of prototyping probably we would have spent just 2 years doing prototyping, building and testing before we could actually go to market. That was also the first product. We did not understand the complete, this chain of innovation. If you ask me to do a similar product I can do it in much less of iterations, because now we know where the failures are likely to happen and you understand the community and the market better which did not happen with the first product.

So, that is also one reason why we have to go to the 12th version which went to market. When we did the subsequent product, they did not go through those many iterations.

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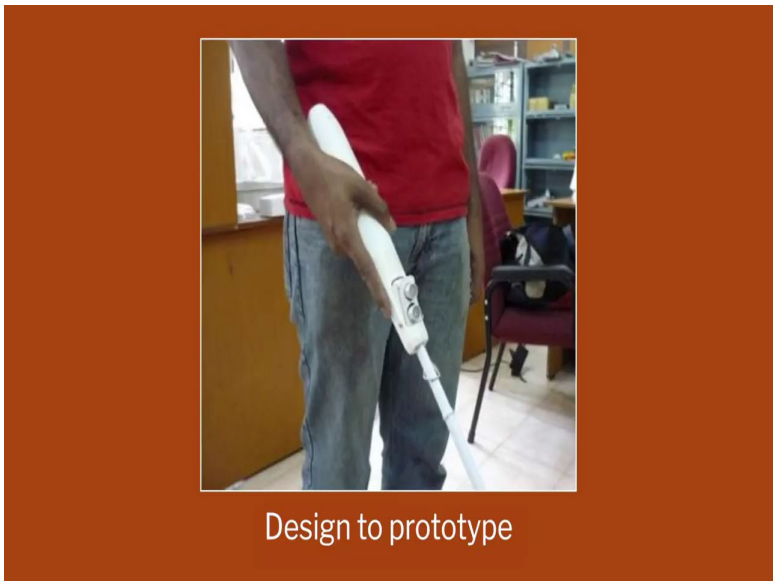

This is a lot of testing. Every time you do (make changes), you need to go test with the people some are more of functional prototype.

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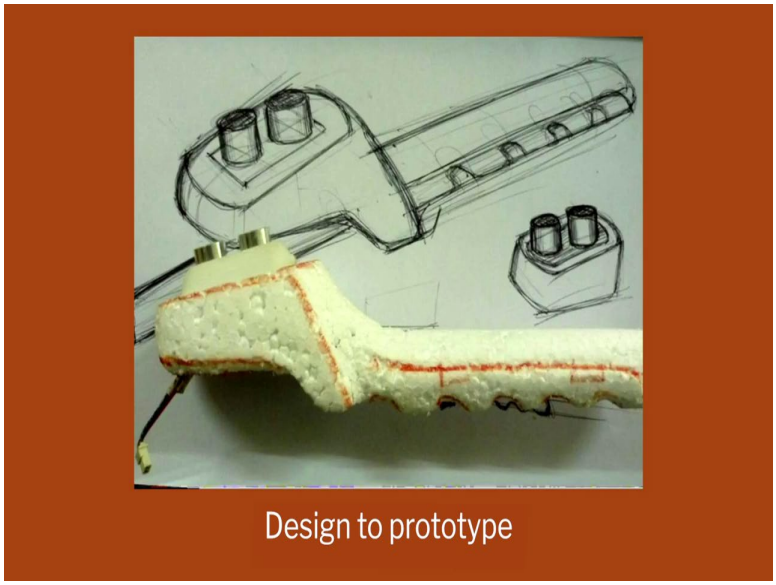

Some more like models in styrofoam or thermocol, but you had to go through these aspects.

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This is one of the versions 9 which is there and also people said that there are controls in the smart cane: How do you indicate?

Somebody put Braille points in this. Now the moment you put a Braille, this also goes into mould, correct? Because when you are doing a 3D printing it is easy, but when you go for a mass you need to do it. But this was a mistake to put Braille. Why was it a mistake?

No. Which Braille?! Hindi Braille? English Braille? Tamil Braille? Correct? So the Braille is different. Only, it is still a 6 or 8 dot system, but the combination is different for different languages.

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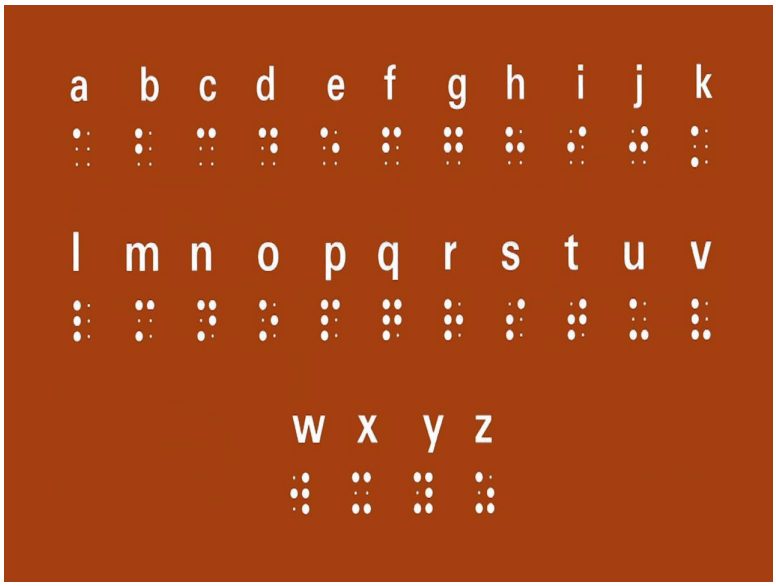

You cannot just prepare a mold for one language and do it which is there. So what we had to do is we had to come back and remove the Braille and just put it as symbols and let the symbols be explained in the manual for people to know that this is a on off button.

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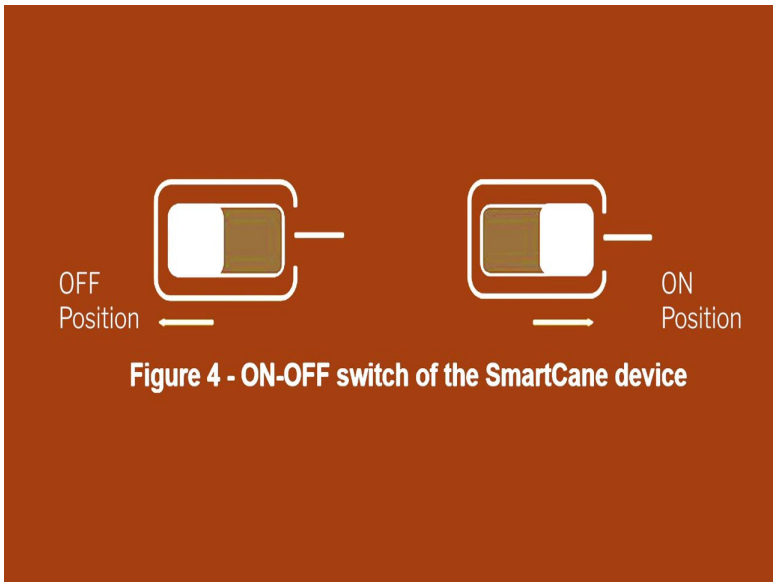

Figure 4 - ON-OFF switch of the SmartCane device

And there is also a button where you can set your range to 1.5 to 3.5 meter.

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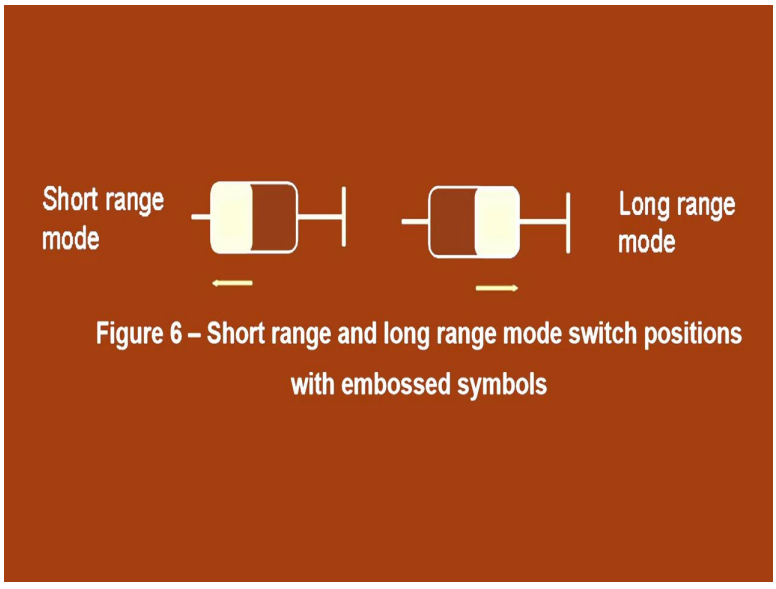

Figure 6 – Short range and long range mode switch positions with embossed symbols

Why 2 ranges were given is that in a place like this many of them are within 3 metre. It will always be giving vibratory feedback. So I would like to set a smaller range when I am indoors. So you have a control for that. Now, how do you tell the users that these controls exist and these are the

symbols? Now that is another research which has to be done. How do you indicate a power button on any of these devices? What symbol do we use?

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A circle with a line. But that does not make any sense to them. Because that is more symbols, those symbols are designed for visual route to comprehension. But I think when you are going through a tactile route to comprehension the same symbols do not make sense. Then we look at what is the power symbol for, if you want to use a touched route, then we found that there is nothing like that exists in the world.

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So what was basically done is a small symbol which is in the form of a T shape. One end is on and another end is off, so we just put a T symbol and explain in the manual that this end is a power on and this end is power off. And we had to do it because symbols for them are still not standardized and do not exist, and all these things are important. Suppose if this symbol exists, and if I do not put still it is a crime because they (will) say they would be looking for that symbol which is the standard and if they do not find, they cannot find that there is a power symbol.

But only have to do research and find out if such a standard does not exist so you have a choice to do it. Now, the world is meeting. There is a big consortia in the world who are actually trying to make such symbols for the blind person in the world, but it will take many years before they become a standard.

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So, if you look at the prototype, the first one and the one in the market, all the features have changed and all of them are user ratified. So, that is where you know somewhere, 'Ok, now that it completely co-created with the user, it is less likely to fail.

White cane comes into version. One is a foldable version. Another is a non foldable version. Many of the people use the foldable version.

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So, here also you can do the foldable version. And the moment you say fold, the users came up with another aspect: 4 folds or 5 folds?

Some people use 4 folds and some people use 5 folds. So, we thought ok we go with 4 folds. But then most of the women were very not happy. They said, ‘When you have 4 folds it does not come in my purse. But the moment you put it is a 5 fold it comes in my purse’. So, then we have to switch over from 4 folds to a 5 folds.

So that women are also happy and the normal bag which they carry can also have, fold and keep it, this aspect. Just, it is a very small thing but it can probably please or displease somebody. And that could be the reason for your failure too.

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So in fact, one of the things probably I did not bring out is that this smart cane is actually an attachment. It is actually detachable and you can put it and any of the white canes. And the good thing is worldwide people have standardized the diameter of the white cane and that standard came to us very handy that I can make it detachable. So it can detach, and do that. And this detachability is extremely important.

Suppose in case I, my white cane gets damaged because of certain things, sometimes it happens. What happens is you are actually going and suddenly somebody who is actually going on a bicycle or a bicycle wheel can entangle with your white cane. It happens sometimes. So, when your white cane gets damaged, you do not have to throw away an expensive one, you just have to replace your white cane and still the smart cane still works.

There is another important question. Can the people use just a white cane, a smart cane only, without white cane?
Some people tried and though we said it is a smart cane is something which complements the functionality, it is not an independent product. But still some people used and they shared their experiences how they could detect some aspects in this, but it is still a risky proposition?

The risk, which is there is, as I said, if it is a structured environment still there is a less risk, but in an environment suddenly, let us say, the municipality has opened the manhole cover for this thing,

and they have not put it. Then how do you come to know that there is a serious drop off. And this brings a very important aspect. When we do the user trials, we generally do a multi location trial. When we did 30 user trials of the first product, we went to 5 cities. In 4 cities it worked very well but in one city it was a failure.

It worked very well in Bangalore, we went to one rural area called Chitrakoot, which is also well known, so we went to Chitrakoot. We did it in Delhi. We went to Shimla. In Shimla it did not work. We came to know that in cities like particularly in hills, people do not use even the white cane. It is very risky to use even the white cane when you have serious valleys and drop offs. And they generally use only sighted assistance to move.

Now how do you tell the people that it cannot be used?
You have to put it in your manual clearly. If you do not put it and if they still use it, you are still legally culpable. So there is a legality also when you prepare a manual etc., that what it is that you put. Some risks you can mitigate in the product, those things which you can mitigate in the product, you still warn the people. I think that is what most of the medical devices and drugs would do. They say there are certain risks associated with this, please read that carefully. You cannot use the drug during any situation.
Same thing happens with assistive and medical technologies too. So these are products where there is a risk. Now whenever there is a risk, it will be regulated also and you have to follow those regulations which is very important.
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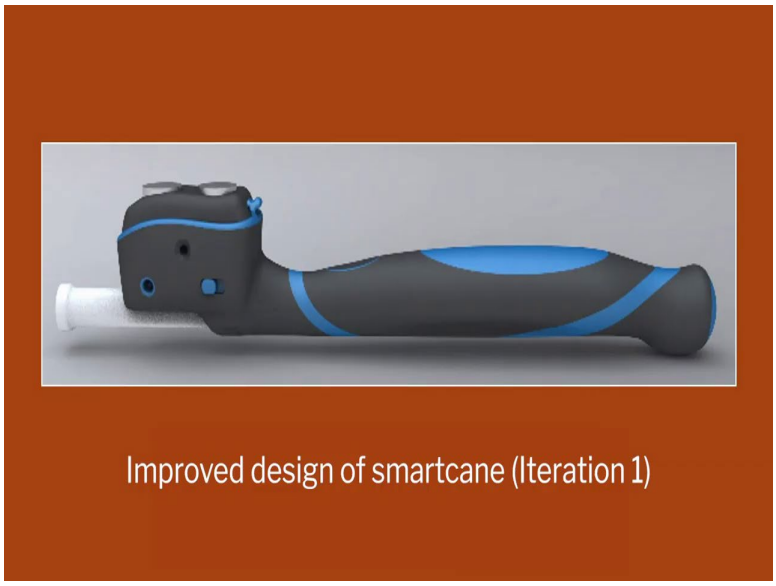

When colours were demanded we just also made it in different colours.

It (Center of mass) is solved because the problem is you had a huge centre of mass, so every time I would move it actually turned, so the, then you do not know whether the sensor is pointing out in the right direction etc. Now the geometry itself gives you the tactile features on the surface where you are holding, tells you clearly what is the direction in which the sensor is moving. So those tactile features have to be built in while you are doing this thing.

And ultimately when you are doing a form you need to take care of certain ergonomic and human factors that require you to come with a more optimized form, that time you can also incorporate this. You have to solve that. There are certain features, which you do not solve people would not accept. There are certain things which probably still can be accepted or your market may shrink.

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Various aspects, like one of the versions we did, the colour choices for men and women is very different for visually challenged. So you need to do a small survey to know what their colour choices are.

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Lot of issues came from the school going girls. They said the form which you have come up with is something which is probably, pains at certain positions.

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So then we had to actually go to the schools, give them clay models and do a complete ergonomic analysis to know. For example, what are the regions, like, you can also know how the pressure is being distributed on your palm for a given form. You can do a very simple study and then see what are the regions where it actually pains because typically a user is going to use it for about 2 hours a day.

And if you are using it continuously it can be very painful. And that is what most of the elderly people complain about their cane which they use. And still in the market, this is an unsolved problem, something which is a good ergonomic came is still, many of them are not very ergonomically designed. It is still an unaddressed need in some way. So this has to be done with various people and, then do optimize, and then once you have a clay model, which is kind of an optimum, then you can do a scan, build a CAD model and then go and build the molds and etc.

So, but a continuous process of reverse engineering etcetera; had to be done if you want to incorporate user choices.

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It is not only important to have a product but how you package, what are the manuals. One aspect is that they are given one hour training, but other than that they also need manuals. Now, how do you write these manuals?

See you need to do it in Braille. Now once you say it has to be done in Braille, you do in multiple languages.

And then you also need a charger, and initially the first few versions your charging used to be for 4-5 hours, but later this was done almost, like, 30 hours of charging. If I am using for 2 hours per day, I had to do (charging) once in a fortnight and they (the users) were very happy. Initially when it used to drain this thing. There the technology optimization comes. So you need an electrical engineer who is very good in terms of power electronics, optimising, (to) bring their own domain knowledge. So that is why this team which actually built, had mechanical engineers, computer scientists, electrical engineers, industrial designers, social workers, and it is a highly multidisciplinary team.

That is a very, very good question. Let me demonstrate through this. So, how do you know that the battery is left?

Now, this string is a, many of them used with the white cane and they wanted even if there is a smart cane you have to give this. What people do is actually put this and hold this. Why they hold is they see that under any circumstances your cane is not separated.

Somebody said: Is this detachable? Like, you can always detach. This is the smart cane and this is the normal white cane which you get. And since the string has to go you need to have features to do that and a, so when I actually switch it on it had two beeps and also two vibrations.

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Battery Charge level	Device turned ON in long range mode	Device turned ON in short range mode
Full: 70% to 100%	Three beeps with three vibrations	Three vibrations
Medium: 30% to 70%	Two beeps with two vibrations	Two vibrations
Low: less than 30%	Single beep with single vibration	Single vibration

Now 2 beeps say that your battery is 40 to 70%. Single beep is less than 40%, 3 beeps is 70% and above. There is no other indicator to do so you need to use audio. But there is also a vibrator. India also has a large number of people who are both deaf and blind and for deaf and blind, tactile is the only route. So this is a device which can be used for deaf blind also, and we have a large number of deaf blind users who are using this particular product. So all the vibratory, the tactile hepatic aspect takes care of this particular aspect. So this is the one, this is the indoor outdoor navigation I can set.

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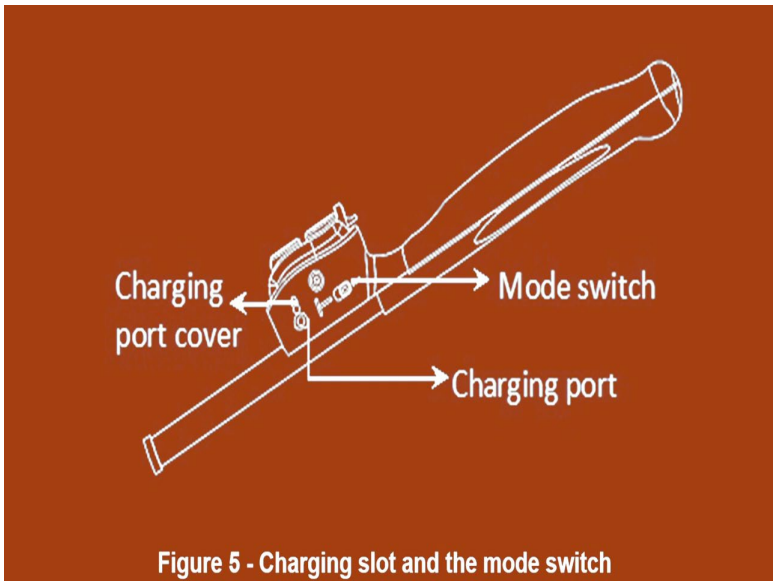

Figure 5 - Charging slot and the mode switch

And then this is the charging port where I can charge. Usually people sometimes hold like this, sometimes they hold and when you are holding your angle is changing, so you should be able to adjust your sensor to a different angular position.

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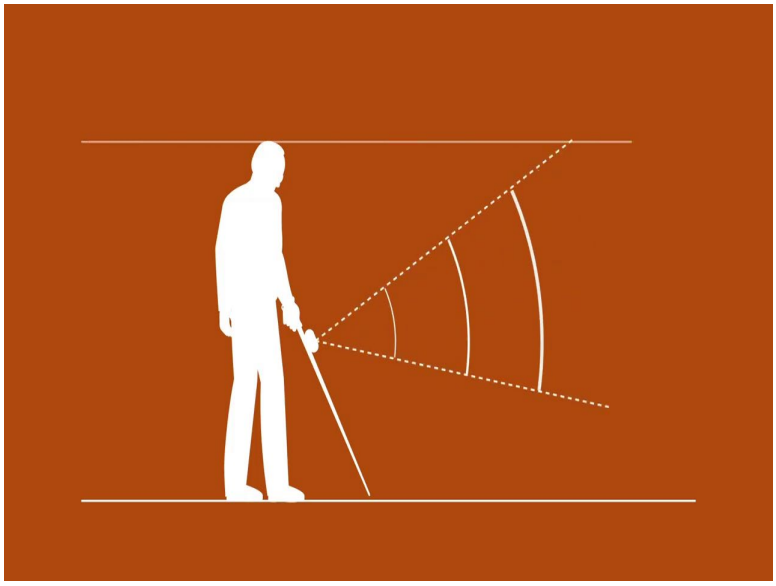

The sensor should ideally be put in such that that ultrasonic ranging covers from knee to head. And there is also a methodology to set this particular angle, which is there, if you are standing at such a metre then this should be pointing to a, like basically, the chest of a person and there is a methodology which you will also find in the manual.

Very simple in terms of technology, ultrasonic ranging is there for many decades now. The challenge is not just with the technology. Technology is one aspect where you need to optimise but also you need to work with the design and the features etcetera.
What happens is there are International Standards for objects which are vibrating where the vibration is felt either to hand or to body, and what is the extent of vibration which is permissible. So, when you design such a product you actually go and do this testing. For example, there are some products where your whole body vibrates.

Like for example, a bus. A driver is sitting in a bus, for a certain hour the whole body is vibrating. But then it says what is the vibration intensity? Which is generally measured in terms of acceleration. If my acceleration levels are this, then you are allowed to have 4 hours. If acceleration exceeds then you can only have 2 hours. If acceleration even further, you can only tolerate 1 hour. So these standards have been made. So when we put a vibrator and do, before we launch a product we need to do these testing and see that this is safe for this thing.

If I do not do, you are right. Then, if somebody the vibrations are really, this thing. Then you will have a repetitive stress injury. After sometime your palm will become numb, which is a serious medical condition. So those regulations, the risk which is caused by the product has to be mitigated before you do that. So, that is the regulation part. Suppose if I want to launch this in one of the countries, will they permit me to do so or will they check whether there is any risk this product is going to offer.

So what we generally do is we apply for certain regulatory standards. Like one of the regulatory standards, which is commonly used is CE (European Conformity) marking. You may have seen, correct? Most of you may have seen the CE marking which is there. So, this is a CE marked product. The moment it is a CE marked product, in 90 countries I do not have to take any permission to go and, let say, launch this particular product. The problem only comes in case if I am infringing any intellectual property.

Somebody has, let say, a patent or a design registration and if I am mitigating, only in those situations come. If I have freedom to operate, then as long as I have taken care of the regulation.

So, in the US if you want to use this, this should be approved by the FDA (Food and Drug Administration). And FDA regulations are very, very strict. People do not even try making products because it is very difficult to get an FDA. So this is an FDA approved product. So, I can go and sell, there is no problem.

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So, this is right now (at a) price of 3500 rupees. So the 3500 rupees, you get the white cane, you get the smart cane, you get the charger, you get an audio manual, you get a Braille manual and 2 hours of training.

Same thing, when you put your specifications, you need to say what is the temperature, humidity and other aspects which you do. Somebody says, like for example, is this waterproof? Correct? So even that, there are many levels, for example, this is a Splash proof.

What do I mean by a Splash proof is that suppose the, if this gets wet. Some of the water goes inside. It may stop working, but once it dries up it starts work. So somebody, when we said, this is waterproof and splash proof, one of the users went and put it in a bucket of water, just to try. And luckily after drying it started working. So that shows, 'Can I use this when there is rain?' Answer is many people do not use it when there is rain.

There are 2 reasons. One is that there is also a splash proof requirement which is one, because your electronics etcetera become the problem. The second thing which people say is even the water

droplets are treated as the obstacle. So it is beeping, you do not know whether the beep is because of the water droplets, or is it because of the real obstacles. So those regulations become very important. Like for example, is this material good for skin?

Is this material biocompatible? You need to tell that when you go for regulation. So biocompatibility also has a dozen levels. If the material goes inside your body. It is a very serious biocompatibility required. If it is only touch, you have less of a biocompatibility required. So biocompatibility testing is also done and there are different levels to do it. So, getting all those technical tests done to get this regulation itself costs about 50 lakh rupees. Just the tests and regulation and getting FDA, CE approvals. So that is the money which goes into also building a product.

And the important thing is if I can say that I am not doing all of them. I primarily want to sell it in India. I can probably reduce the cost, but I am giving you an inferior product, that people do not accept. Usually if you say that an affordable product which is less quality, usually that does not work and because the aspirational aspects are very, very important. People do not want to compromise anything. It is like saying here is a poor man's product.

Go ahead. So what happens is, say, you are very right, how is this regulated, technologically, is, in fact, in some of the cases when the risk is less, you can do a self certification, what you are saying is. But in case, suppose let us say, because of that risk happened to the users then you are liable. Suppose if I have a, if somebody else does the test, a regulating body and then they say you are safe, then you are much better off. Then you say that we did not do the testing, testing was done by the Laboratory which approved the safety norms of that, so I am not liable.
So in some cases users can also do the self certification, but some people choose to do it, some people still want Laboratories to do the test and give a certificate for the safety aspect.

When we were doing this research to design, when we shadow a large number of users, we came to know that most of them go to the nearest social organisation or an NGO to show such products because there is no other serious marketing channel which is available.

And it is not only this concern, last month WHO was debating what should be the marketing channels for this, in Geneva, when we had a meeting. Because it is the same situation worldwide, not only in India.

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And also you have to do a manual in multilingual. Very interesting thing is, one of the persons said, 'What is this ultrasonic ranging? I do not understand'. How do you explain to a blind person that ultrasonic ranging is a cone which probably diverges kind of thing.

Then we have to make diagrams and then we realise in India, making diagrams for the blind is still not a mature technology. So, we have to come up with a methodology to prepare these embossed figures where you can actually touch and feel the ultrasonic ranging etcetera.

We found that this is a gap, now we have a complete startup, which does only these books for NCERT (National Council of Educational Research and Training) making maths and science books accessible to the blind.

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And this is the issue which is there with some of the products. So where do you position it is very, very important. These were there in the market but not within the reach. The question is even that is a little, many people feel, how is that we are able to go to that small, is a very important aspect. What happens with technology such as this is that the user does not have a buying power. All the countries like the US and UK, what do they do, they give every visually challenged person certain amounts of money or subsidy to buy these products every year.

Like in one of the country's, every blind person gets a $1,000 coupon. Every year you get $1,000. Out of these thousand Dollars, you can buy products from the market and the government will pay for a thousand. Anything above thousand dollars, you have to pay yourself. Now in India we still have those aspects but not for products such as this. So, if you put it in a market and say this is going to cost 20,000 rupees, it will not sell. Or it may sell but the numbers or volume would be so low that you cannot make a profit out of this.

What was done is we went to a charitable organisation which is called Wellcome Trust. And this organisation said, ‘We will take care of all the development cost of this product, like making moulds, setting up manufacturing, all the regulation calls, getting CE marking, getting FDA approval’. It's going to cost about 3 crores of rupees or 4 crores and they said, ‘We will give you that money, but in view of this you have to price it low’. So we went to a manufacturer, if the manufacturer would have taken up and made it, it would have been 20,000 rupees.

But since all his development costs were met by another organisation, we negotiated and said they should be priced at 3,500 rupees. If you do not do that then this person probably may not even take it up, this product would have never happened. So the charitable organisation is happy because the whole idea is to reach out to such people and do the charity, and the company is also making profit even with 3500 rupees. That means there are certain products which need very different business models, and very different ways to reach out to people, they are not market driven.

It is not like a mobile phone, if I suddenly have some wonderful feature a million people or 10 million people would buy. That does not happen with such products. And that is assistive technologies are particularly ramping. What the government does is they sometimes buy wheelchairs and white cane and give free of cost to the users. That Indian government also does, but they are able to reach out to a very small populations, but not to a large population still.
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So, Indrani is one person who is, like, more exploratory than the other people and she does not want any, curtailing her freedom for mobility etc. She was like one of our very early users. You also need some users who are ready to help you with your product development, who are like your focus group people. And Indrani was one of the focus group members for that, who gave a lot of this etcetera and is a good case.

And though this product was designed for obstacle detection and negotiating the pass, but people came and told very different uses for which the product is not defined or designed for.
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Like one the person came and said, 'This actually helped me to follow a queue'. We did not know what the person was saying. He says, 'Every time I keep my cane, I know how far the person in front of me is. If the person is moved a little, then my vibratory pattern has changed and I take one more step to know that the queue is moving kind of a thing'. This we never even thought of this as one of the specifications when it was given.

Most of the young girls are very happy, young women are very happy. They say, 'Before this even with the white cane we were able to be mobile, but there used to be very, many unwanted collisions with the people'. And particularly women did not want that. They say, 'With this we are now able to avoid unwanted collision with other people', which is another use case. So, sometimes you design for something and people come up and say very interesting stories for which it was not designed.

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So since you mentioned that how we actually reached out, so one is that we went to, we did the product release in multiple cities to know that such product is now existing. And referral is still very important in this community. The moment they come to know that there is a wonderful product, they have their own communication system and it spreads very well unlike an advertisement etcetera. So, referrals helped us a lot. We also had a channel partner.

We have 50 organisations in India which are basically working for, these are people, these are organisations working for the visually blind. They take the orders, and then the industry which is actually manufacturing in Chennai, it's called Phoenix Medical System, which has been given this particular licence to manufacture this product. They ship out to these people and these 50 organisations also provide that 2 hour training, and then give the product to the people.

And there is a scheme of the Government of India which is called ADIP. If your product is less than a certain amount, then the government can also buy it and they can give it to people in a lot of camps etc. A lot of our sales have also happened where the government has bought the product and given it to people too. And it is important to know what that amount is. Suddenly one of the products, very recently launched, they priced it as 20,000 rupees and the Government said 20,000 rupees is too high compared to the 12,000 limit we have and hence the entire Government market is now closed. So even to know that these things exist when I am designing a product is an important aspect.

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And we have E-Commerce but it is not, the numbers are very, very small. We also did small innovations there. We negotiated with the E-commerce website, you put two options for the people: Either buy or you can also give users to donate. Suppose if somebody donates 3,500 rupees, one person gets it free also. So, few of them also happened through donations because sometimes donations do happen in this space.

And then there are some marketing channels which are specific to AT (Assistive Technologies). There is one in Bombay and one in Delhi, 2 organisations. One is called BarrierBreak in Bombay and Saksham in Delhi. They sell only assistive technology products. We have products with Aravind Eye Care, L.V. Prasad which is a very big hospital. What they do is when in the ophthalmology department you try to restore, let's say, vision of a person through surgery. In case

the surgery is not successful, then the hospitals do a rehabilitation aspect. So in that part of rehabilitation, they also suggest SmartCane as a tool for probably living with blindness.

So you also need to go to that and there are few blind associations in countries like Canada, Australia, US. We work with those aspects.

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And then a lot of training. You need to take care of the training required for children, elderly. One of the first lessons in innovation, Who are your early adopters of your solution? If you start with people who are not very excited about your product. It may even have a failure. You go to a particular community, like, elderly people have a lot of inertia to accept any new technology. So, we went to elderly people almost towards the end. And the initial population which we targeted was 15 to 35, and they were our early adopters. And that is also an important decision.

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Piyush is a PhD student who is working on mobility for the visually challenged and he was a part of training a large number of users. And then there is another category of people who train users in mobility. These are called Orientation and Mobility Experts. So he trained a lot of orientation and mobility experts and then those people went and, like, we now have launched in multiple countries, 20 countries. So how do you train the people there? We train their (the countrie's) orientation and mobility experts, then they train the people in these things.

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And then you have to do a lot of testing with various obstacle courses, etc. This is also one of the requirements before you actually launch a product.

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And as I said a lot of technology related testing which I mention biocompatibility, ElectroMagnetic interference, EM interference is a very big thing, what about, like, if there are two people using the SmartCane come face to face. Or you have another ultrasonic sensor which is coming from, let us say, a car is backing off?

They also use ultrasonic sensing, what about the interference with those products? You need to test that and see that you still do not have a risk. And here you need to do a lot of technology optimization.

So another thing is just to use the technology, but to use optimum technology there is a lot of research in engineering also has to be done.

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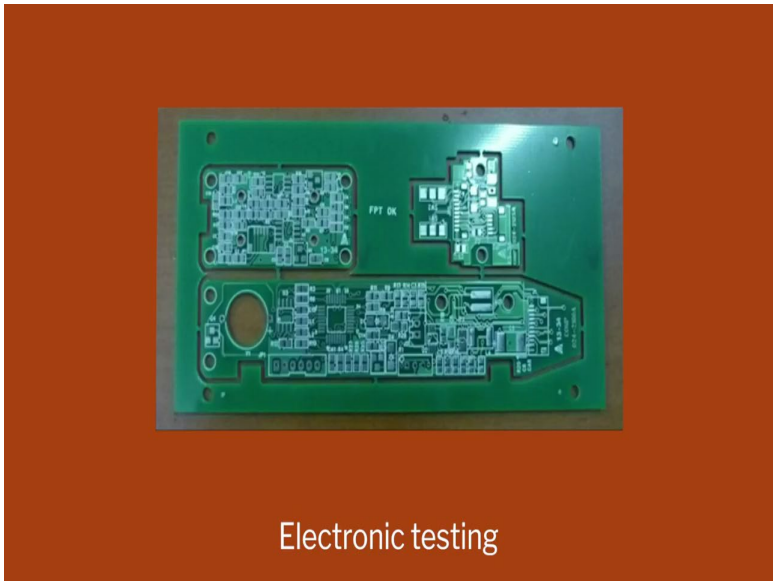

And a lot of compacting in terms of electronics, because you need electronics for multiple things. One is for sensing and another for vibrator.

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All those aspects have to be incorporated, and all of them should be within the handle. They should all actually go inside this small body and you have to do multiple technology related iterations to compact them and fit into this small.

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So these are the people, like, Wellcome Trust is an organisation based in the UK, and they fund 800 million pounds every year for medical and assistive technology charity, mostly product development and solution standard. So they gave us this liberal funding to do so that initial development cost can be met. The company which produces also got the entire, this thing, met and so that we can do. So, they are almost second to Gates Foundation in terms of funding in the world. Gates Foundation is still number one.

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And then we did a product release to people. The Prime Minister himself bought 3,000 units because he distributed them in his constituency, Varanasi. MP's also have a fund and a certain percentage can be used for distribution of that.

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We had a Mumbai release by Vidya Balan (Indian actress from the Bollywood industry) in this city. (We had) different camps which we had initially for people to know that such products exist, one needs to reach out in large numbers.

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There are also a lot of similar training programs. You can see Piyush probably training all the people in various countries. And these all Orientation and Mobility Experts who will now train their people in the SmartCane. So, there is a request from 65 countries. We have launched only in 20. We still have to reach out to other countries. We have not done that.

And I think the product, one thing which people found out particularly, because from the design perspective people think that this product is very simple to use. In spite of all the things the product finally comes out to be very simple. That is why this also now has more number of awards, (for) both the students who worked and others.

For example there is a TR35 which many of you may know which MIT review gives, technology, that is 35 innovations below 35 year every year get it.

Then this is also there in many international design museums like Smithsonian, then it is also there in Bill and Melinda Gates Foundations Discovery Centre. Also places like Scotland national Museum you can see the; and we did not go to anybody to this thing. I do not know how they came to know but this has also been accepted as a product for those exhibitions because of its impact.

This is excellent again, you have taken a lot of effort. I think the way you captured the total journey from the design is fabulous.