Interaction Design
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Lecture - 03
System Model, Mental Model, and Representation Model

Let us begin today's session by listening to a short story. The story is a bit historical and the title of the story is Grass, Fodder, Grass.

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What you are seeing on your screen is if you could identify you have Peter, he was Czar of Russia and he was also called Peter the Great. His full name was Peter Alexeyevich. He was Czar of Russia from 1962 to 1725. This story involves Peter, one of his military commander and his soldiers. So out of a recent experience involved with Sweden in the battle of Narva in the year 1700, Peter the Czar of Russia realized that he would have to professionally train his soldiers.

He found that his soldiers in the recent war with Sweden were not really exhibiting a professional attitude when it comes to military warfare. He understood that it was important for his soldiers to get trained in military traditions and discipline including the use of weapons and this is best possible during the peace time. So at the peace time, they could prepare themselves for the eventualities that would be coming later.

Once he passes through a company of soldiers what he saw was something unusual for his times. Soldiers were very well disciplined and they were marching in perfect order in their files. He also saw a young officer Radetzky in command of the soldiers who himself was marching ahead of the platoon. He went close only to realize that the commands used by the young officer Radetzky were not from the military manual at all.

Instead of asking his soldiers to follow an order like left right left, left right left, he was shouting grass fodder grass, grass fodder grass. Seeing this Peter pulled his horses lead ropes and he stopped to get a further closer look. He was a bit annoyed seeing that the military in the manual was not getting followed. He saw that the soldiers had tied something with their legs. They were tying green grass in their left foot and dried yellow fodder in their right foot.

The young officer quickly noticed Peter around and he ordered his men to halt. To his order, his man complained with the tough elegance. He came running to him and offered his salute. Peter asked him to be at ease and asked Radetzky what he was doing and why his soldiers had tied those things with their legs? The young officer told him that he was trying to train the soldiers in marching in an order.

This as an activity he was trying hard for so many days and his efforts were going in vain. His soldiers were not able to distinguish the left foot with their right foot causing a bit of confusion while they were marching. Thinking about his reasons of failure, the young officer realized that most of his soldiers were farmers. They came from far off places in Russia and would not understand a command like left or right.

However, since they were farmer, he presumed that they would know very well the difference between the green grass and the dried yellow fodder. These were the things his soldiers had known since their childhoods that was why he ordered his soldiers to tie grass in their left foot and a dried fodder in their right foot. After this modification, he observed that his soldiers were following his orders of grass fodder grass, grass fodder grass and were marching in perfect symphony with each other.

So there was a considerable improvement as a result of young officer Radetzky's tricks. Although, Peter was about to get angry with Radetzky for not following the military manual but he found his explanation quite appealing. In fact, he thought that it was quite an

innovative idea. Few weeks later, he summoned all his companies and their commanders for a march-past in the royal grounds.

From a distance, he could see a company with a young officer in command marching perfectly in an order. He and his soldiers were distinctly best amongst all the others present on the occasion. He asked one of his general who is that officer and the general replied Radetzky. So you see that the story is indeed interesting, is not it? But apart from being interesting does it has anything to do with our understanding of interaction design.

I would say that yes; it does have a lot to do with our understanding of interaction design. Like the young officer Radetzky in the year 1700 as the narrative goes in a similar way I think interaction designers are also required to understand their users. In fact, this is a theme of our last session. We paid a lot of emphasis on understanding user needs, desires, motivations, movements of frustrations and delights.

So one must try to understand users if one were to be an interaction designer. In fact, let us improve that statement. If you were to design interactive products which engage better with their users, then one must understand his or her user groups. Today's topic of mental models is one such topic which will help you understand your users better. The whole idea is to estimate in as clarity as possible and as much as confidence as possible what your user needs and how do they think about interactive products.

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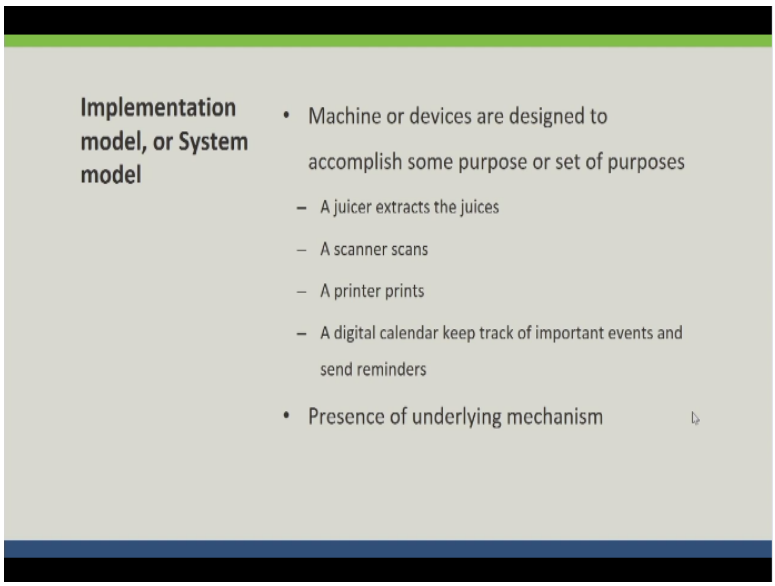

One of the very first thing that you will encounter while you are embarking on a topic of mental models is something called implementation model or system model. So you see that the machines or devices are designed to accomplish some purpose or set of purposes. What you are seeing on your screen is a written statement that says machine or devices are designed to accomplish some purpose or set of purposes.

So for example a juicer is designed to extract the juices out of fruits. A scanner is designed to scan the documents. A printer is designed to print the documents. In a similar way, a digital calendar keeps track of important events and send reminders and notifications. So you see that all of these and many other interactive products they are designed with a certain purpose in mind or a set of purposes in mind.

So there is a presence of underlying mechanism, the act of designing is also about paying emphasis on the underlying mechanism. You must have remembered that in our last session we had spoken that in a typical setup involving design and development of interactive product, there are teams which are working in tandem with each other. For example, the engineering team, the marketers team, the management team and the design team.

So if engineers were to design any such product, they would also put their logics in place. They would also try to see how information or any particular data point is flowing within that particular code or algorithm or mechanism. So there is a presence of underlying mechanism that is what we call implementation model or system model.

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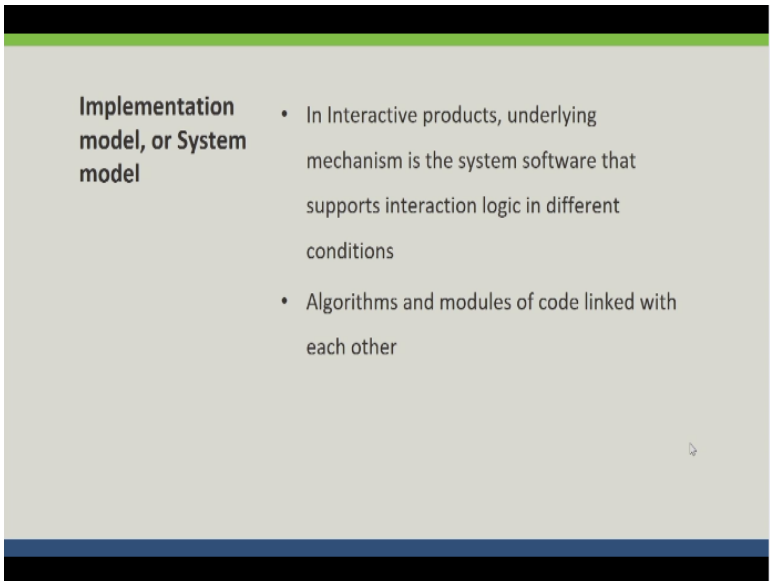

In interactive products, underlying mechanism is the system software that supports interaction logic in different conditions. So for example if you are listening to music on a music player which is maybe like a handheld music player, then there are different conditions under which a user is listening to the music. An engineering team had to imagine all those conditions and put logic in place in the algorithms or software that they design.

So in interactive products, I reiterate underlying mechanism is the system software that supports interaction logic in different conditions and these are algorithms and modules of code linked with each other.

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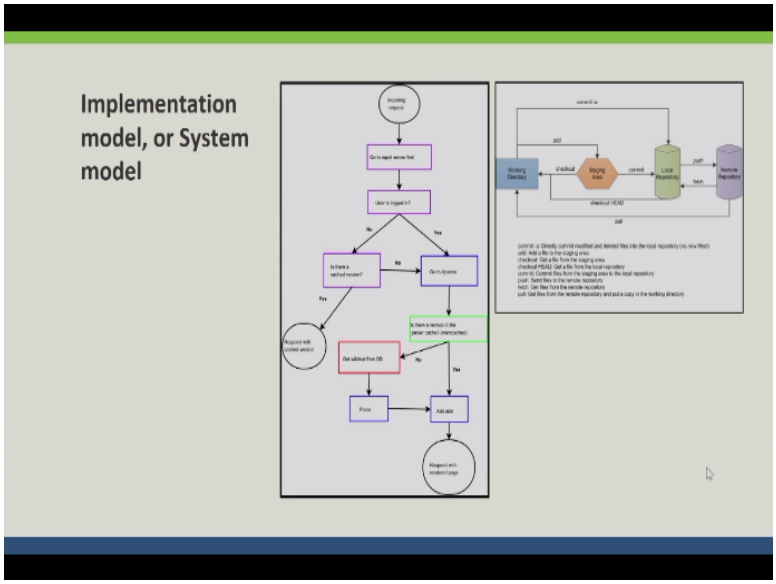

What you are seeing on a screen is one such system model or implementation model. So you see when I was talking about the algorithm or the logic, this is the logic which is not revealed to the user but it underlies the design and development of the system. If you notice your flow charts or the data base flow diagram on the screen, you would see that these are pretty mechanical in nature.

In the sense that these are modules of code that are linked with each other and they are communicating with each other under specified conditions. So there are lot of conditions which are being put and that is how beneath the interface layer is the entire engineering is accomplished. So what you are seeing on your screen is an example of implementation model or system model.

But as you would imagine users never get to see that. In fact, users are most unaware of these algorithms and data charts and information flows.

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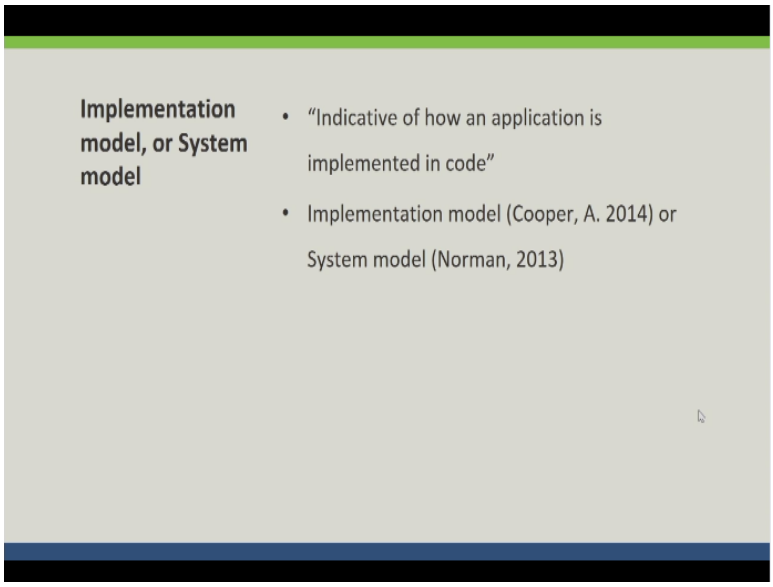

So in a way the implementation model or system model is with respect to the interactive product. It reflects the product vision; it reflects the engineering team or the team that is developing that product. How they are implementing different states of the model that is what the implementation model is suggestive of. So it is indicative of how an application is implemented in code.

And there are different as if we are using constantly two different terminologies. These two terminologies come from two different authors. So implementation model comes from Cooper, while the system model comes from Norman.

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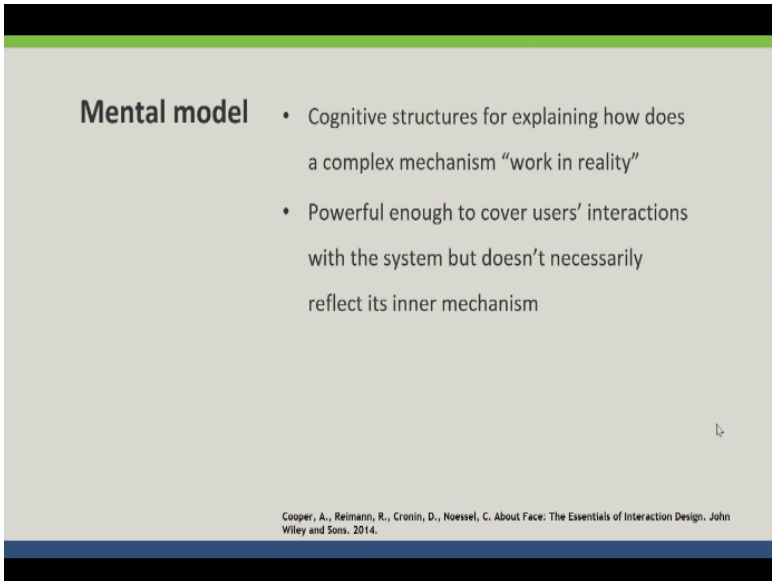

Let us move onto the mental model. The mental model is a cognitive structure for explaining how does a complex mechanism work in reality. An important difference between the implementation model or system model and mental model is that they both reflect two different entities. As you would have noticed, the implementation model or the system model was reflecting the machine or the device flow of information or different data points.

While it comes to mental model, it is the user's estimation of how the system works in reality. So for example, if you were to answer how does a scanner work while you might be completely unaware of how does a scanner really scans the document. You would eventually form an explanation which is good enough for you to use the scanner. So these are the cognitive structures which are used for explaining how does the complex mechanism work in reality, but these are powerful enough to cover user's interaction with the system.

And as I have said, they do not necessarily reflect its inner mechanism. The concept of mental model is burrowed from cognitive psychology.

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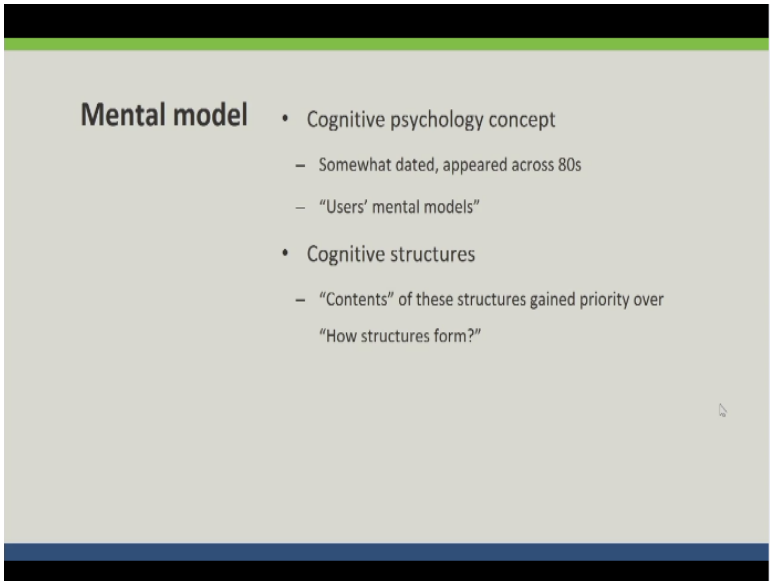

In fact, it is a bit dated, you found that the lot of studies in 80s mention mental models and the most common phrase that we encounter is user's mental model and these are as we have seen in the earliest lectures, the cognitive structures and it is important to know that in all the available resources we are given a good insight about the content of these structures. So what these mental models? What is the content of the mental models?

But there is a very less information on how the mental models themselves form. So content of these structures have gained priority over how these structures form and mental models are expressed with respect to skills.

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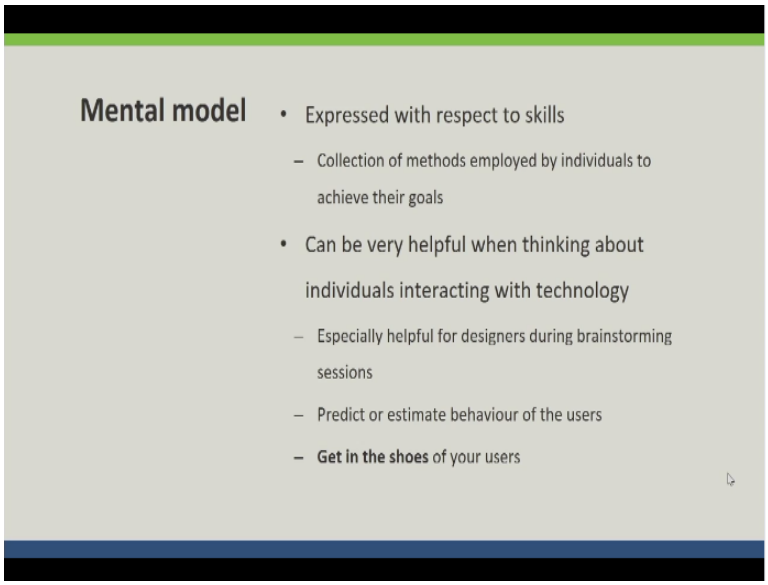

So while you are approaching to interact with an interactive product, let us say a smart washing machine which runs on its own which takes your clothes but does everything, it

soaks them, it agitates the cloth and it dries them for you. So if you are approaching one such interactive product, you are approaching with a certain skills in hand. So for example you can very well put the clothes into the drum. So that is one skill that you have.

So it is expressed with respect to skills. The other skill would be that you could identify that a specified level of water is required for a specified volume of clothes. You could understand those controls on the interactive washing machine. So you are approaching your interaction with any interactive system with a certain set of skills and that is where mental models are expressed.

So they are expressed with the respect to the skills. These are collection of methods employed by individuals to achieve their goals, can be very helpful when thinking about individuals interacting with technology especially helpful for designers during brainstorming sessions. So if you are aware of something called mental models during brainstorming sessions, you could contribute possibly more to the team.

And you could think in terms of how the users would think about your interactive product. So you would have the possibility to get into the shoes of your users and think like them. That would enable you to predict or estimate their behaviour.

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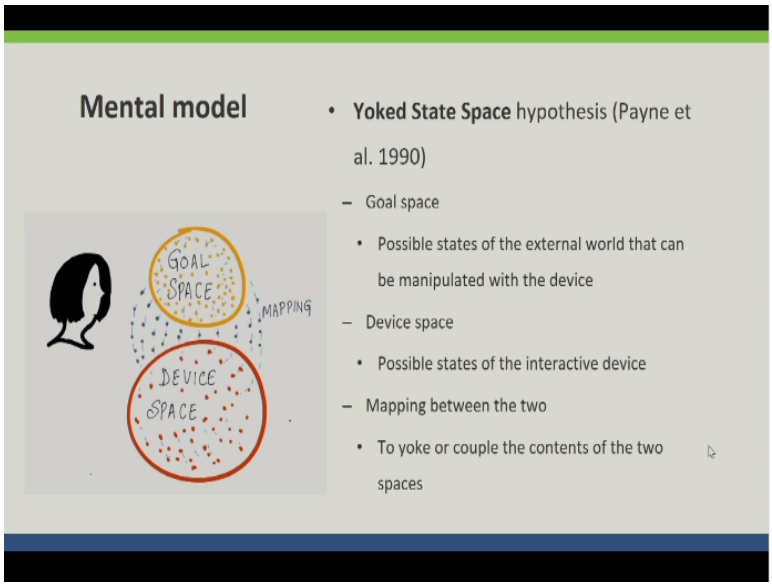

With respect to mental models, we have one interesting hypothesis in place. What we call as Yoked State Space hypothesis, YSS hypothesis. It was given by Payne et al. in 1990 and it says that what you are seeing on the screen please have a look at that. It says that every user

has a goal space and a device space okay. So he is saying that the yellow circle on the screen is the goal space while the red circle on the screen is the device space and both of these spaces have certain content.

So the content is the possible states of the external world that can be manipulated with the device, possible states of the external world that can be manipulated with the device okay. So that is the content of the goal space. While the content of the device space are all possible states of the interactive device. We will understand this concept very soon by considering a live example.

So as I am saying, the device space has possible states of the interactive device and the user wants to map between these two content types or the user wants to couple different contents in both the goal space and the device space. So that is what the Yoked State hypothesis is.

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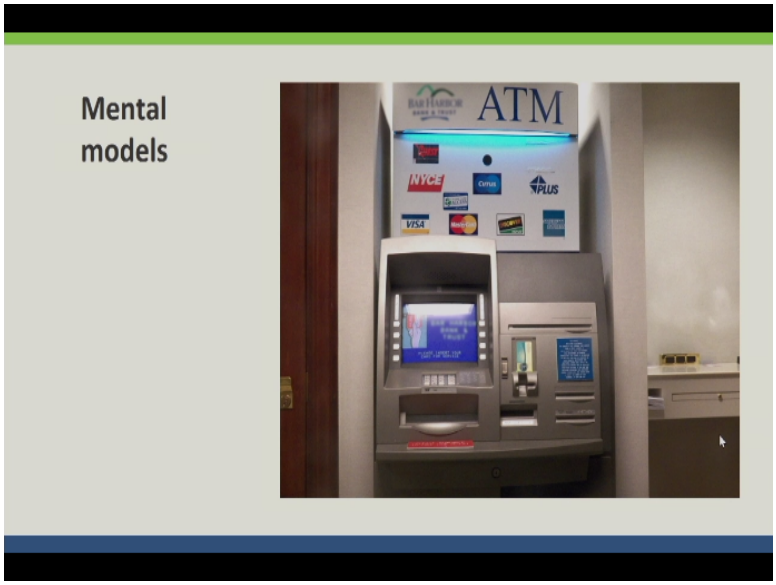

Considering the same hypothesis, Payne in 1991 he carried out a very simple experiment of asking people about their use of ATM. He interviewed users for their beliefs and for understanding of the mechanism behind ATMs. In fact, as a psychologist he was interested in knowing if people could explain how the ATM as a machine is operating, people gave him different explanations and he called those explanations the mental models.

So mental models in a way is a set of speculations given by the user to understand the inner working of the system.

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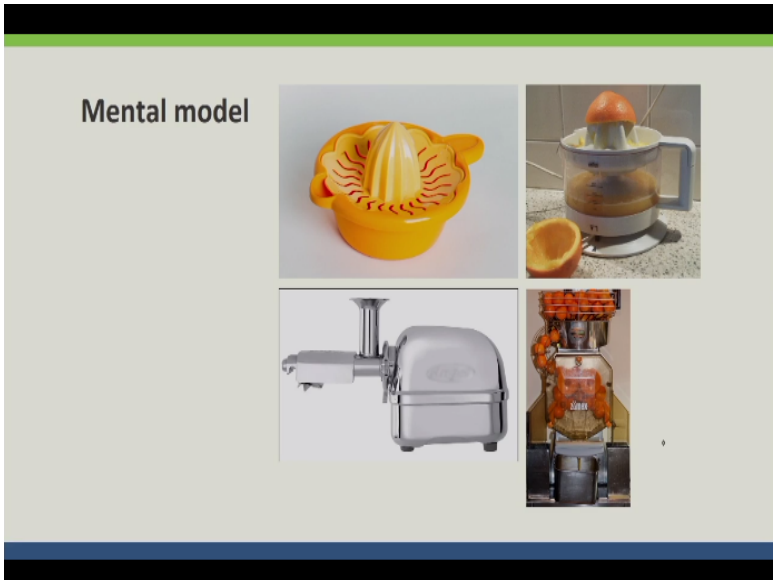

Let us consider the other example, on your screen you see different types of citric juicers okay. So maybe you have seen all of them. The first one is definitely something that we all have seen that is the citrus juicer, a plastic juicer most simplest of all. So while we are using and we very well know how does it work because we see it from our merchandise.

So we press the citric fruit against that protruded area and when we rotate it and we see that the juices are coming out and pouring towards the bottom of the container. That is the simplest of the citric juicer. Now consider the other one, we know that still we are doing almost the same kind of things but here the facility is we do not have to rotate the citrus fruit. You just have to press the fruit against the protruded area while the area itself rotates, those protrusions they themselves rotates.

And how do you rotate? There is a motor behind that. So still this is pretty interesting, I mean you could still explain this as a device. Now look into the third one which is more like a steel surface, cold press juicer. This is something which we may have some lesser familiarity with. So we do not know how does this extract juices out of a citrus fruit, we do not know, but we do have an idea that we see that there is a compartment where the motor is kept, while there is a pipe which is used to feed citrus juice.

And there must be somewhere you know some opening from where the juice is coming. So this is still now we are seeing you know from the yellow one to this stainless steel cold press juicer, we are seeing that how we are more entering from a real explanation of the device to a

speculative explanation of the device. If you see the one with so many of citrus juicers which is more like an industrial juicer, you may wonder how does it work.

And at times, you may be required to get closer and see its working. So you may want to get closer and you know see through these acrylic or glass casing and then you would be in a position to explain how does this industrial citrus fruit juicer work. So as the device is becoming complex, let us put in other way, as the technology behind juicing is becoming more and more exotic or complex, our explanation of how does the device work is getting more and more speculative.

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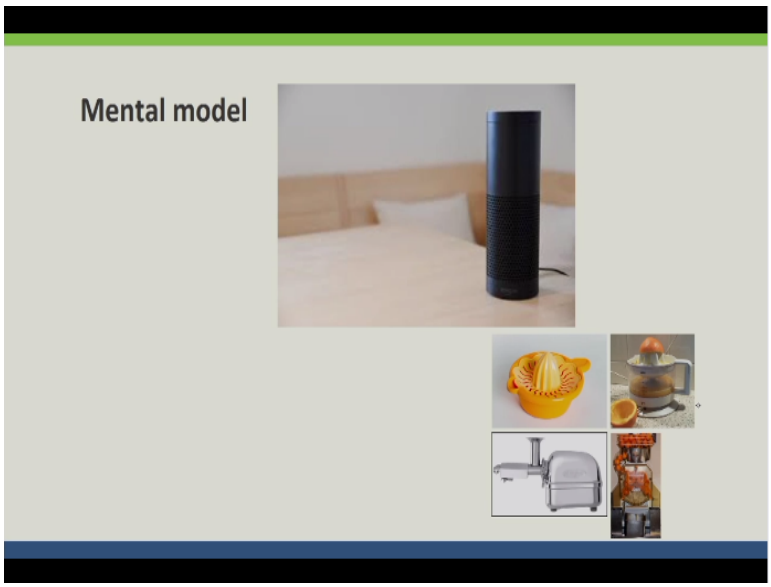

Let me give you one extreme example. Consider a smart or intelligent speaker which claims that once spoken it has the ability to run a juicing machine for you. How do you explain that? So you issue voice commands to this speaker and then it does something, it connects with the juicing machine which can receive its input and then the juice is ready on its command. So you are delegating the act of extracting the juice to the speaker and you are not yourself doing that.

While in all the other devices that we have seen earlier, it was you who was doing that. So how do you explain this particular interaction? So the point is that as technology goes on being more and more exotic, more and more complex, user's mental model becomes more and more shallow, magical and superficial. So they are more speculative in nature. I am going to give you a different study which is interesting when it comes to mental models.

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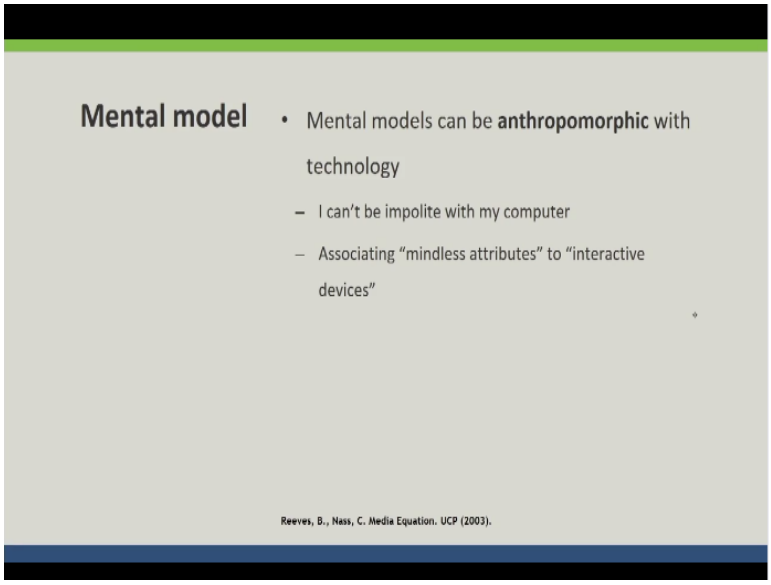

So mental models can be anthropomorphic with technology, so if you happen to look into the work of Clifford Naas and Byron Reeves in the book called Media Equation, you would find that they are reporting cases when people are trying to be not impolite with computers. So the experiment that they explain involved that you know you had computer which is running a tutorial for you.

And then the same computer asks how did I perform after the tutorial, people are not impolite to this computer. They would say no you have performed good. You know I have learnt a lot but if the same question is being asked by another computer about this computer then people are more truthful about it. They will say oh the computer A which was giving me a tutorial was not that good.

So you see that people are not being impolite to the same computer which has given them the tutorial but they are free to express themselves when it comes to computer B. In a similar way, what is happening is what they claim is happening is that the people are trying to imitate the social behaviour in a very normal day to day life which is more like a reflection of how they have been doing things for a long, long time.

And they are trying to replicate those things when it comes to interacting with computers. So the equation that they put is that people associate mindless attributes to interactive devices which is completely counter intuitive. You would never believe that a computer could be treated as a human being but yes you see that people are doing that. So mental models as the

technology goes more and more exotic, they could be more superficial, shallower and magical.

And there comes the idea of how do we design an interactive product which fits? So let us do a quick review. By now, we have seen what an implementation model is. We know that an implementation model is also called a system model. We have also heard about and have seen examples about mental model. We know that a mental model is a kind of a cognitive structure which is given by the users to explain the complex inner mechanisms of an interactive product.

Let us now come to something called represented model.

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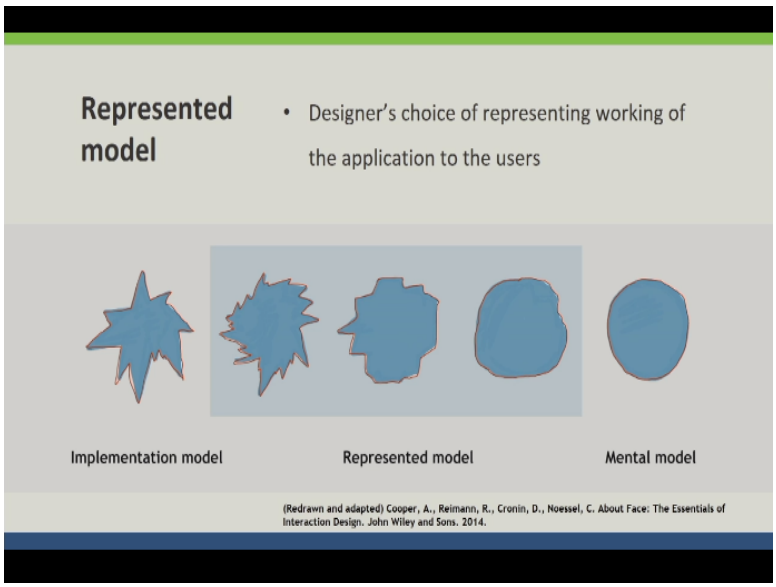

Represented model is designer's choice of representing working of the application to the users. So designers are in control of this model. What you are seeing on your screen are two different extremes in a scale, towards your left is the implementation model or system model and towards your right is the mental model or conceptual model of the users and in between you have 3 different varying shapes which indicate represented models.

And if you can imagine that you know implementation model indicates device structures, inner structures while mental model indicates user's vision. So if a designer has to come in between and he has to design an interactive product, he may design anything in between these two.

So what you are seeing on your screen are 3 different represented models which means that at one end of the scale is a represented model which is closer to the implementation model while at the another end of the scale is another represented model which is closer to the mental model. So implementation model as I was suggesting, it aligns with technology. It is the code, it is how you implement a technology, it is the database flow diagrams.

So implementation model aligns with technology. It suggests how different features of the device are implemented with a code or an algorithm or some database diagrams while mental model aligns with the user's way of seeing the world. So it is the designed model, the represented model where designers have a control, where designers can take decisions and the mandate of the designers would be that bring represented model as close as possible to the mental model.

So whatever you are designing should be as close as possible to user's imagination of how does the particular interactive product function. So that is why it is said that designers mandate is to bring represented model as close as possible to mental model. Interactive product was represented model is closer to user's mental model is better than those where represented model is based on implementation model.

So what you see on the screen you know the representation model which is closer to the mental model would be better in terms of satisfying user needs, desires and his goals. Then, the one which is closer to the implementation model. As designers, one must try to create designs which are closer to mental models and that is where you can design an interactive product which gives enough satisfaction to the users out of the interactions.

Mental models created by users often are simpler than implementation model. Considering this, as a designer if you were to design a represented model you must try to design it so that it becomes simpler than the implementation model. Remember this scale, you know you should try being closer to the mental model than being closer to the implementation model. Mental model is simpler than implementation model.

So a model which is closer to the mental model should also be simpler than the implementation model okay. So that is what is said in the slide. Let me introduce you to another interesting concept called affordance.

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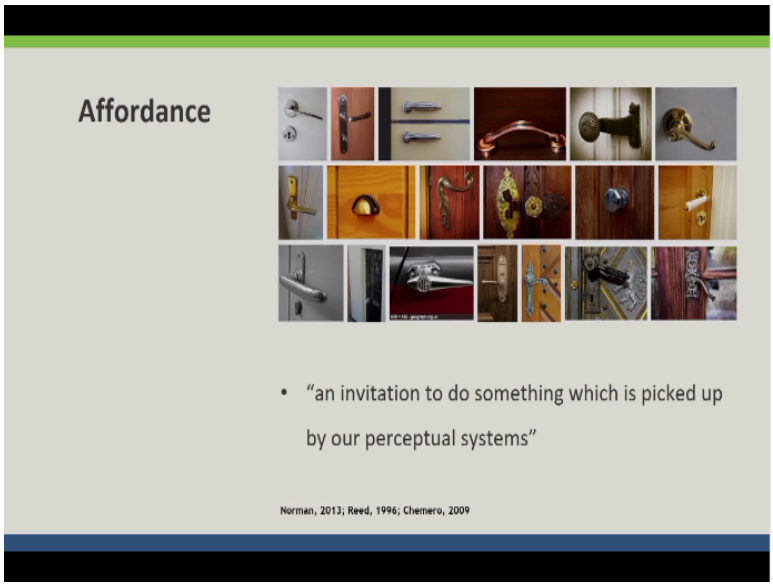

An affordance is an invitation to do something which is picked by our perceptual systems. So you know the different kind of images of all different doors that you are seeing in front of you on the screen, you can very well identify and you have a sense of where does the knob turns, whether I need to pull the knob or I need to push the knob, whether I need to bring the knob towards the downward direction to open or I should bring up to close.

So different door handles give you that invitation. They give you that clue so different doors that you are seeing in front of your screen provide affordance in terms of suggesting their users as to how they can be turned. So if you have understood this concept of affordance, let me show you this particular image.

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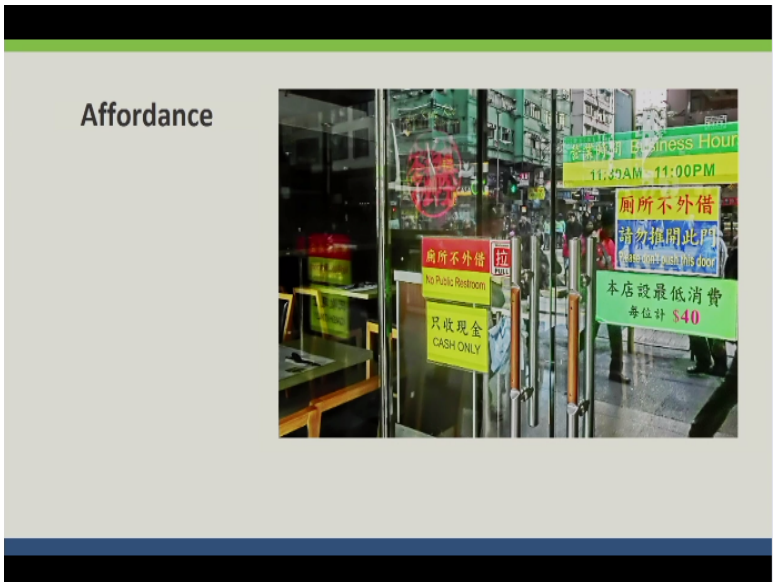

In the image, you can see that there are steel door handles okay. There are two door handles in fact and this is a glass door. There are lot of messages being conveyed on the glass board so no public restroom, cash room, cash only, please do not push this door, business hour, pull, lot of these messages. So do you think that the door has enough affordance? Well. let us take it closer look.

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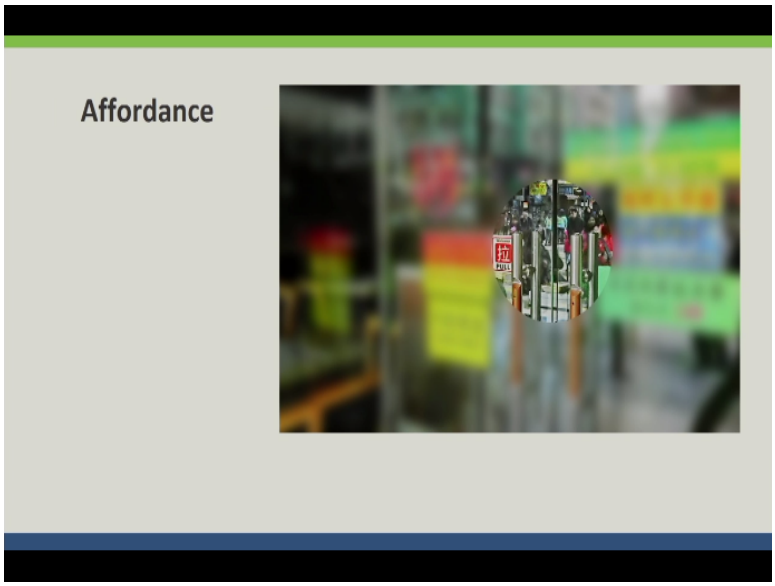

Let us clear the clutter, so next to door is this message called pull okay and if you zoom in the message is becoming more and more clear. So this door if you see this is a glass door and the handle itself its design does not suggest its user whether one needs to pull it or push it. The only message that it conveys is that you can hold the handle. This is where you should hold the handle. That is the only message this door handle conveys.

And that is where you need an additional message like pull or push along with this door handle. So if the designed artefact, if the designed object themselves do not have enough affordance then as designers you have to communicate an extra message to let people understand how to operate that product. With respect to interactive products, we modify this concept of affordance and we speak in terms of perceived affordance.

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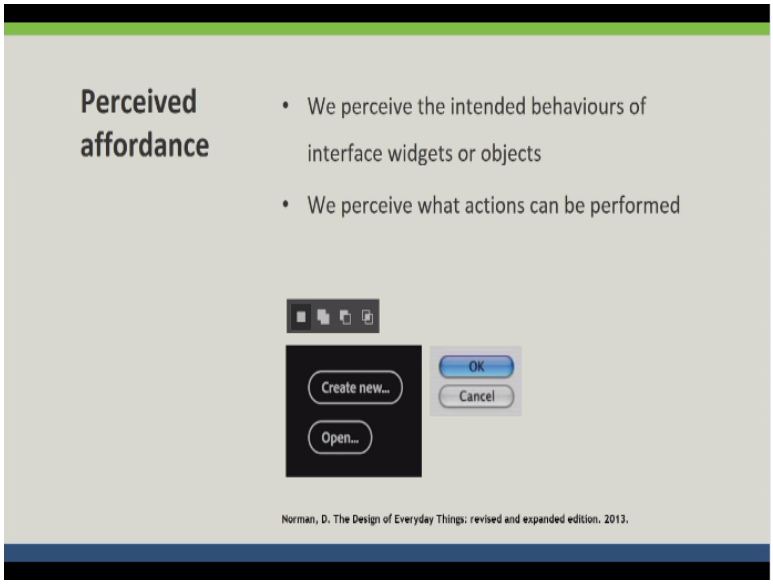

Because interactive products are slightly complex in nature, so we perceive the intended behaviour of interface widgets or objects. So something like a button that you see on your screen. You know when the button is pressed, you know when you hover over the button and you know when the button is active or deactive. So you get a sense, you get a message out of these different buttons that they are active, inactive, whether one is pressed or not.

So we perceive what actions can be performed and that is what we called perceived affordance. So you see that if you were to design an interactive product, in such a way so that the represented model is closed to the mental model then you should also consider affordances which are understood by the users. Let us come back to the topic of mental models.

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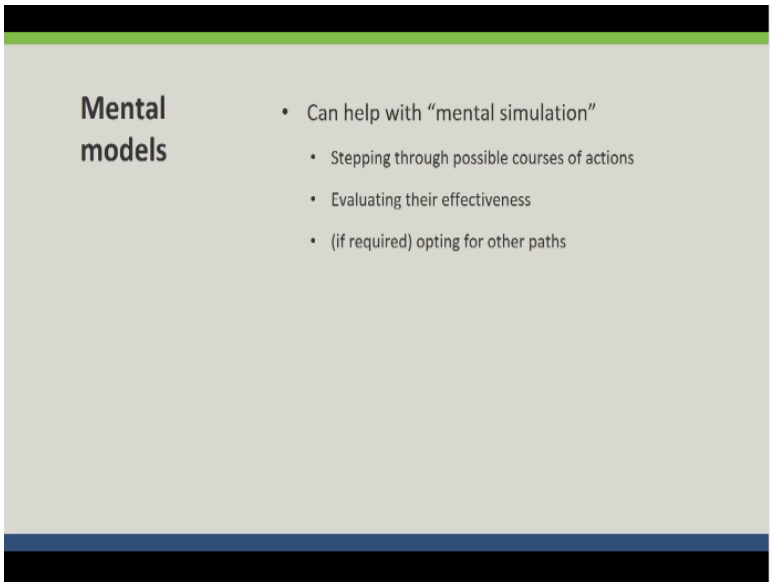

If you were a designer and you have the knowledge of user's mental model, how would it help you? So it can help with mental simulation, so for example you can step through possible courses of actions which might be taken by the users when they have different goals in mind that is something that you could do. You can evaluate the effectiveness of all these possible courses of actions.

And if out of your evaluation or judgment, you have found one of the intended course of action is not performing, adequately then you can decide to change that course of action as well.

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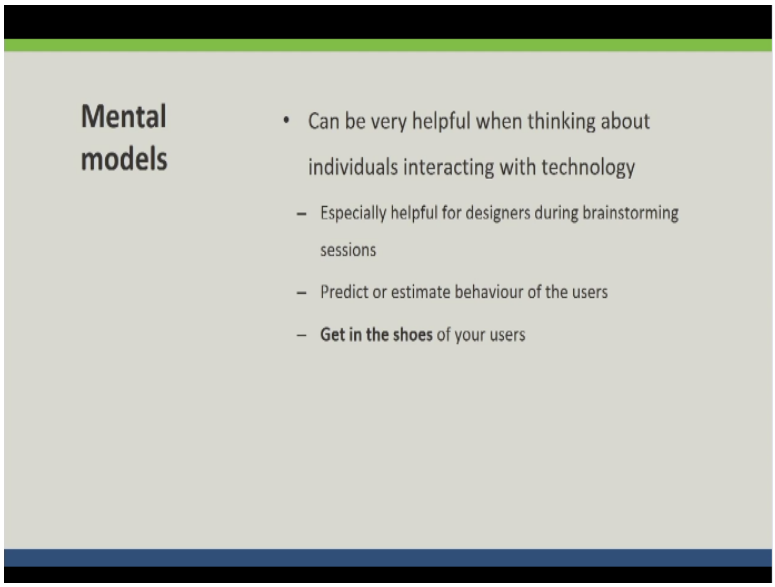

Knowing about mental models can be very helpful when thinking about individuals interacting with technology. Mental models can be very, very helpful when thinking about individuals interacting with technology especially helpful for designers during brainstorming sessions, predict or estimate behaviours of the user and as I told you earlier it helps you get into the shoes of your users.

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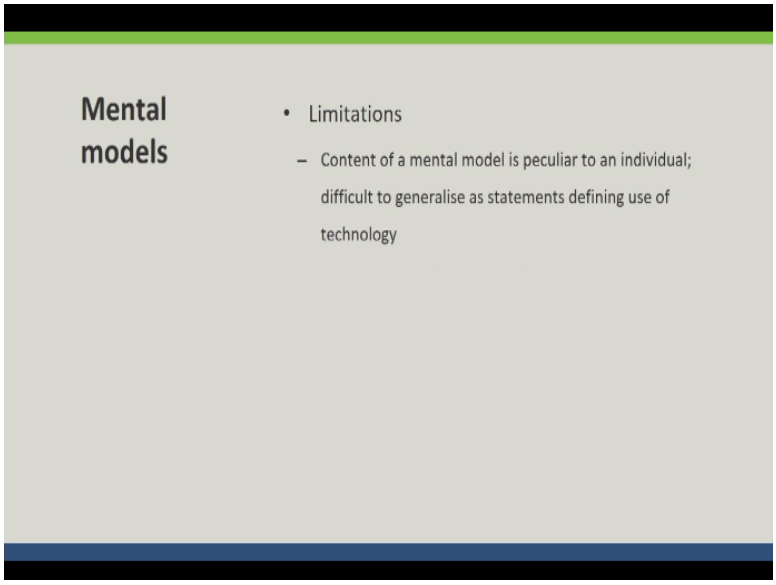

There are limitations to this concept as well. Mental models are often described with a respect to particular individuals. So it is very difficult to derive a generic understanding or a generalized insight just based on mental models. That is the limitation of mental models. In the Yoked State hypothesis, we know that the users create two different spaces. The first one is the goal space and the second one is the device space.

The contents of the goal space are all possible states of the external world that can be manipulated with the help of the device and the content of the device space are all possible states of the interactive device and as user one is interested in mapping these two contents across these two spaces. This concept might be a little harder to grasp, consider it with the help of an example.

Let us consider first goal space. It says contents of the goal space are all possible states of the external world which can be manipulated with the help of the device okay.

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So the device in the example is a normal printer, so the possible states of the external world which can be manipulated with the help of the device are the following.

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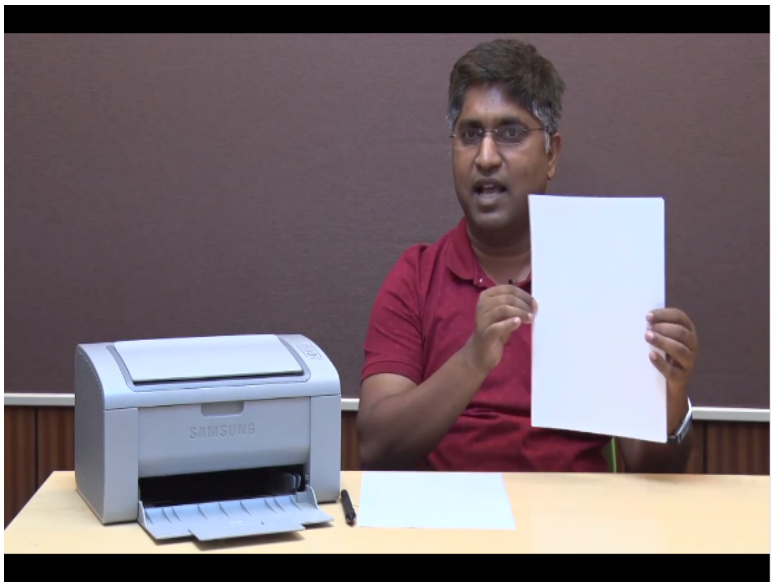

This is an external world, this is a physical paper and it has got two possible states. The first state is that the page is blank. There is nothing printed on the page. As a user, I might be interested in printing on this page. So that is these are two different states of this particular object in the external world that I am trying to manipulate with this device. So the other state would be as I am saying this is a printed page.

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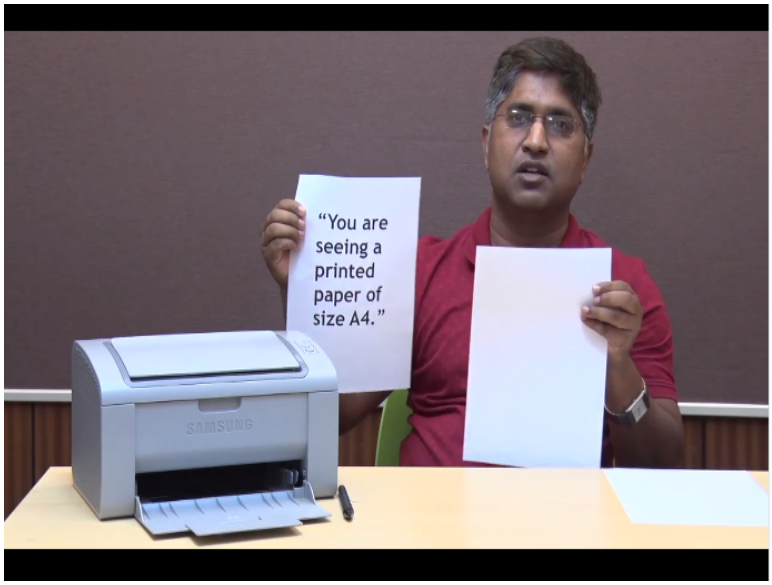

So these are two different states of this external world which can be manipulated with the help of the printer. What you do?

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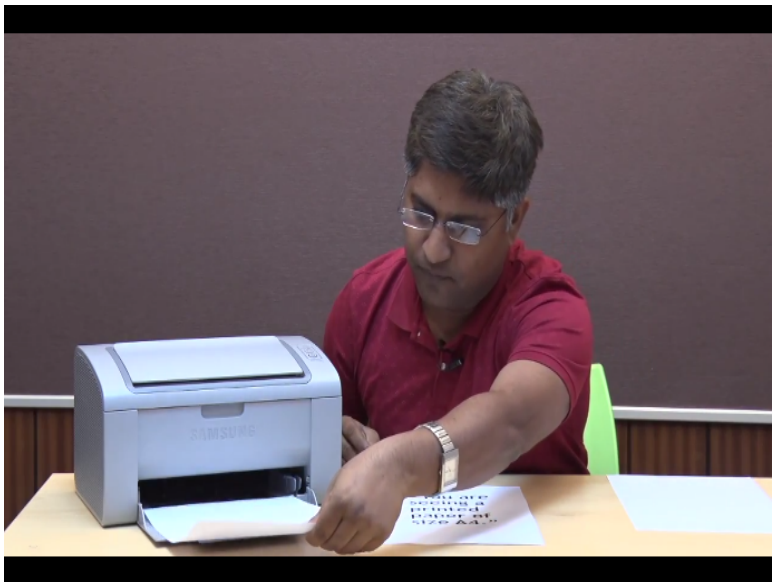

You put page in the printer tray and here if you see this is the device space. These are all possible states of the device corresponding to contents of the goal space okay. So the device knows whether there is a paper in the tray, device knows if the paper is stuck across different drums and the device also knows if the paper is successfully printed. So you see that if this is the device space, you have all possible contents of the device state.

It can be in an online mode, it can be in a standby mode, it can be in a troubleshooting mode. So these are all possible states of the device. This is the simple example to understand the

Yoked State hypothesis. Let me give you few more examples of affordance from our physical world.

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What you see in front of you is a pen like object and if you notice its shape, it is clearly suggestive of that one should hold it at this position. So if you see that the object has enough affordance that tells you where you should be holding it. Let us consider the other object.

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Even a simple water bottle suggests you from where you could pick it, so like the simple shape of the water bottle you know you can pick it here but it is something which is unusual, most usual position is this and nowhere on the water bottle is it written from where you should be holding it. So it is an invitation by the shape of the product which is picked up by the perceptual system of ours.

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Consider another example like this sprayer, like you could see that since there is a trigger which has to be initiated for it to start spraying, there is a particular shape which is given by the product designer so that you could by the nature of the very shape you could understand from where you need to pick it. So these are the examples of affordances from our physical world.