Usability Engineering
Dr. Debayan Dhar
Department of Design
Indian Institute of Technology, Guwahati

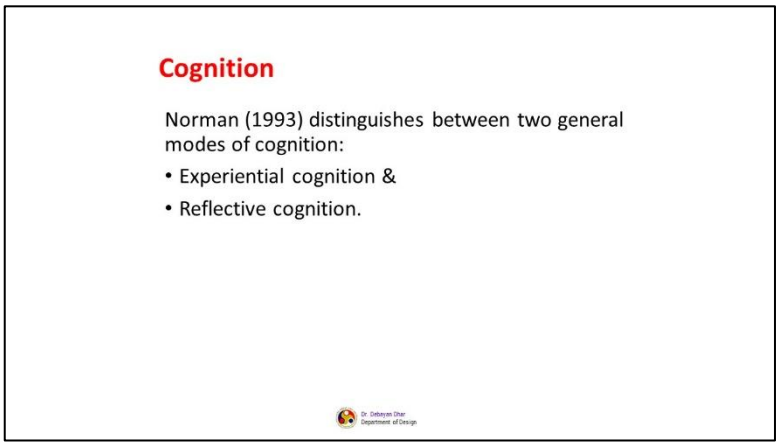
Module - 07
Lecture - 24
Cognitive Issues

Welcome to module 7, lecture number 24.

(Refer Slide Time: 00:40)

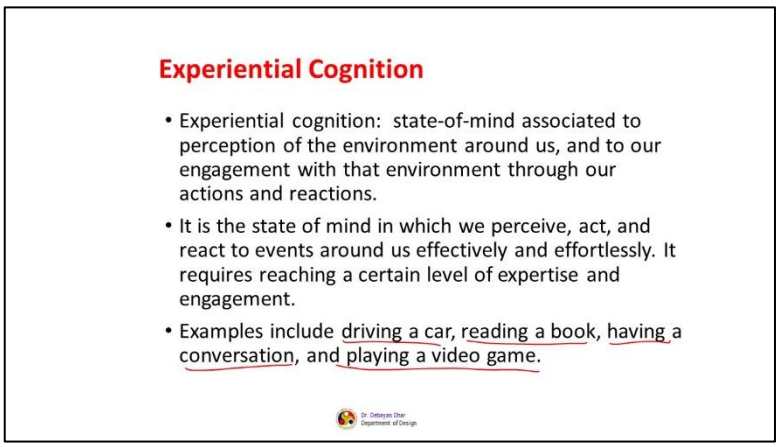
In this lecture we are going to discuss a little bit more on cognition, we intend to take forward the discussion we had in the last lecture. And we also intend to introduce two unique concepts which we called as the mental model and the conceptual model.

(Refer Slide Time: 01:00)



So, let us begin. Now, until now we have discussed the idea of cognition we have discussed about the various cognitive processes. We have also discussed about cognitive loads in specific to the situation, to the demands of the user. Now Norman in 1993 distinguishes two general modes of cognition. And he calls them the experiential cognition and the reflective cognition.

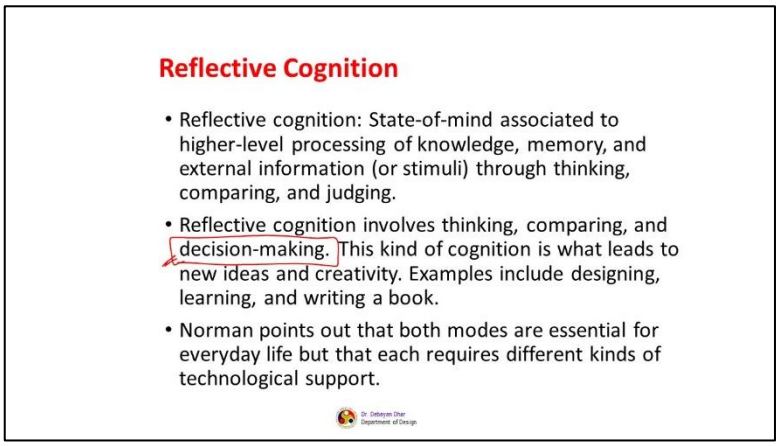
(Refer Slide Time: 01:44)



Now experiential cognition is a state of mind which is associated to perception of the environment around us and to our engagement with that environment through our actions and reactions. It is the state of mind in which we perceive act and react to events around us effectively and effortlessly.

It requires reaching a certain level of expertise and engagement, examples include driving a car, reading a book, having conversation and playing a game. Now, in all these examples one unique thing that you can see here is that all these activities, driving a car, reading a book, having a conversation and playing a game includes a little mastery on basic activities that play the foundation for these actions to get performed. And therefore, these are classic examples of experiential cognition.

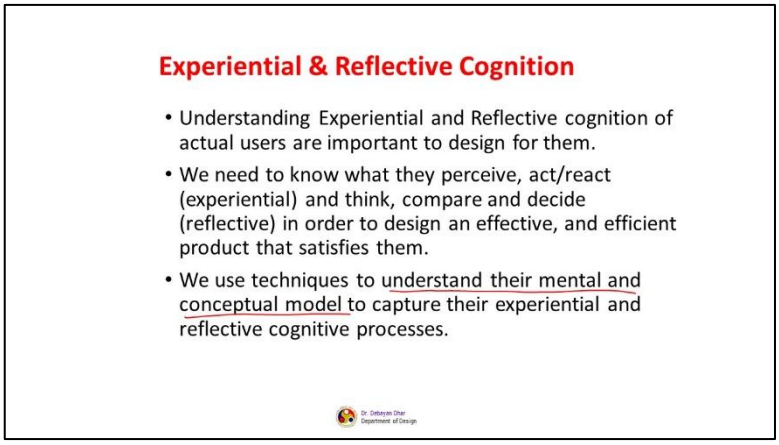
(Refer Slide Time: 03:06)



In the case of reflective cognition, it is understood that it is a state of mind that is associated to higher level processing knowledge. It is a higher-level processing of knowledge memory and external information through thinking, comparing and judging. Now, reflective cognition involves thinking comparing and decision making, remember this is what is our focal point as a designer. Now, this kind of cognition is what leads to new ideas and this leads to creativity. Now examples include designing, learning, writing a book.

So, Norman in this seminal work points out that both modes are essential for everyday life but that each requires different kinds of technological support.

(Refer Slide Time: 04:18)



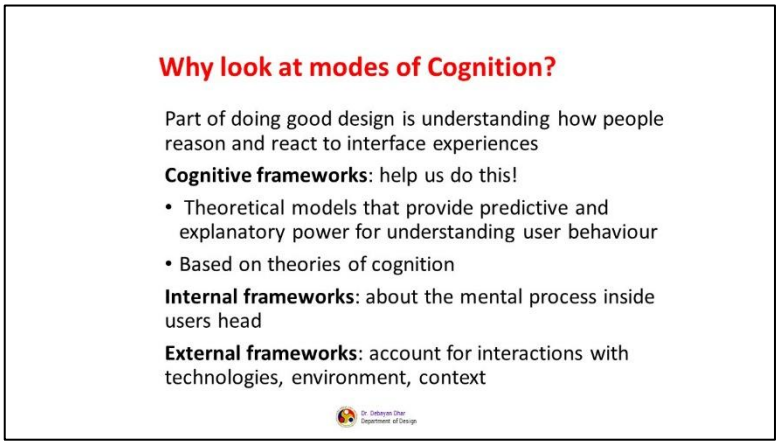
Understanding experiential as well as reflective cognition of actual users are important to design for them. We need to know what they perceive, act, react that means, the

experiential aspect of the activities and think, compare, and decide which is the reflective part of the activities in order to design an effective efficient product that satisfies them.

We use these techniques to understand their mental and conceptual model to capture their experiential and reflective cognitive processes. See here we are gradually entering into the periphery of the mental models that we would like to discuss. With the aspects of experiential and reflective cognition what we literally understand in terms of the structure is the way in which our actual users conceive or represent their reality.

And that is what we are going to discuss in the subsequent part of our lecture as the mental model and we would also see how this would support us in our endeavor to design an effective conceptual model that we are going to embed into our product.

(Refer Slide Time: 06:09)



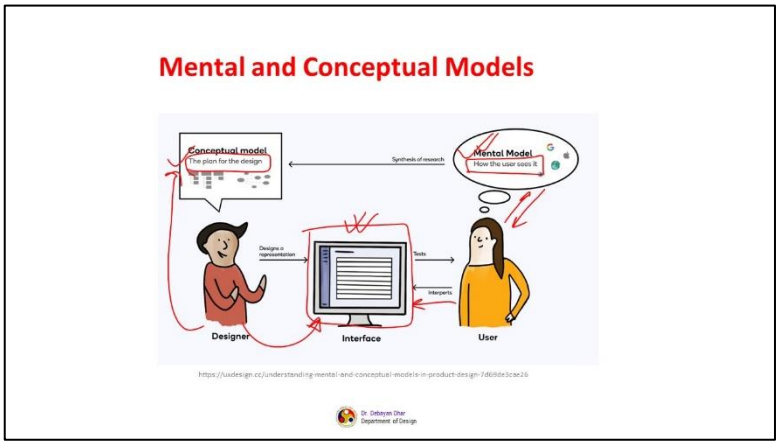
Now, why look at modes of cognition? Why do we need to understand or focus on these experiential and reflective modes of cognition? Part of doing good design is understanding how people reason and react to interface experiences. Cognitive frameworks helps us do this, as we start discussing about various frameworks we understand that these theoretical models provide perspective and explanatory power for understanding human behaviour. And these frameworks essentially are based on theories of cognition.

These frameworks are broadly classified as internal frameworks and external frameworks. Now, by internal frameworks we mean those mental process which are inside the user's head, that is operating inside the users head and by external frameworks are those that account for interactions with technology, environment and context.

(Refer Slide Time: 07:34)

Would now begin discussing about understanding mental and conceptual models in product design.

(Refer Slide Time: 07:43)



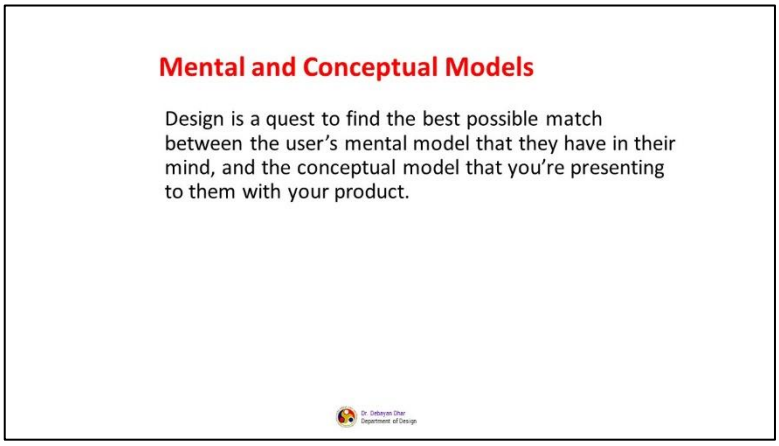
Carefully observe this illustration, you would realize that this illustration represents two very unique aspects of what we classify as the conceptual model and the mental model. When we talk about mental model, we see that this is the interface that we are talking about and it is being designed by the designer. Now, this user interprets and understands what this interface provides support to the user. Now, this person does all these activities in relation to the interpretation of the reality to the ideas and the concepts the user has inside him or her.

And that is what is represented as the mental model it means how the user sees it while the designer can be attributed to define the plan for the design; that means, whatever interface

or design the user perceives through the screen is something which can be articulated to the designer and it represents a model that the designer has conceived as part of the design activity.

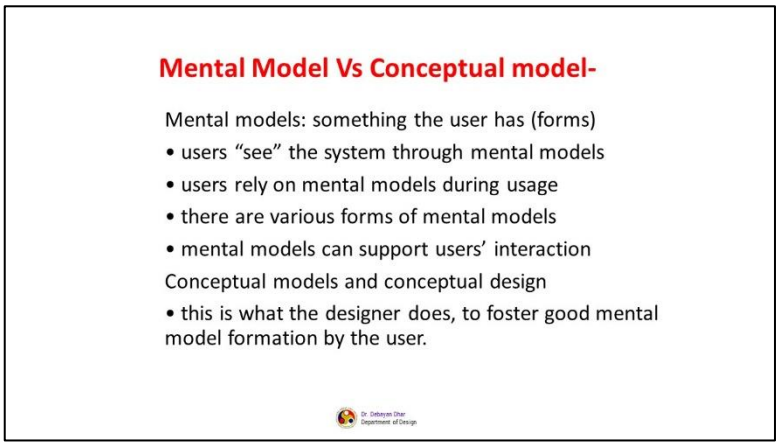
So, in short what we see is that the user interacting with the conceptual model of the product, this conceptual model represents the designer's model and this user interacts with this conceptual model in relationship with the mental model that the user has. Now, this interaction between the conceptual and the mental model is what ensures whether this interaction is going to get become a satisfied interaction, a meaningful interaction or whether it is going to be a interaction that would end the adoption of the product. Let us now discuss mental and conceptual models in detail.

(Refer Slide Time: 10:08)



Now design you must understand is a quest, is his journey to find the best possible match between the user's mental model that they have in their mind and the conceptual model that you are you as in as a designer presenting to them with your product.

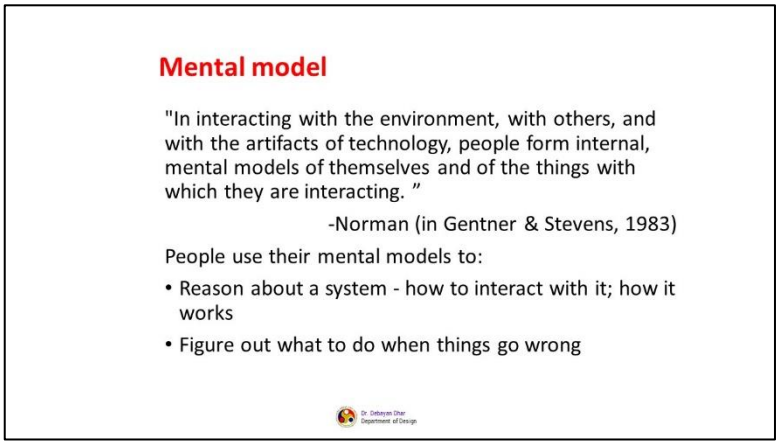
(Refer Slide Time: 10:32)



So, what do we mean by mental model? A 'mental model' refers to a user's underlying expectations, remember it refers to users underlying expectations and these are shaped from past experiences and these expectations about how something should work it is formed based on what they already do, or and their prior experiences with similar products, or by assumptions they have made based on how it appears. And these are also many a time known as perceived affordances.

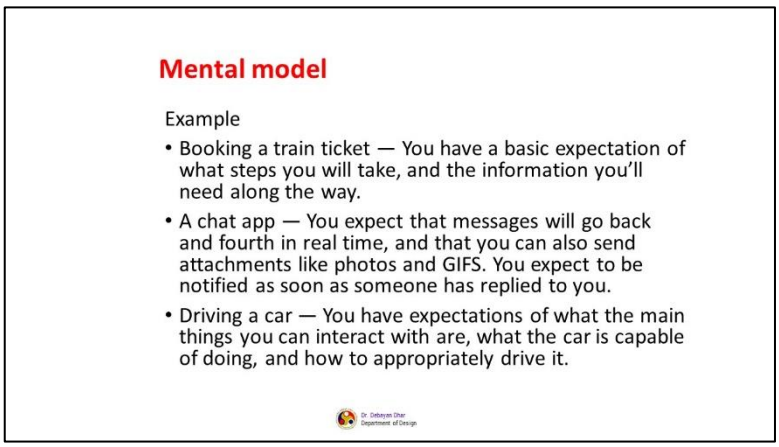
Now, understanding and designing for a mental model involves uncovering deeper understanding of motivations of their frustrations of their expectations and the requirement of experiences that they intend. The thought processes and the emotional state of your users independent of your product.

(Refer Slide Time: 11:49)



Norman correctly said that “in interacting with the environment with others, and with the artifacts of technology people form internal, mental models of themselves and of the things with which they are interacting”. People use their mental models to reason about a system: how to interact with it, how it works, how does it respond. Figure out what to do when things go wrong.

(Refer Slide Time: 12:27)

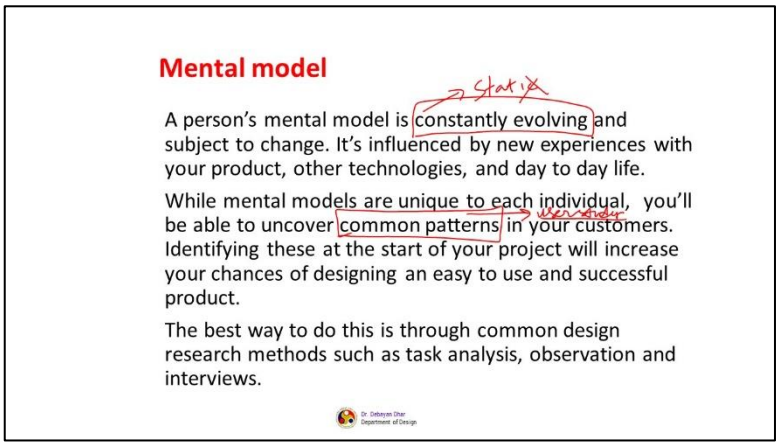


Let us take some examples to understand mental model more clearly, take the example of booking a train ticket. You have a basic expectation of what steps you will take and the information you will need along the way this expectation forms your mental model of the product that you want to use and get to reach your goal. Similarly, consider a chat app: you expect that messages will go back and forth in real time and that you can also send attachments like photos and GIFS.

You expect to be notified as soon as someone has replied to you, that is what we are referring to as a mental model, these are your expectations. Consider the example of driving a car you have expectations of what the main things you can interact with are what the car is capable of doing and how to appropriately drive it. Now, these expectations are examples of what we are terming as mental model and these influences how you are going to interact with the product in future.

They have the power to ensure that your interaction becomes a memorable experience or it breaks your expectations and ensures that the product does not get adopted because of gap in expectations or lack in expectations rather.

(Refer Slide Time: 14:16)

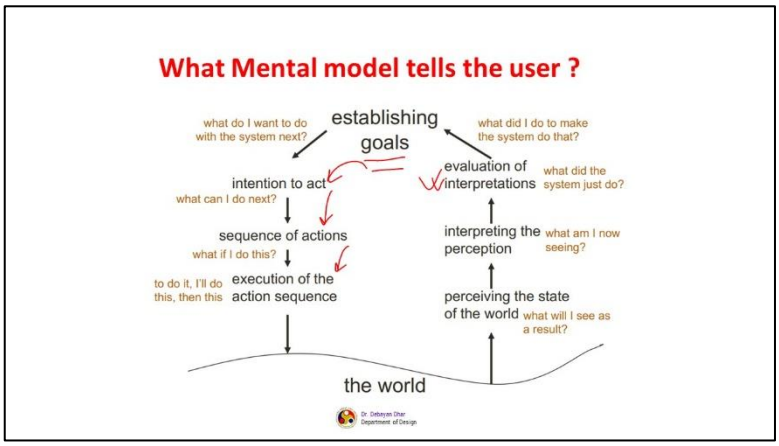


Now, a person's mental model is constantly evolving remember. So, a person's mental model is constantly evolving it is not static, it is not static. Now, why it is constantly evolving? It is constantly evolving because the person or the user in focus is has not stopped experiencing reality, continuously, every moment he experiences reality he interacts with the environment, he interacts with multiple products.

And as these interactions as these behaviors goes on the reality is defined again and again and therefore, we know that a person's mental model is constantly evolving and it is subject to change. So, it is influenced by new experiences with your product, other technologies and day to day life. While mental models are unique to individual you will be able to uncover patterns in your customers.

These are the patterns that we have extensively discussed during our user study phase. How do we identify these patterns and extract these patterns and see that we are designing for them, identifying these at the start of your project will increase your chances of designing an easy to use and successful product? The best way to do this is through common design research methods such as task analysis observation and interviews and we have discussed them in our in past modules.

(Refer Slide Time: 16:22)



Let us understand what mental model tells the user. What you see in your slide is the figure where in the bottom the world is being shown as a representation. At first the user perceives the state of the world, then he interprets the perception, he then moves to evaluation of interpretations. Then he establishes goals there is an intention to act sequence of actions take place after the intention is formed and then execution of the action sequence is performed that affects the world.

Now, if you see this journey what you will realize is that the moment this person is perceiving the state of the world what will I see as a result, this is what he perceives through his senses. And he then interprets what am I now seeing and this interpretation is an interaction, this interpretation and the valuations of the interpretation what did the system just do these are all being done in the context of the past experiences that the user has.

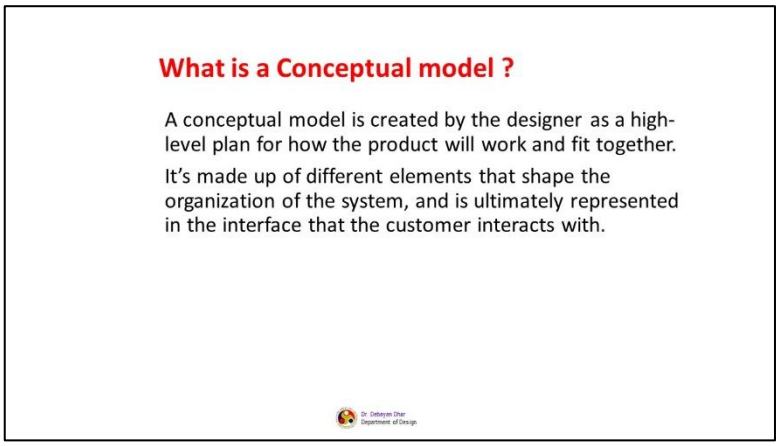
What did I do to make the system do that? Now, he is establishing goals from here, the next goal is; what do I want to do with the system? Next, he is now forming the goals; what can I do next? Ability to start approaching activities and actions in order to reach his goal; what if I do this? The sequence of actions now starts and finally, to do it I will do this then this, these are the actions that are being performed.

Now, this is a summary of the structure of the mental model of any user, any person, whenever he is there out there performing an activity or doing an action or task these are the ways through which his internal processes, his internal realizations happen. And it is important for us as a designer to understand these intricacies of the processes and to realize what are the barriers to these mental models while he is performing an activity. What are

the pain points, what are the frustrations, what are the motivations that what we have discussed.

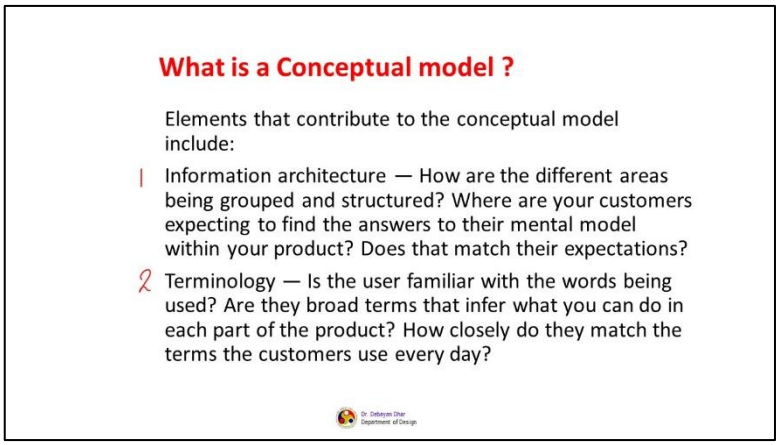
Because these are the important factors remember, that will influence his future adoption, his future interaction with the product that you have designed for.

(Refer Slide Time: 19:17)



We would now start discussing about a conceptual model. Now a conceptual model is created by the designer as a high level plan for how the product will work and fit together. It is made up of different elements that shape the organization of the system, and is ultimately represented in the interface that the customer interacts with.

(Refer Slide Time: 19:47)



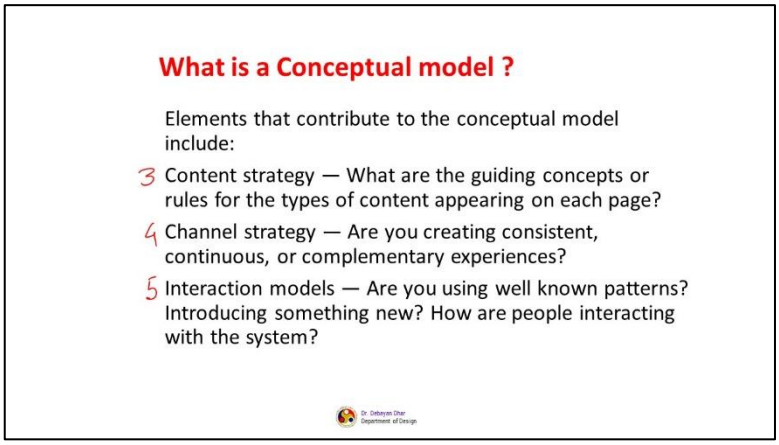
Elements that contribute to the conceptual model include information architecture now by information architecture we mean how are the different areas being grouped and structured? Where are your customers expecting to find the answers to their mental model

within your product? Does that match their expectations? So, in short, the way you are presenting information in this screen its hierarchy and the way these are linked together in a way through which the user finds a meaning out of them so that they can reach and complete his activity.

The second one is terminology: is the user familiar with the words being used? Are they broad terms that infer what you can do in each part of the product? How closely do they match the terms the customers use every day? Now, terminology plays a major role in ensuring that the your user find the relevant and important features right in your interface because if the terminology does not suit or is not relevant to the user he may end up in not even exploring your product.

If it is too broad he may conceive wrongly some functions as part of one because of the broadness of the terminologies. So, therefore, terminology is a very very important aspect of your conceptual model.

(Refer Slide Time: 21:33)



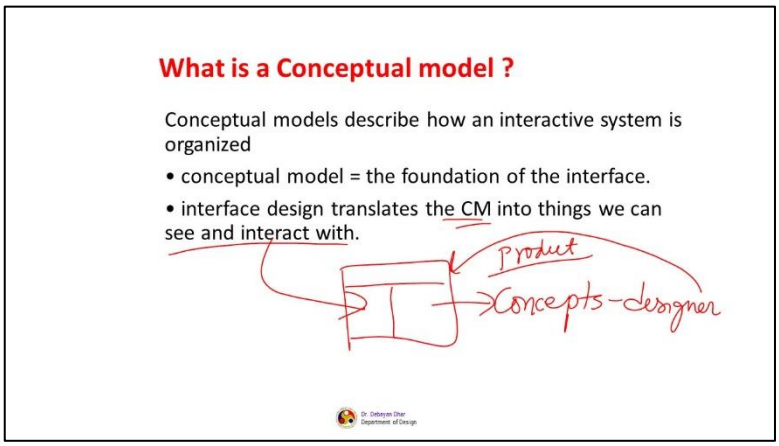
Third is your content strategy: now what are the guiding concepts or rules for the types of content appearing on each page? Remember there is a logic behind how your contents are being presented through the interface and these forms the basic structure of mental model of your user. If the basic logical structure becomes very close or similar to what the mental model of the user is there is a direct match between these expectations and the reality of the product.

Fourth, channel strategy: are you creating a consistent, continuous or complementary experience? Consistency is very important for adoption of products. So, what kind of

strategies are being defined by you as a designer to ensure that it is consistent throughout the product lines, it is continuous. It is not looked upon as if it is something different than what you have already offered earlier. So, these experiences matter in product adoption and in defining how it is being in sync with the mental model of the user.

Then interaction models: are you using well known patterns? Introducing something new? How are people interacting with these systems? We will discuss them in detail now.

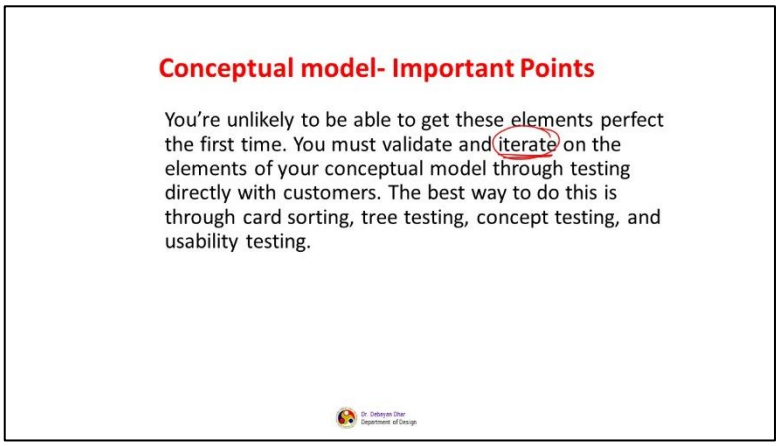
(Refer Slide Time: 23:13)



Now conceptual models describe how an interactive system is organized, conceptual model means the foundation of the interface. So, the entire interface that you are trying to conceive is what are the concepts that you have that the designer has and is embedded as a product, as the product right.

So, conceptual model is the foundation of the interface, interface design translate this conceptual model into things that we can see and interact with. So, what you see as an interface is actually a conceptual model that the designer has put forth in order to ensure that the requirements of the user are met.

(Refer Slide Time: 24:09)

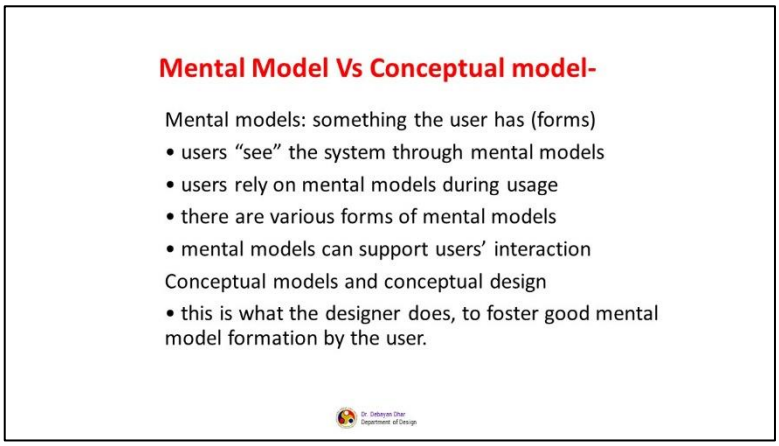


So, you are unlikely to be able to get these elements perfect the first time. Remember, that when you are designing a conceptual model it is very tough that the first, the first exercise that you do that you would start doing in this course if you want to you would get all these things correctly in the first time. No, you must validate and iterate the mantra for being successful in conceptual design is to spend a lot of time in iterating your concepts on the elements of your conceptual model through testing directly with users.

See we have talked earlier about this also and we now see the relationship of the importance of iterativeness of the design process. Whenever you feel you are stuck you are stuck with defining the conceptual model go back to your users, go to your actual users, go for testing get their feedback and work accurately. This is how you ensure that the conceptual model is in close sync with the mental representations of your or the expectations of your user.

And the best way to do this is through card sorting, tree testing, concept testing and usability testing which we have discussed earlier. We would be discussing about usability testing in the subsequent lectures. Now, how do we differentiate between these two that we have discussed until now, mental model and conceptual model?

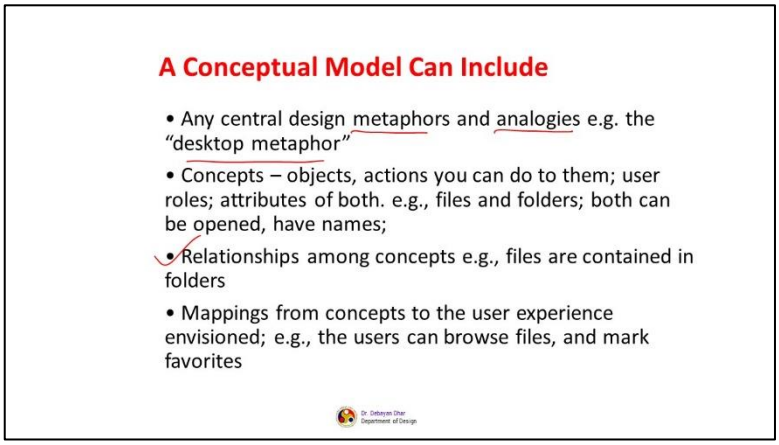
(Refer Slide Time: 25:41)



Now, mental models are something that the user has, these are his expectations. The user "see" the system through mental models: this is how he perceive that the system would be these are his expectations. Users rely on mental models during usage: so, when his when a new product is introduced and the user intends to use the product it is these mental models that define how he is going to adopt that product, how he is going to start interacting with the product.

There are various forms of mental models and mental models can support user's interaction. Conceptual models and conceptual design because we are talking about conceptual models that are being designed by the designer this is what the designer does to foster good mental model formation by the user.

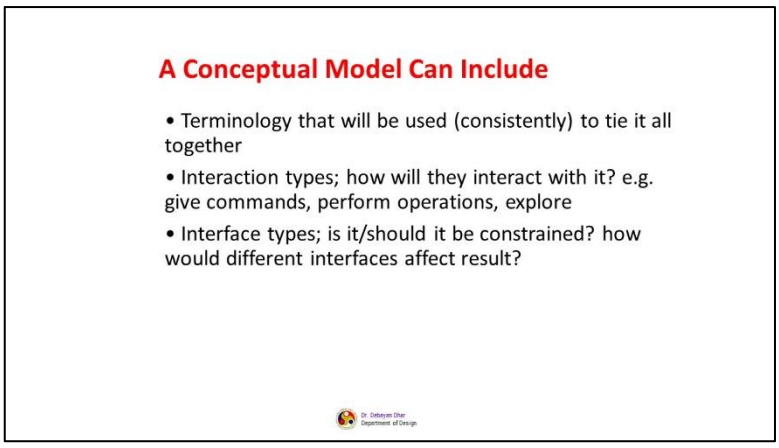
(Refer Slide Time: 26:49)



Now, a conceptual model can include what? Let us discuss about the factors that it includes. Any central design metaphors and analogies it must include metaphors and analogies like a “desktop metaphor”. It must include concepts like objects, actions which you can do to them; user rolls; attributes, files and example files and folders; both can be opened, and have names. Relationships among concepts, right files are contained in the folders, these are relationships of these entities.

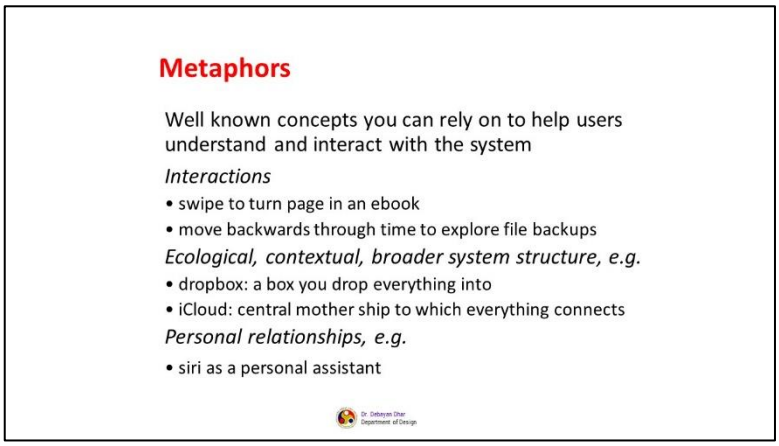
Mappings from concepts to the user experience envisioned, the user can example the user can browse files and mark favorites right.

(Refer Slide Time: 27:40)



Terminology which we have already discussed, that will be used consistently to tie all this information together. Interaction types; how they will interact commands, perform operations, explore. And finally, the interface types; should it be constrained how would different interfaces affect the result of their performances so on and so forth.

(Refer Slide Time: 28:11)

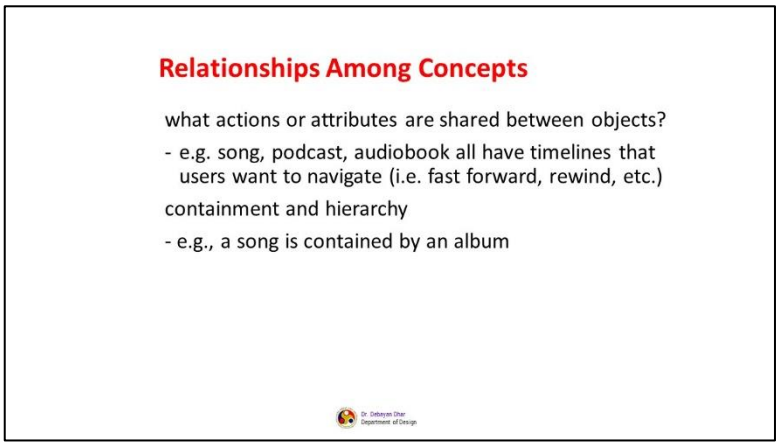


And we will now start discussing each one of them in detail. Let us start by understanding metaphors. Now, you create a conceptual model you must understand that the ideas that you are forming should have a metaphoric representation to the reality in which your users are working. Because that is how they would understand the relationship of what you are try as a designer you are trying to express through your design queues.

So, metaphors are well known concepts you can rely on, to help users understand and interact the system. Interactions some examples of metaphors are like the swipe to turn page in an ebook these are metaphors, move backwards through time to explore file backups, these are also metaphors. Ecological, contextual broader system structure, example; drop box: a box you drop everything into a very nice metaphor.

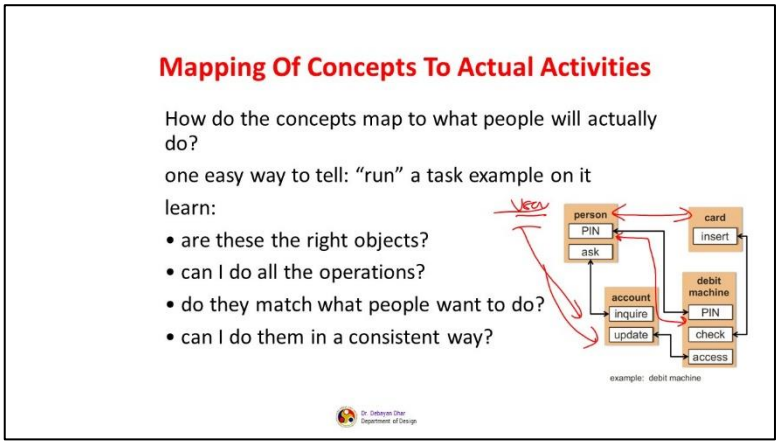
Personal relationships for example: Siri as a personal assistant is also a metaphor for personal relationships right. So, metaphors allow your user to get related with the functions that they are aware of, that they are using everyday day in and day out and with these they intend to start interacting with the conceptual model of the product that you have designed right. So, check out with metaphoric design, metaphors should be the first point where you should start exploring, how conceptual design meets the expectations of the mental model.

(Refer Slide Time: 30:06)



The second part is relationships among concepts. Now, what actions or attributes are shared among objects? Example: song, podcast, audio book all have timelines that users want to navigate, fast forward, rewind examples. So, containment and hierarchy example: a song is contained in an album right. So, these are the relationship between concepts and these should be very very clear in terms of the reality that the users are aware of.

(Refer Slide Time: 30:51)



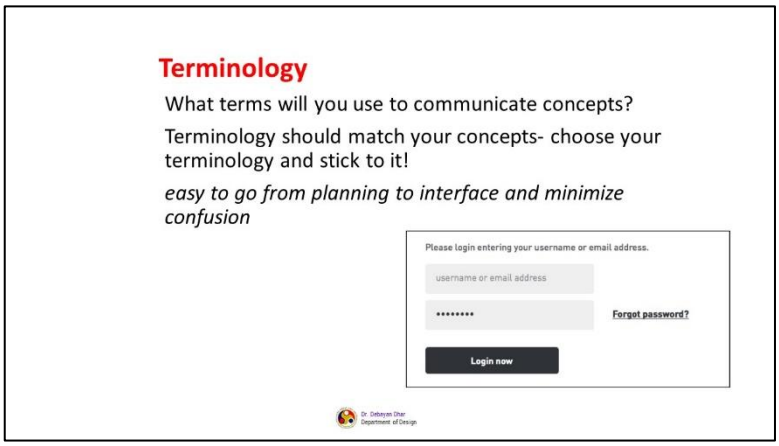
Mapping of concepts to actual activities. How do the concepts map to what people will actually do? One easy way to tell is "run" a task example on it. You can run a task example for example, learning are these the right objects? Can I do all the operations? Do they match what people want to do? Can I do them in a consistent way? You know in this slide what you can see here is the example of a debit machine.

Now, you can see a conceptual model and you can see how these concepts are being mapped to actual activities. So, the person is the entity that we are referring to as the user and this person has the pin and when he inquires he is inquiring about an account in terms of the activities like he can ask for an update. He can ask the debit machine and check he can check for his account details.

He can access and update his account details and he did all he does all these things by ensuring that his PIN matches with the PIN that is being registered along with his card. And all these actions are being performed in relationship or in interaction with the machine that the user performs using the card. Now, whenever you feel that you have issues with understanding these activities or you want you are getting issues in mapping the concepts go for running an experiment with your users.

And it is there that you would be able to understand whether the conceptual model that you are defining in terms of the actual activities that are being performed are being actually reflected by your users or not.

(Refer Slide Time: 32:56)

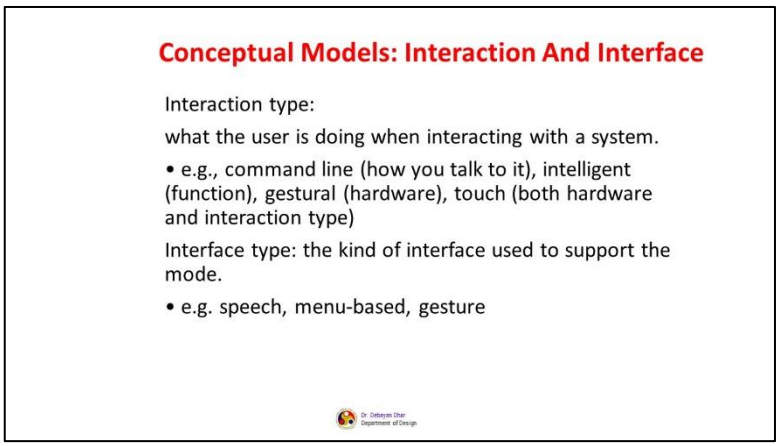


Then terminology: what terms will you use to communicate concepts? Terminology should match your concept, choose your terminology and stick to it. Easy to go from planning to interface and minimize confusion because terminologies can confuse, many a time you would see that interfaces are designed with such horrendous terminologies that even before performing the activity your user get confused by reading those terminologies.

Ensure that these are not repeated and you are you as a designer must see to it that you use terminologies which your users are aware of and they have already an idea of the activity

that these terminologies would perform. So, therefore, the most important thing that we should keep in mind is that it should not be too abstract, it should be specific in terms of the activities that it triggers or that it does.

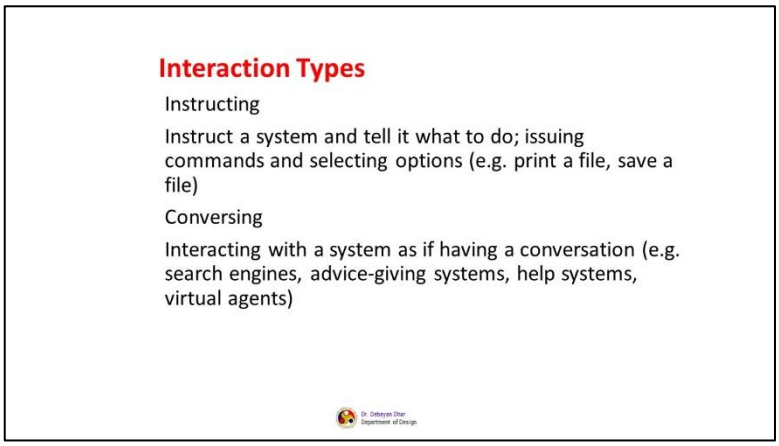
(Refer Slide Time: 34:04)



Now, when we talk about conceptual models it is important to understand that how we define the interaction type. Now, what the user is doing when interacting with a system? Example, he can interact with the system using a command line, like how you talk you just you know make a statement, he can use an intelligent function ok; gestures, touch all these things are interaction types.

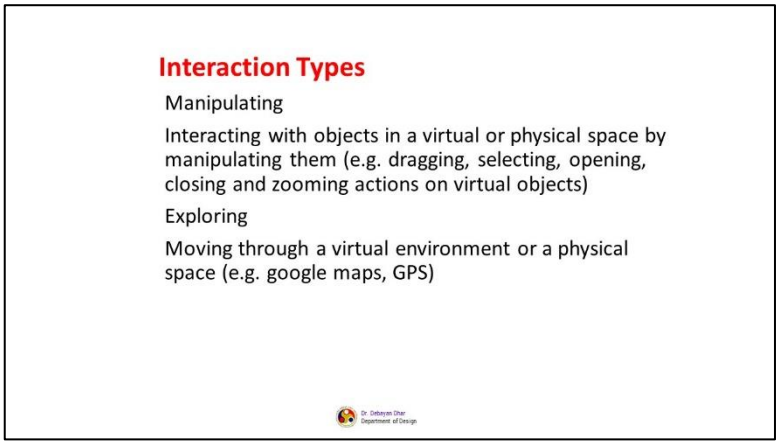
Because these are giving inputs a trigger input to the system to respond and the interface type can be anything it can be a speech-based interaction type, it can be a speech-based interface. It can be a menu-based system where you have a lot of menus you click on the menus and see whether you would like to go where and see how to complete the task, it can be a gesture-based interaction gesture-based interface ok.

(Refer Slide Time: 35:07)



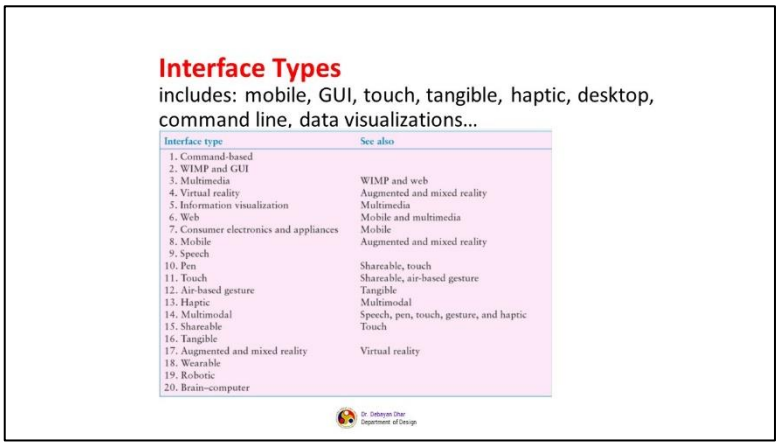
Now, interaction types can be instructing or conversing. So, by instructing we mean instruct a system and tell and tell it what to do; issuing commands and selecting of options example: print a file, save a file, so on and so forth. Conversing means interacting with the system as if having a conversation; that is search engines, advice giving systems, help systems, virtual agents so on and so forth.

(Refer Slide Time: 35:41)



Then we have manipulating: interacting with objects in a virtual or physical space by manipulating them; that means, dragging, selecting, opening, closing and zooming actions on virtual objects. Then we have exploring moving through a virtual environment or a physical space like the Google maps, the Global Positioning Systems GPS.

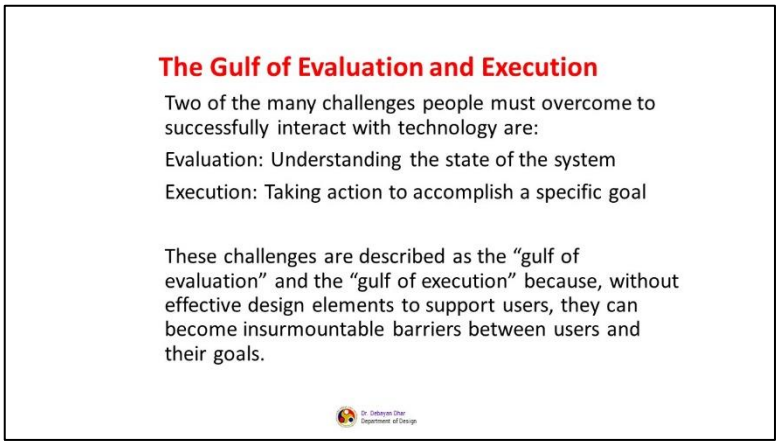
(Refer Slide Time: 36:15)



Now, we also have a lot many interface types and this includes mobile, graphical user interface, touch, tangible, haptic, desktop, command line, data visualization. I just compiled a series of various interface types that you see command-based, WIMP and GUI, multimedia, virtual reality, information visualization, web, consumer electronics and appliances. The hardware based interface, the mobile, speech, pen, touch, air-based gestures, haptic, multimodal, sharable, tangible, augmented and mixed reality, wearable, robotic, brain-computer right.

All these things are examples of the various interface types that can be used as a way through which your user interacts with the product. You can look at each one of them going to detail about their structures and see how you can create them as a part of your conceptual model as you design your interface and conceive the product to address the need of the requirements, to address the requirements of your users.

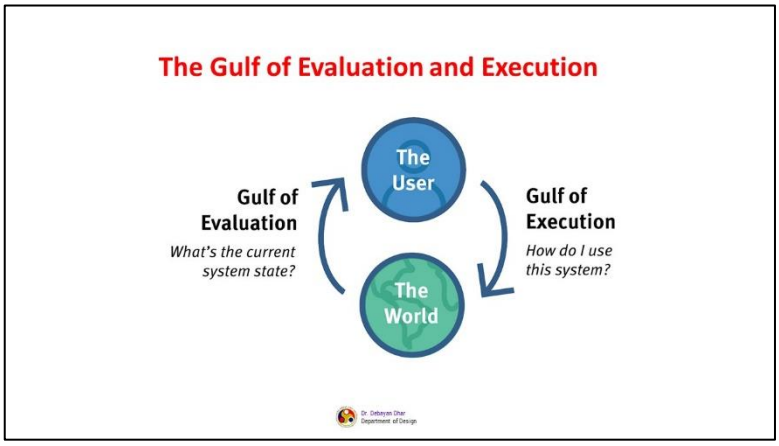
(Refer Slide Time: 37:33)



Now, with this understanding about the mental model, the conceptual model, it is important that we now discuss about the gulf of evaluation and execution. And this is important because understanding how mental models plays a role in ensuring product adoption would make us aware about how precisely we must define our conceptual model.

See there are two of the many challenges people must overcome to successfully interact with technology and these are evaluation and execution. So, when we say evaluation we mean understanding the state of the system and when we say execution we mean taking action to accomplish a goal. Now, these challenges are described as the gulf of evaluation and the gulf of execution because without effective design elements to support users they can become insurmountable barriers between users and their goals.

(Refer Slide Time: 39:01)

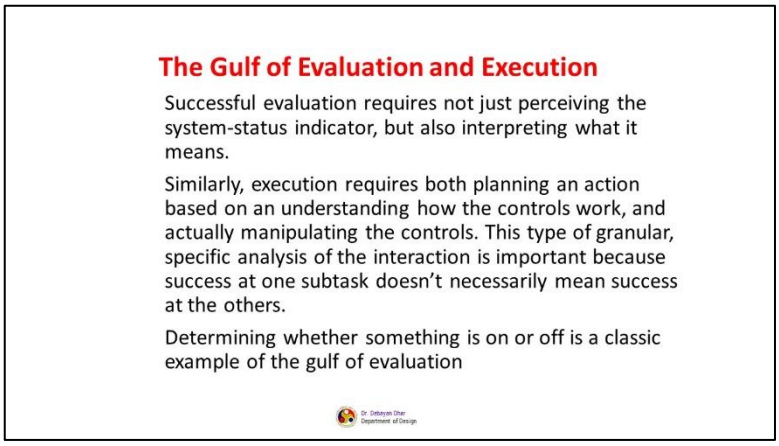


What you see in this image in this slide are the examples of gulf of evaluation and gulf of execution. You see the user is there and the world is there, the reality your product is there. What is the current system state? Is the gulf of evaluation, while how do I use the system? Is the gulf of execution when the user tries to interpret the reality; that means, when the user is trying to understand the product. We consider this phase as the gulf of evolution because he has a mental model the product that you have designed as a conceptual model and now the user is trying to interpret that product.

So, therefore, he is trying to understand the situation, he is trying to see how distant his expectations are from what reality he has in front of him or her. And the gulf of execution means he is trying to interpret he is trying to not only interpret, but he is trying to execute functions, he is trying to work with the product. Now, the extent to which he has to jump

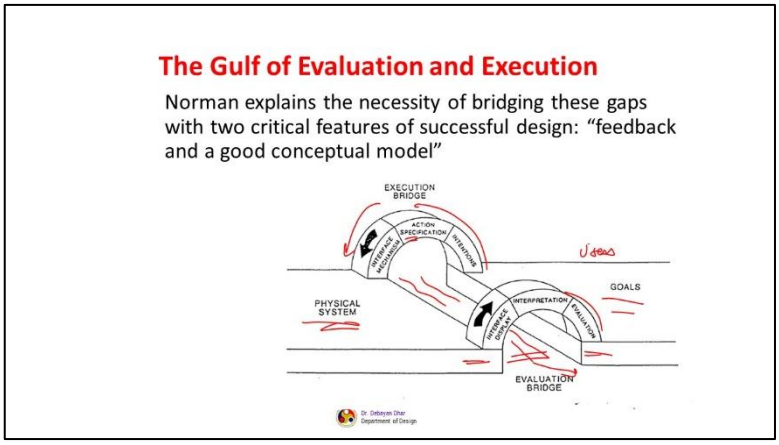
from his expectations, from the mental model in order to start interacting with the product is what we call as gulf of execution.

(Refer Slide Time: 40:27)



Now, successful evaluation requires not just perceiving the system status indicator, but also interpreting what it means. Similarly, execution requires both planning and action based on an understanding about how the controls work, and actually manipulating the controls. This type of granular specific analysis of the interaction is important because success at one subtask does not necessarily mean success at others. Determining whether something is on or off is a classic example of gulf of evaluation.

(Refer Slide Time: 41:25)



Now if you look at the figure you would understand about the gulf of execution and the evaluation bridge. Now Norman explains the necessity of bridging these gaps with two critical features of successful design and these are "feedback and a good conceptual

model". So, what you see in the figure is the physical system and these are the goals of the users and there is this bridge that exists.

What you see is that this physical system has interface that is displayed to the users and the users first evaluate and then interprets it in order to understand how to appreciate or conceive the reality of the physical system. And then the user form intentions, action specifications are executed and interface mechanisms are used to actually use the physical system. This gap that you see between the physical and the goals are the gaps because of the distance between what the conceptual model is offering and what the user's expectations are.

And this is what we call as the gulf of execution and the gulf of evaluation, this is the execution bridge and the evaluation bridge, two sides of the situations.