System Design for Sustainability
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Lecture - 04
Systems Approach to Design

Hello everyone, this lecture is meant for all those students who do not have an idea about what is Systems Approach to Design. In this particular course this will be a very important concept to keep into consideration. When we going to discussing about sustainability and how to design for sustainability, you will see that how systems thinking designing with a systems approach is the key element of in this particular in a course. So, let us go through the basics of systems approach to design.

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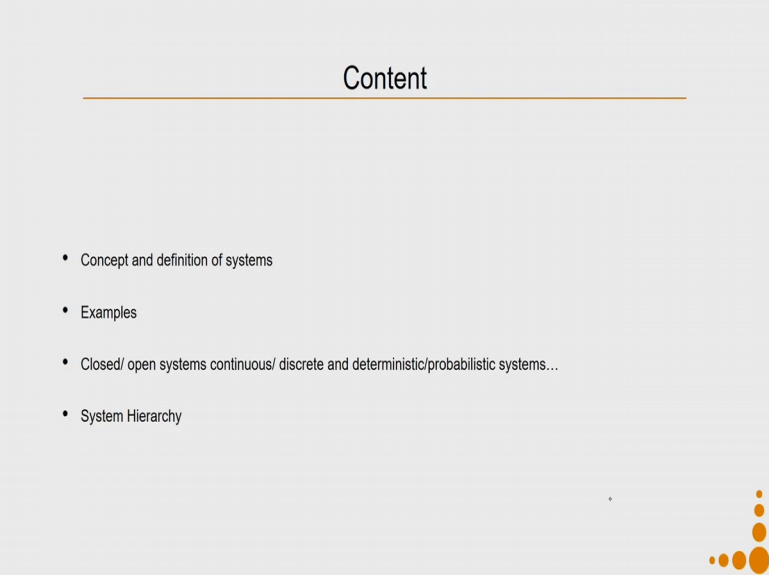

What we will cover in this particular lecture is, we will be talking about concepts and definition of systems, then we will see through certain examples to understand more about systems, then we will go and look into different different types of systems. So, like closed or open systems continuous, discrete systems deterministic probabilistic systems and so on.

Then we will look at system hierarchy and finally, we will try to understand how to make a systems map so, that we can get this systems approach to design. So, let us go ahead. So, the first question that that comes to our mind is what is the system? You might have

use this word very casually and yet you might have been right in the usage of the world. Say for example, you might have said the educational system in our country in a works in this particular manner or you could have said that the system in this particular mess to get food is by paying at the beginning of the month, we commonly used this term system.

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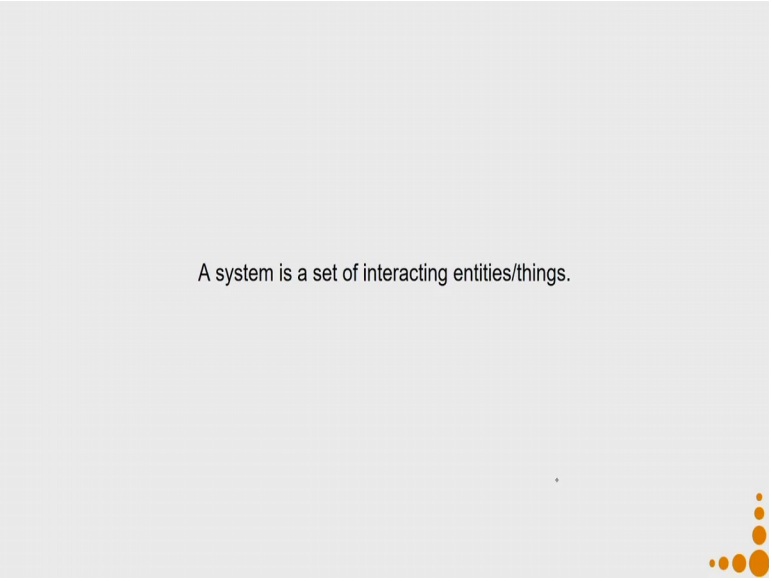

So, what is the system? So, a system is a set of interacting entities and things. So, as we ahead with the whole course, you will know that everything is about systems. So, whenever there are one or more entities or things they are interacting with each other we get a system.

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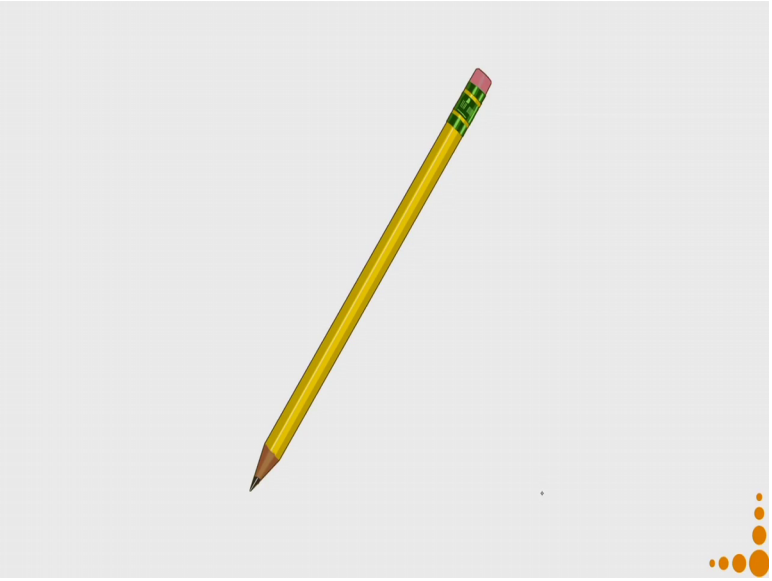

Say for example, this pencil; this pencil is a product it is an entity or it is a thing.

Now, when I see this pencil I can have different types of pencils, I can have hb pencil, I can have 2h pencil I can have bb pencil as one there are many types of pencil I can also have coloured pencil.

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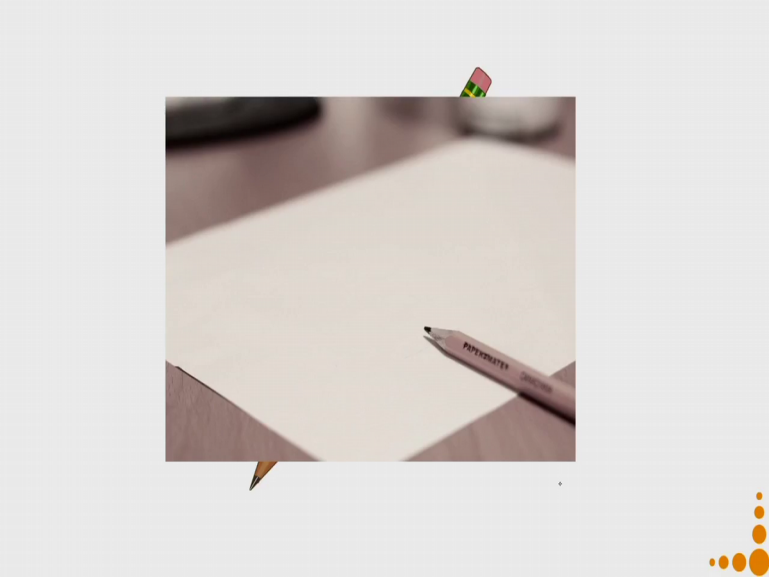

Now, if I think of this pencil as one entity or thing, as soon as I bring a paper and the pencil and I considered the paper in the context of pencil, I might say this paper is not good to write with this pencil or this paper is very nice to write with this particular pencil

or whatever.

So, what we are talking about now this pencil and paper are interacting with each other. So, they have together become a system which is the writing system. Now I have to hold this pencil in my hand and I have the write, for that you as a kid you are taught how to write with the pencil still not everyone of us right with the pencil the same way, we all hold the pencil in different manner somebody might be holding it very close to the lead somebody might be holding it, way much more farther away somebody might be using all the fingers, somebody might be using only three fingers and so on depending on how we found it comfortable.

So, now, in the system what all we have in this writing system? Our hand, the pencil and the paper. So, together all these three things are interacting with each other. Interestingly what I am bringing in over here is a human element. So, the pencil and the paper they are non-living creatures what I am bringing in this particular system is a human being. As soon as I bring in the human being everything like whether the pencil is comfortable to write or not why is the eraser on top of the pencil; because when I am writing I might need to erase things also and having a separate eraser you might lose the eraser it is not convenient, we have to carry two things. So, you just have your eraser on top of it

So, resulting out of this interaction between the human being and the two objects that we have we as designers realised that rather than having the eraser as a separate entity, why not let us integrate it with the pencil itself it is more easier to use. Are we supposed to think of the table on which we will keep this paper and write or is this paper coming with the paper board, paper clipboard on which I will put this paper and then write because I need hard base to write it will I consider that will I consider the environments. So, say this is for writing in the school. So, you have particular kind of bench or this is for artist who is trying to draw or is it for engineering drawing, where you have a special table and you have some other tools as well.

So, whenever we are talking about the system, we have certain entities that we place inside the system and we have the rest of the system or rather say we have a system boundary in which I am facing right now all these products and the human being, and everything outside the system is the environment. So, whenever you have a system you always have a boundary and you have a environment.

You have boundary a does not mean that the system ends over there, but it means at that point of time that when you are trying to design the pencil, you are in that system boundary of the paper type of paper the kind of activity the human being and the pencil. You might also interact with some things which are in the environment that is the possibility you might have. So, in that particular case we are in an example of open system, where my system interacts with the environment. I might be also in a close system where my system is not interacting with the environment so, let us go ahead.

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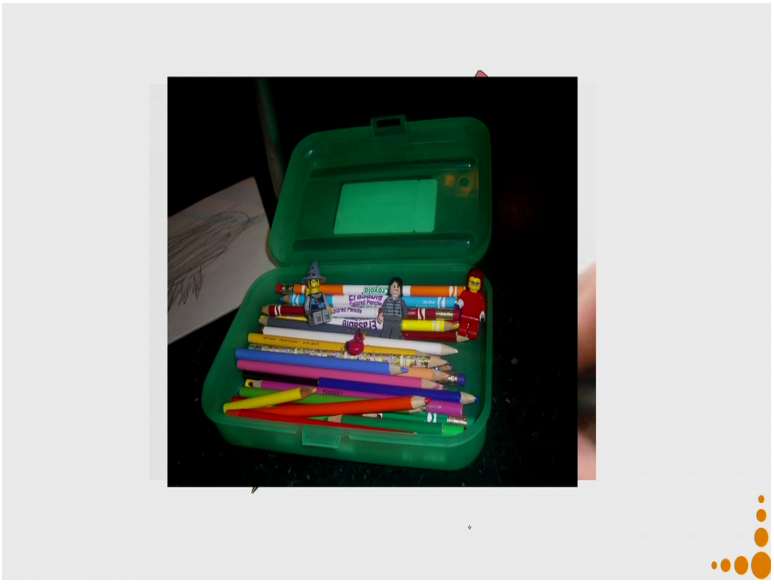

Now, I am adding another element to this system, I need to carry this pencil so, for which I need a pencil box. Now when I put a my pencil in the pencil box the lead of the pencil should not get damaged. I might also carry other components in this pencil box. Say if this pencil box is meant for school use it will be different kind of pencil box. So, here comes the importance of context, because that is a different environment in my which I am going to place the system. If I use this pencil box for engineer wants to use it in their office then it the pencil box has to be very different because it has to created to the requirements of the office environment.

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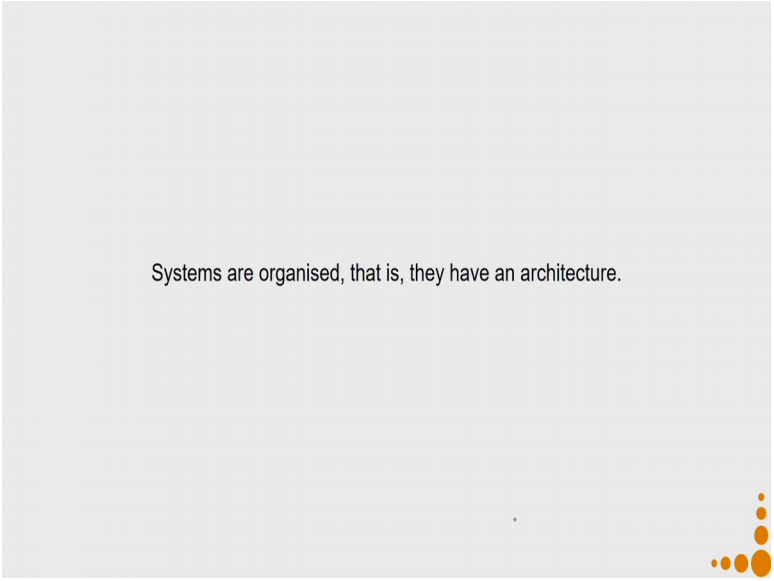

So, systems are organised that is they have an architecture. So, they have a architecture which means structures. So, they have a kind of a structure and they are organised in that structure.

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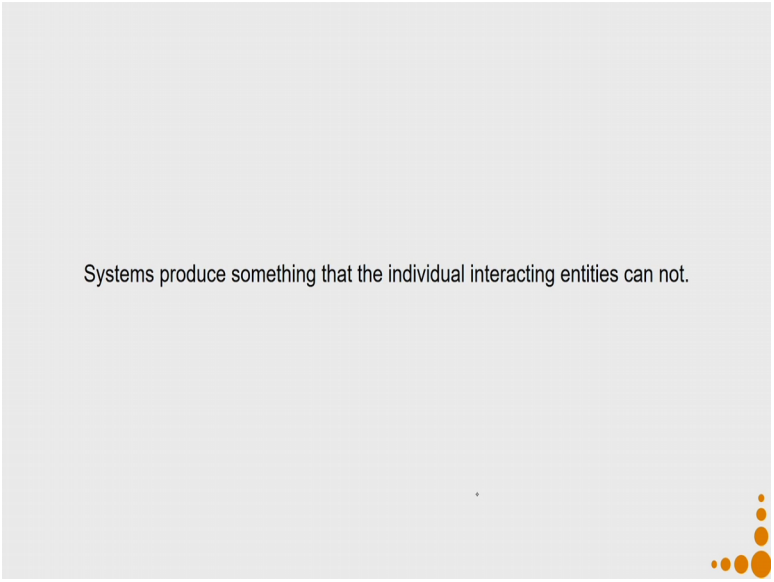

Systems produce something that the individual interacting entities cannot. So, a single pencil plus a paper plus a hand plus a pencil box, if they were together going to form my system, then they together produce something that is greater than the individual interacting entities. And the individual interacting entities could not have given all those

possibilities.

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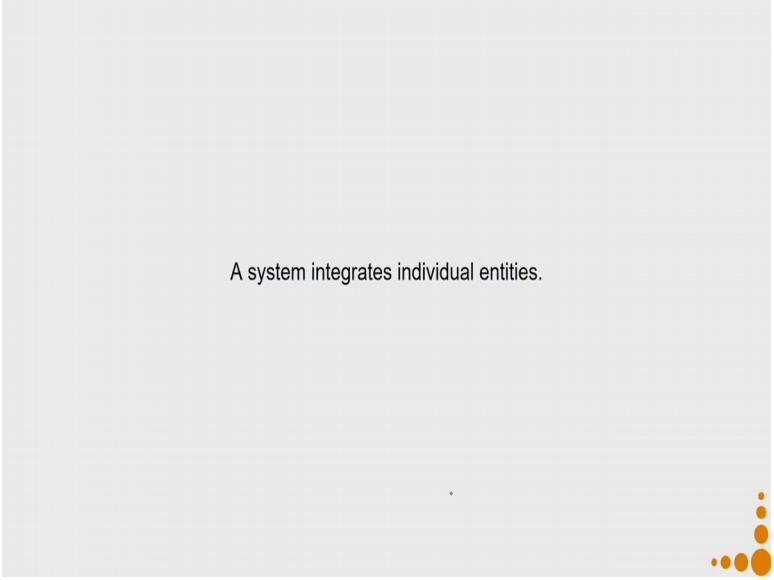

So, a system integrates individual entities. So, anything in which you have couple of entities and then there is a way in which those entities are integrated to each other you can call that as a system. So, systems will always have a boundary.

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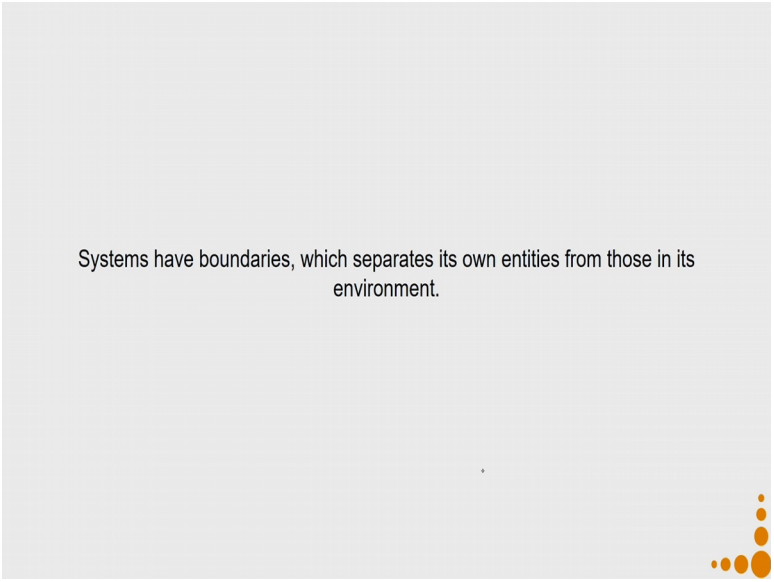

So, when I am designing that pencil, I am not thinking about the chair on which the person will sit and draw with the pencil, why? Because I put the chair outside my system boundary, but I put the human beings hand inside the system, I put the eraser inside the

system. So, while I am designing the pencil I will also think how do I integrate the eraser within the pencil.

So, systems have boundaries which separates its own entities from those in the environment, but it does not stop those entities or the system from interacting with the environment. But for the sake of our design ease of making the design, we always set a system boundary.

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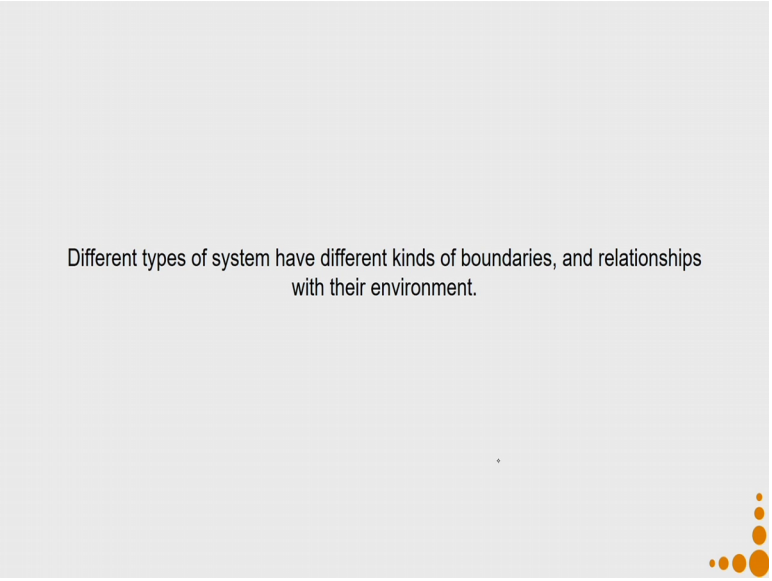

Different types of systems have different kinds of boundaries and relationships with their environment. So, let us see some examples that will make the idea of systems more clear and you will also see that everything is about system.

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So, let us first talk about natural systems. So, the natural system consists of physical and biological materials, and intertwined processes, which make those physical and biological materials never. Say for example, growth of plants is a system; in growing the plant is going to use a sun the nutrients which it is drawing from the soil, it will be using the oxygen in the air in order to do photosynthesis it will use the carbon dioxide from the air. So, in natural systems we it consists of physical and biological materials and the intertwined processes in the examples of it growth of plants, whether system fertility of soil. So, they exists in nature independent of human modifications.

Now, let us talk about agriculture. So, agriculture happens when human organisational system introduced to existing natural system to control and modify it. It is affected by the natural systems such as weather ability of soil to produce crops and feeding patterns of livestock and so on.

So, agriculture because I am introducing human organisational system over there. So, agriculture comes out of the natural systems and it becomes a manmade system. But in this particular system the system exists with because of the interaction that it has with the natural system.

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Let us check out another example; the environmental and ecology systems. So, it is the support world around mankind. So, everything the which is our support world around us can be classified as a environmental and ecology systems say for example, the Himalayas that is an aspect of the environment that we have, and it also has certain kind of ecology within it. So, examples in this category can be say gardens the pond or lake or river the Himalayas and so on. So, these are all support world around mankind.

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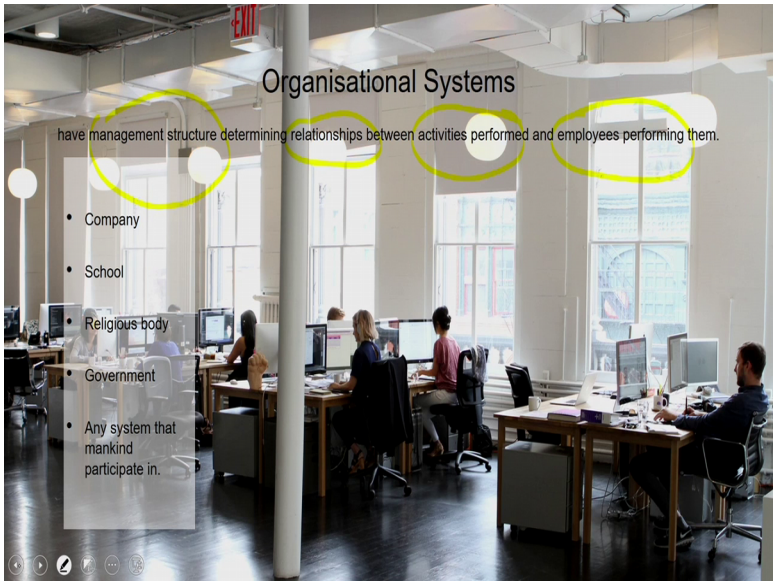

Another kind of system, organisational systems. So, organisational systems as the world

organisation refers to they have management structure, determining relationships between activities performed and employees performing them. So, key elements in this particular concept are management structure.

So, the next system that we are going to study will clearly show what is the implication of these words. So, in organisational systems whenever we are talking about organisational systems we are talking about the management structure which determine relationships between activities performed and the employees performing them.

So, what are the examples in this context? Say for example, any kind of organisation that organisation can be a company, it can be a school, it can be a religious body any organisation. Any organisation which has a management structure which determines the relationship between the activities performed and the employees performing them. So, say for example, in a school you have organisational structure. So, you know what students are supposed to do what teachers are supposed to do, and so is the case with the company or a religious body or the government any system that mankind participate in

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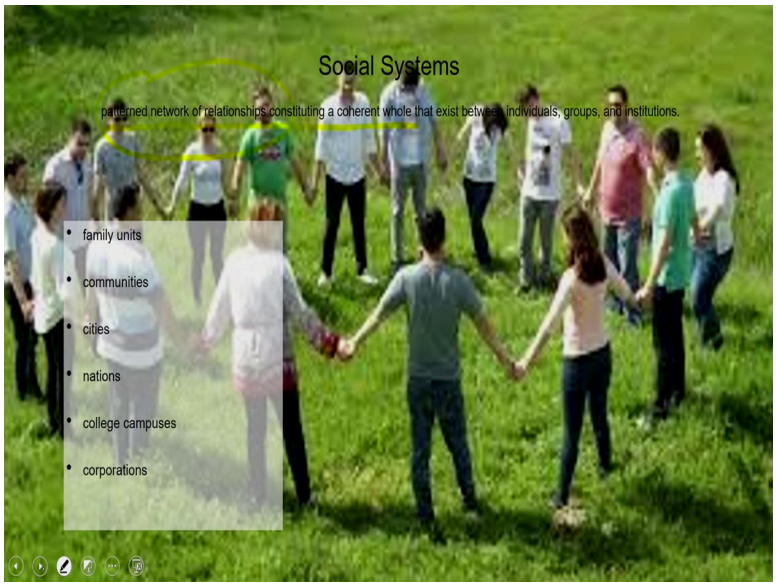

How is it different from the social systems? So, a social system is a pattern network of relationships, constituting a coherent whole that exist between individuals groups and institutions. Say for example, if I say I belong to IIT Guwahati. So, that is because of certain pattern network of relationships. So, as soon as I say I belong to IIT Guwahati, this person belongs to IIT Guwahati, we have something in common between us which is

created because of the social system, which is the pattern network of relationships constituting a coherent whole.

We can also belong to different social systems. So, and a point of time I can belong to IIT Guwahati, I can also belong to another social system. Say another social system which I think I relate to say on the basis of my language or any other affiliation. So, in social systems it is the pattern network relationship, which determines that you belong to a particular group. As soon as we say that we are Indians we relate ourselves to certain pattern network of relationships and that is a social system

So, say for example, family units are a social system, communities are a social system, cities can be a social systems. So, usually we keep up we ask each other to the city you belong to, and we also have this way of looking at pattern network relationship like this person belongs to city x. So, must be this kind of person.

So, in order to create this generalisations we always have this because you belong to certain constituents and we do not belong to another, that is what we want to differentiate over here; the nations college campuses and so on. So, one person can belong to many different social systems, corporations. So, when we looked at the organisational system so, we were looking from the perspective of the management structure, which determines the relationship between activities performed and employees performing them. So, when I am looking from that perspective I am talking about organisational systems whereas, I am looking at pattern network of relationships constituting a coherent whole, that is you belong to a particular group or institution, then we are talking about social systems.

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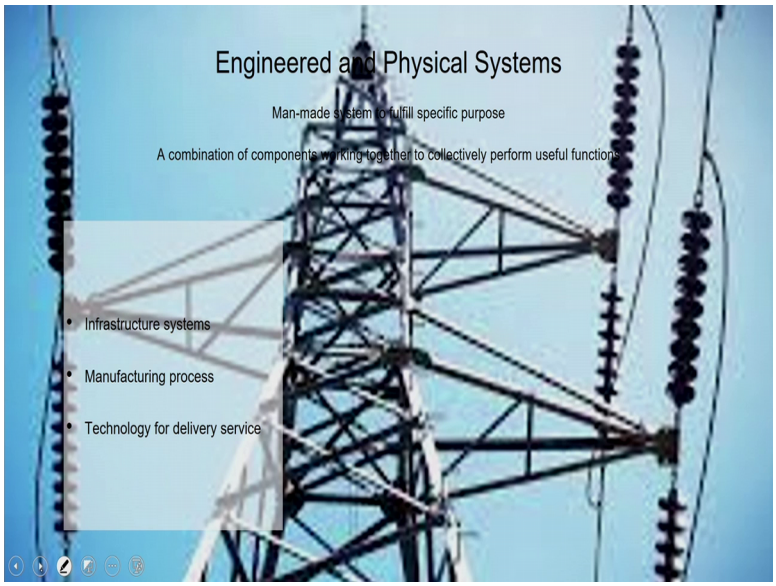

Let us talk about engineered and physical systems. So, any manmade system, which is supposed to fulfil certain specific purpose can be called as a engineered or and physical system. It is a combination of components working together to collectively perform useful functions. Example the electricity grid that is a system which comprises of the all the infrastructure related to the grid, many thermal power plants in many hydro electricity generation plants, may be some nuclear power plants, may be some renewable energy resources and all these connected through some control panel. In case of our country we also have say the northern grid, the southern grid all of them coming together.

So, this whole grid is a manmade system and it is so it comes under the category of engineered and physical systems. So, all kind of infrastructure systems fall under this category, all manufacturing processes fall under the this category technology for delivery surface. So, if I want to deliver some product to you, then again it falls under the same category coming to this next one it is called a sociotechnical systems.

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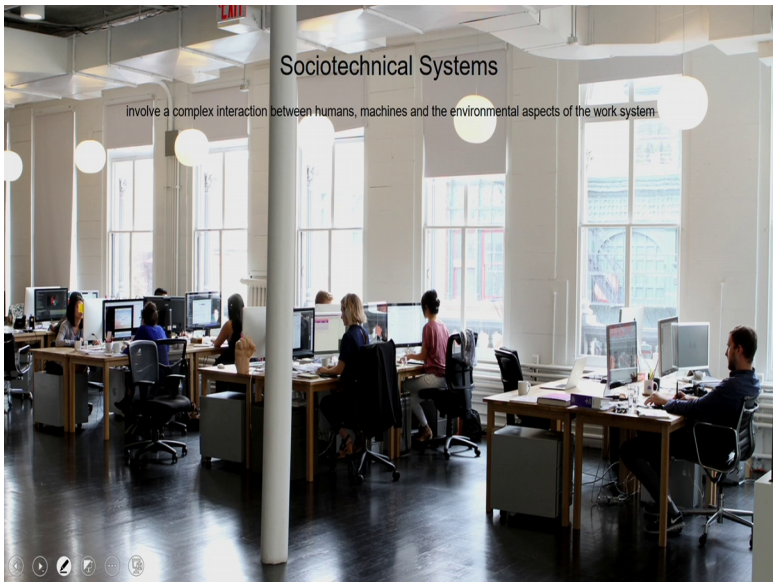

So, it involves a complex interaction between humans, machines and the environmental aspects of the work system. As and when the work environment became more and more complex, what we have to do nowadays is always design sociotechnical systems, why? Make us everything is about a complex interaction between humans machines and the environmental aspects of that work system. Say for example, any office environment that you take up will be composed of human elements it will have different types of machines, if it is a manufacturing unit it will have manufacturing machines, it will always have some computers and network devices and so on printers. So, there are different types of machines and there will be lot of environmental aspects of the work system, there will be a lot of rules structures which help these interactions to happen. So, all of them together make the sociotechnical system.

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Then there are some things which we call as interactive systems. So, computer systems characterised by significant amounts of interaction between humans and the computer, we call them as interactive systems. So, say for example, a tablet where I am trying to interact with it, not necessarily you have to interact with your fingers say for example, a computer with which you interact with your keyboard and the mouse is also an interactive systems. So, wherever there is a component of interaction between humans and the computer we call them as interactive systems.

So, even your washing machine which has the control panel, where you can give certain kind of input is also an interactive system. Because it also has a computing device into it which computes your the information that you have done and converts it into new washing behaviour for the washing machine.

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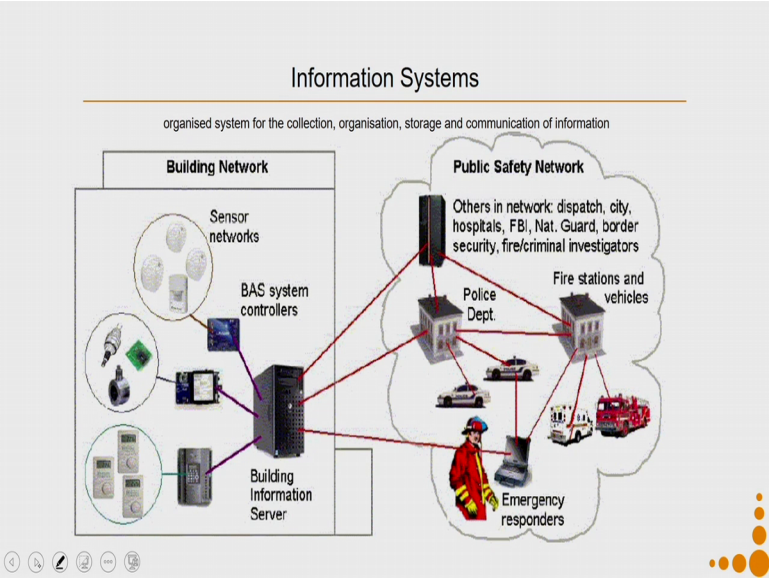

Another kind of system, information systems. So, organised system for the collection organisation storage and communication of information, they as the name suggest it deals with information. But it has to do with an organised system for collection, organisations, storage as well as communication of information.

So, we know lots of examples of this. So, we will have some network, then we will have public safety networks and all of them are interacting with each other.

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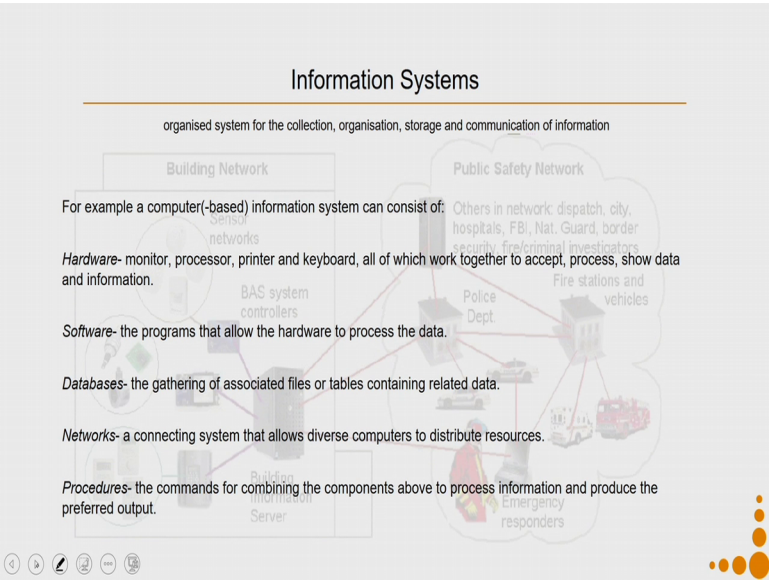

For example a computer based information system can consist of the hardware like the

monitor, the processor, printer and keyboards all of which work together to accept process, show data and information. It will also have some software to do the jobs so, the programs that allow the hardware to process the data. Then it will also have some databases the gathering of associated files or tables containing related data.

Then you will also have a network, because you are talking about system. So, networks connecting system that allows diverse computers to distribute the resources. So, this can be components of a computer based information system, then there will be also some procedures the commands who are combining the components about to process information and produce the preferred output.

So, after going through the all these types of systems and examples for systems let us try to understand the concept of system in greater depth.

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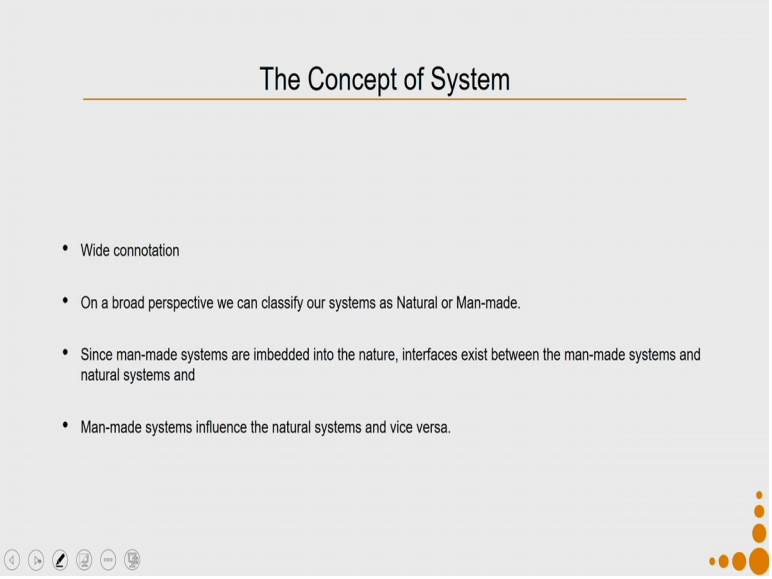

So, we already know that the system the word as such has a wide connotation. On a broad perspective we can classify our systems as natural or manmade. So, natural are all the systems which exist without human modifications and manmade are although systems, which exist because may be human beings created them.

Since manmade systems are embedded into the nature, interfaces exist between the manmade systems and natural systems and manmade systems influence the natural systems and vice versa. So, now, let us look at certain classifications of systems.

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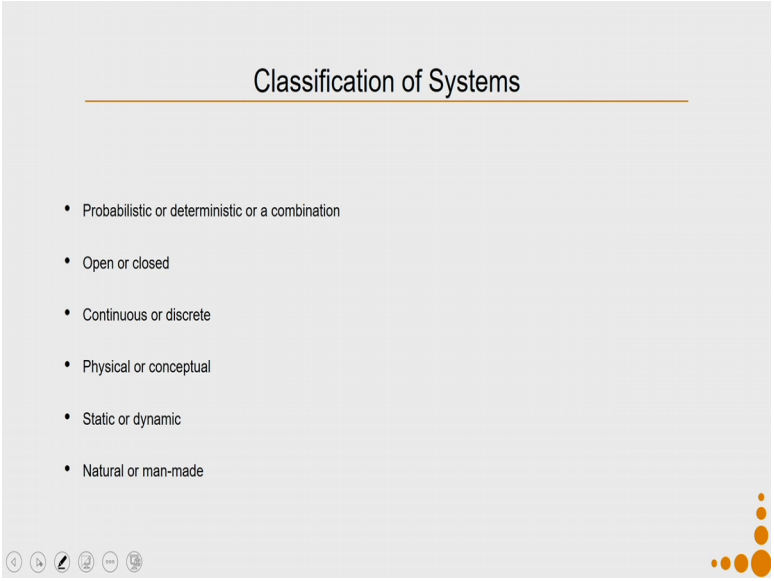

So, there can be probabilistic or deterministic or a combination, there can be open or close systems, we can have continuous or discrete systems, we can have physical or conceptual systems static or dynamic systems natural or manmade systems. Let look let us look a look at each of these.

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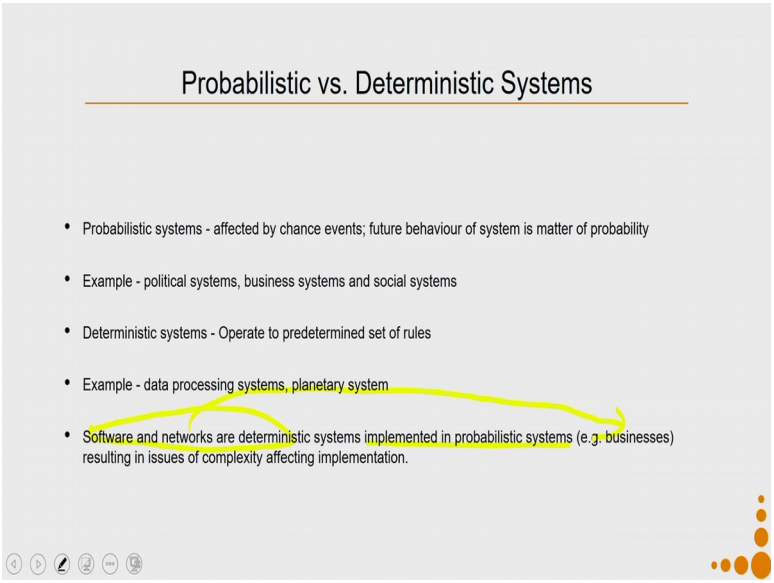

So, probabilistic versus deterministic systems; in probabilistic systems they are effected by chance events. So, the future behaviour of a system is matter of probability. Example; so, say the political system is a probabilistic system by because the future behaviour of

the system is a matter of probability and they are effected by chance events. Similarly a business system is a probabilistic system, again it is affected by chance events and future behaviour of system is a matter of probability. So, we can never say that a business system will take direction a only, we always have that it can take direction a or b or c depending on some xyz chances happening, which lead to context a, some other chance events which can lead it to context b similarly social systems are also probabilistic systems.

Then there are deterministic systems they operate to predetermined set of rules. So, they are not probabilistic, there are predetermined set of rules and they will work according to that; example data processing systems, planetary systems. So, they have certain rules built into the planetary system follows a particular rule of planets rotating and so that is a deterministic system. Data processing systems that we have in our computers they are deterministic systems. Do they interact with each other yes.

So, say for example, software and networks, they are deterministic systems because they always operate to predetermined rules. So, the software and networks are deterministic systems, implemented in probabilistic systems. Say for example, I am may enforce a software or a network system in a business environment in a business system. So, my business system is probabilistic and my software is a deterministic. So, I can have situations in which deterministic systems are implemented in probabilistic systems, resulting in issues of complexity affecting implementation.

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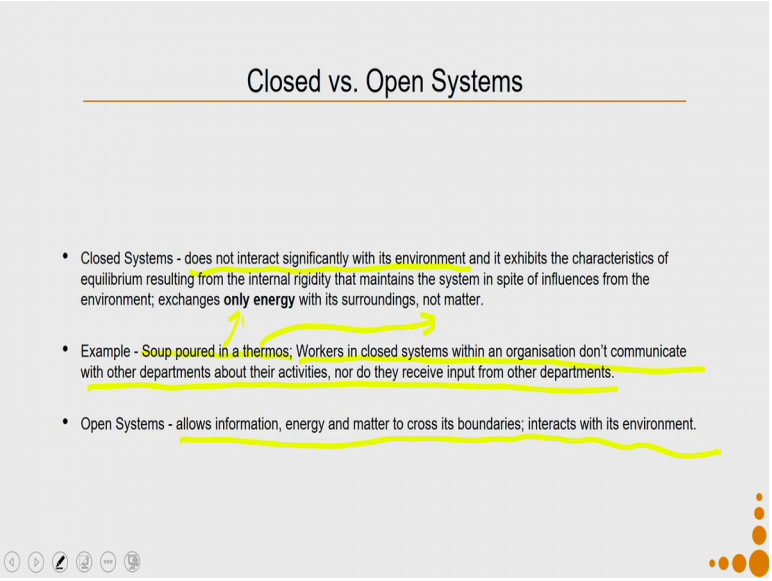

Now, let us look at closed versus open systems. So, your closed systems does not interact significantly with its environment and it exhibits the characteristics of equilibrium, resulting from the internal rigidity that maintains the system in spite of influences from the environment. It only exchanges energy with its surroundings, but not matter.

So, let us see some example that will make it more clear. Say for example, the first example is the easy example, easier to understand because it is from the physical environment. So, if you pour hot soup in a thermos, you are into a closed system because the thermos ensure that mask cannot flow. After a very long time depending on the thermos thermal capability, the hot soup will become its temperature will go down and it will be equal to that of the environment why? Because in a closed system all the exchange of energy happens with its surrounding, but exchange of matter does not happen. Hence the soup is not going to flow out of it.

Let us take another example, which is more close to what we will be working on this course. So, workers in a closed system within an organisation do not communicate with other departments about their activities nor do they receive input from other departments. So, in that context we are talking about a closed system in which the organisation is the close system, each and every department is the closed system.

So, as we saw the definition does not interact significantly, with its environment. So, say for example, workers in two different departments are not talking to each other, what it

has disadvantages is there is lack of transparency, but the advantages because you do not have to interact you do not have to put in so much of energy and time in doing that you each department knows what they are supposed to do, because of some organisational structure so, things can happen much faster.

Now, let us look at open systems. So, open systems allows information energy and matter to cross its boundary, and they have interaction with its environment. Most of the system that we deal with are usually in the open systems category only, but we can always come up across closed systems too.

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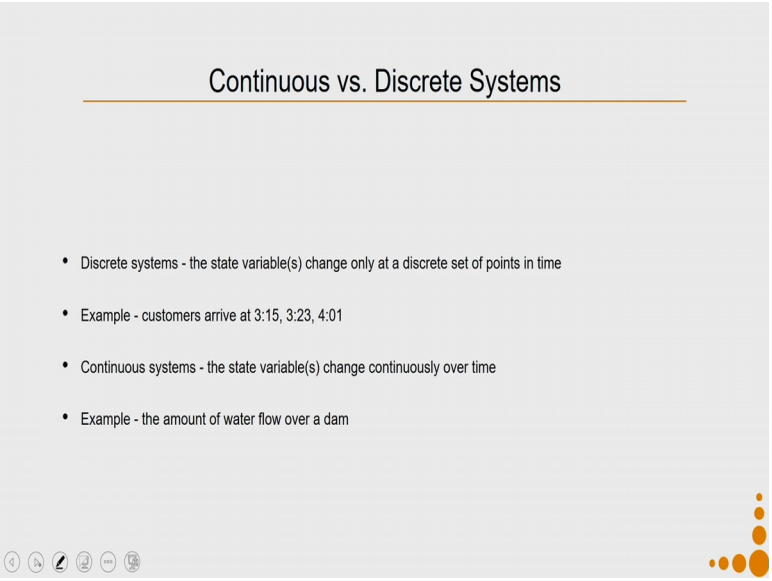

So, continuous versus discrete systems. A discrete system the state variables change only at discrete set of points in time what does it imply? Say for example, my customers are supposed to arrive at 3:15, 3:23, 41 or something like that. So, the state variable in this case customers arrival, it happens only a discrete set of points in time in contrast to that I might have a continuous system where the state variables change continuously over time.

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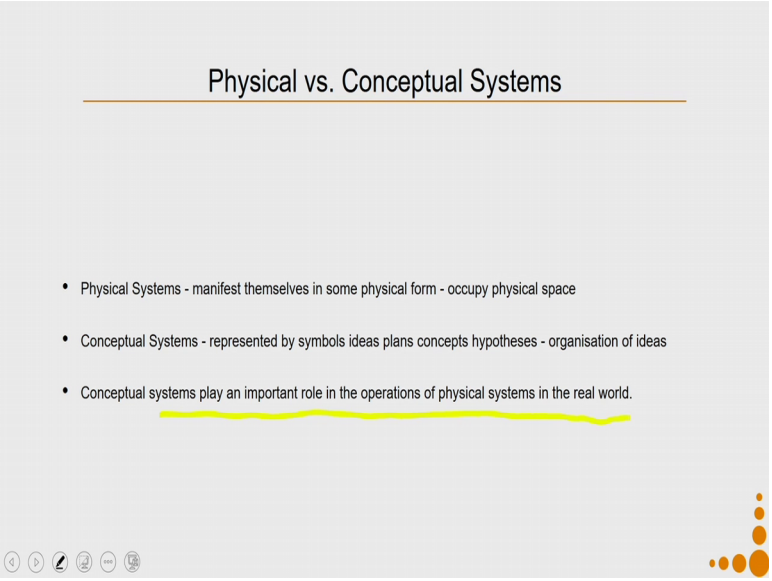

Say for example, the amount of water flowing over a dam, physical versus conceptual systems. So, a physical system manifest themselves in some physical form, that is the occupy physical space. So, say for example, if you have a computer system that is a physical system, because it occupies certain physical space.

Let us contrasted to the conceptual system that makes the meaning more clear. So, conceptual systems are represented by symbols, ideas, plans concepts, hypothesis that is their organisation of ideas, but these two systems they keep on interacting with each other. So, conceptual system plays an important role in the operation of physical systems in the real world.

Say for example, if I have a computer, I have a mouse, I have a keyboard when I switch on my computer, I will see many different icons. So, when I see the icon of a folder that connects me to this idea of that there might be something inside it. So, if I am not someone who already knows what a folder is, because I have seen a physical folder and I see the same symbol I have a connects. So, I create a conceptual idea in my head that this folder might have something inside it.

So, conceptual systems always plays an important role in operations of physical systems in the real world and they keep on interacting with each other. Next is static versus dynamic systems.

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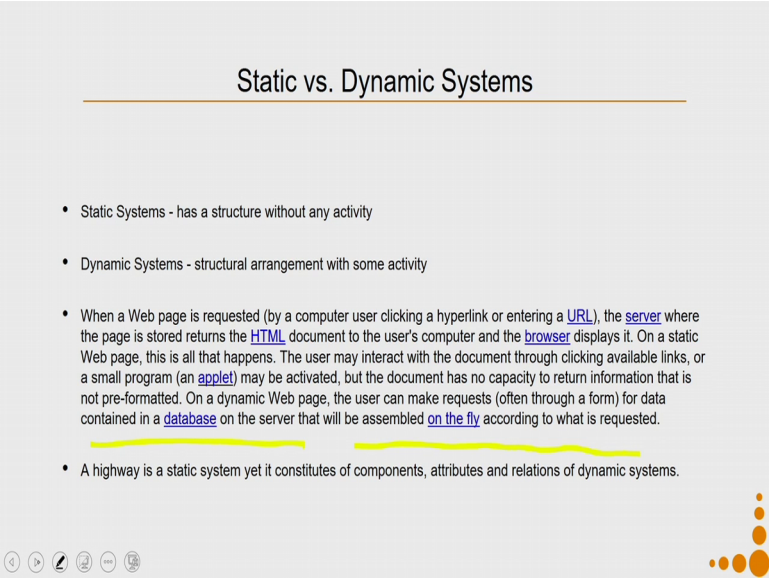

So, a static system has a structure without any activity say for example, a highway. Our country has a network of highways there are national highway, there are state highways, then there expressways, then there are the other routes they are connected with each other with certain kind of a organisation into them this is a static system.

So, it has a structure every system has to have a structure. So, it has a structure, but it does not have any activity. Whereas, dynamic systems they do also have a structure arrangement with some activity, but they again might be interacting with each other. So, say for example, when a webpage is requested by a computer user by clicking on a hyperlink or entering a URL, the server where the page is stored returns the HTML document to the user's computer and the browser displays it. On a static webpage this is all that happens, the user may interact with the document through clicking available links or a small program may be activated, but the document has no capacity to return information that is not preformatted because its static webpage.

But say for example, for a dynamic web page, the user can make request through a form, now depending on the form data filled up, what the server does goes to the database and it will assemble on the fly data for you or information for you. So, that is an example of a dynamic system the highway example. So, highway is a static system yet it constitutes of components attributes and relations of the dynamic system. Because of the activities which are going on along it. Coming to natural versus manmade systems.

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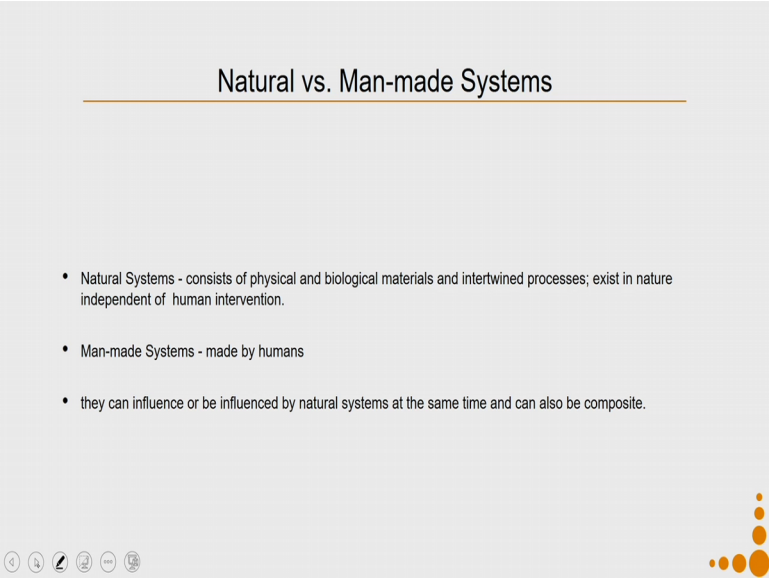

So, natural systems you already discussed consists of physical and biological materials, and intertwined processes it exist in nature independent of human intervention. Manmade systems they are made by humans, they can influence or be influenced by natural systems at the same time and can also be a composite. Say for example, in agriculture it is a manmade system interacting with the natural system creating agriculture.

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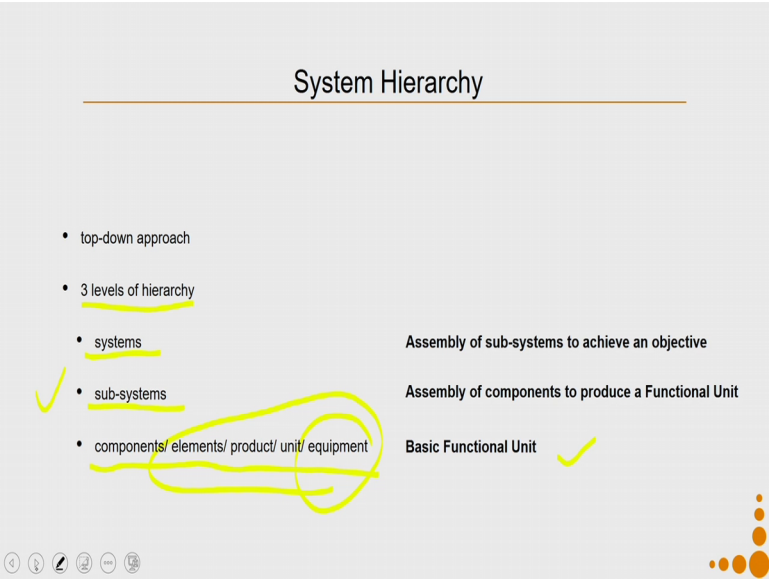

So, now let us look at how we will make a systems hierarchy. So, now, purposes to use

this knowledge that we gain about systems to put into design, in order to do that I need to understand how to build a system. So, let us look at system hierarchy. So, a system hierarchy is consist is a top down approach. So, what we written so then this hierarchy I have three levels, the topmost level is systems, then I have subsystems then I will have components elements product unit and equipment.

What it implies is? So, the components elements products unit or equipment, they are the basic functional unit. So, they formed the crux of the system assembly of these components. So, an assembly of all these things together produce a when they come together to produce a functional unit, I have subsystems. These an assembly of subsystems when it helps to achieve an objective we get a system.

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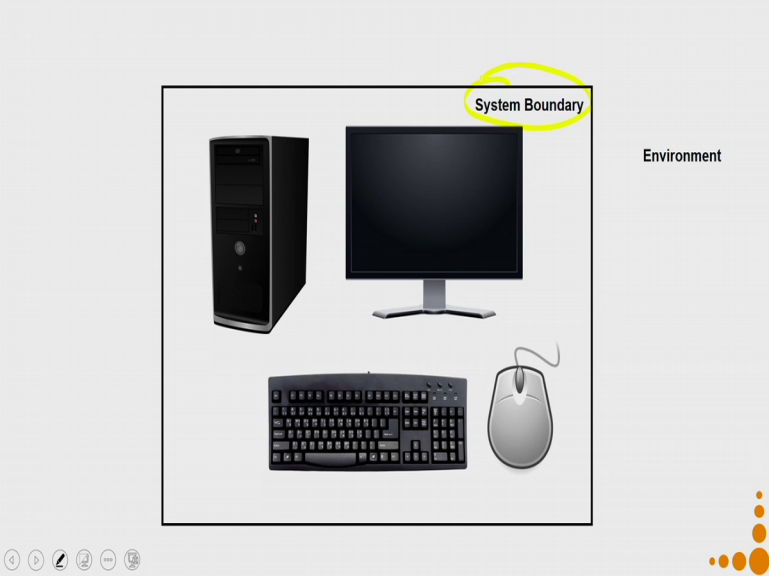

Let us see an example which will make it more clear. So, let us say I want do some computational work. In order to do my computational work I will need a monitor a mouse a keyboard a CPU and some wiring and maybe some softwares and some networks. So, each of these elements they are called as the component or the element or the unit sorry. So, let us take one of these objects like the mouse. So, when you break down the mouse into constituting components, what you get is a basic functional unit.

When I assemble them together, I get a sub assembly which is able to fulfil a particular function units. So, what my mouse does is, it helps me to point onto certain thing and it helps me to select an these activities. So, this is the functional unit. So, this is

subassembly 1 this is subassembly 2 this is sub assembly 3 this is subassembly 4. When all these subassemblies are assembled together, what I get is my system. So, this whole system together then helps me to achieve my objective which is which was to do certain kind of computational activity.

Now, you can see as we discussed we also set a system boundary do it. So, this is my system boundary, I am not talking about the chair and table were these products will be used, I am not talking about the office environment school environment not talking about all of them because for the ease of my work, for achieving the objective of doing some computational work, this is my system boundary, it is made up of all these different products connected to each other.

So, everything outside the system boundary is my environment. So, the definition of system boundary and environment, it actually depends on what is my area of design interest. Since my area of design interest over here was to design a system which helps you to do computational activity. So, I had fed this particular system boundary.

Say for example, my overall objective would be to set up computational in environment in an office in context, in that case may system boundary may change. Because as soon as I talk about office I might also think that I would need to connect each of these elements to other computers, then in that case this whole system becomes one in subassembly rather than being the in whole system and it would be connected to other systems.

So, depending on my design context, I can keep on changing what is my system boundary and what is everything that lies outside the system boundary is the environment.

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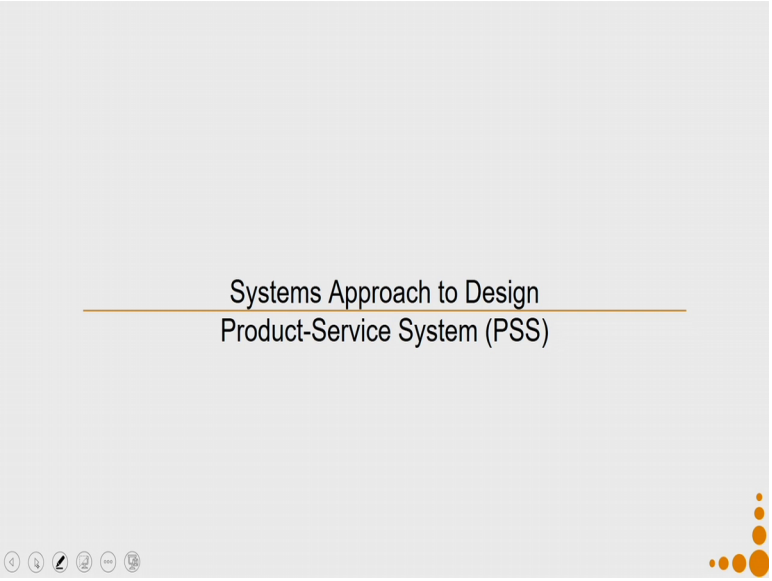

So, now let us talk about systems approach to design the product service system. We apply this all these approaches that we discussed till now when we want to module a product service system, which will be a focus of the course.

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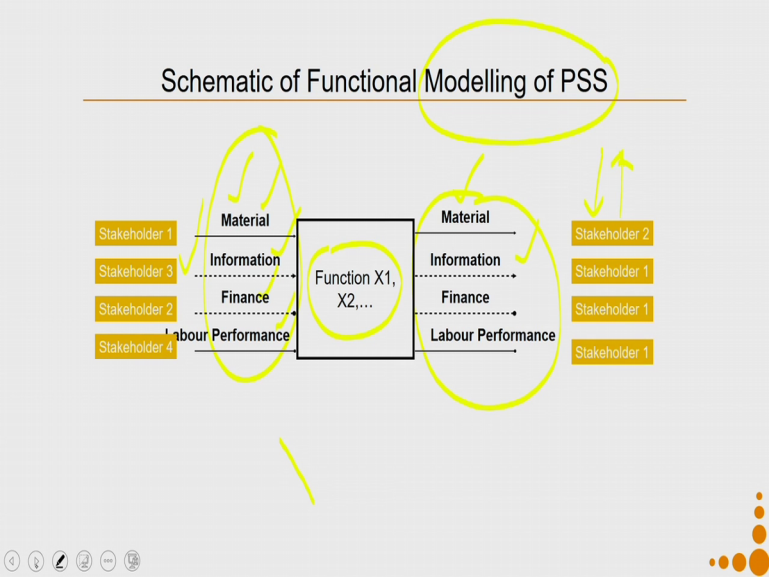

So, this is a schematic of a functional modelling of a PSS. So, you might have functions. Now into this function to perform that function you will have material inputs. Say for example, if I want to make a chair. So, my function over here is making a chair in order to make that chair, I will need to put in material. So, I will put in raw materials, then I

have my function is making the chair and I get material outside which is the chair.

So, here I had raw material, now here I am having chair. Now in order to make that chair I need design. So, the design can be information so, I need input. I might also have other information going out say for example, if anybody wants to recycle that chair, I will have to inform the whoever wants to recycle it what is the kind of plastic that I have used. So, that can be another kind of input which is going out.

Now, let say in order to make the chair, finance has to flow money has to flow somebody has to give money, and when somebody buys the chair will also to make the chair you need money and when somebody buys the chair you get back the money and you will also need people who will make the chair. So, you have labour performance, you can have input labour performance and certain functions will also have output labour performance.

Then in order to do these activities you need people. So, we call these people as stakeholders. So, stakeholders are human beings or human entities. So, say for example, a company, a bank they all are entities made up of human beings hence we call them as stakeholders. So, say for example, stakeholder 1 puts in material to make the chair, now who is going to give money to do that? So, stakeholder 1 puts in material, that raw materials for making the chair, because of the stakeholder 1 expects that it is going to get back money in return for the chair.

So, who gives the stakeholder 1 money stakeholder 2 gives stakeholder 1 money. In return of that of course, stakeholder 2 will not give money if the stakeholder 2 is not getting anything. So, the stakeholder 2 has to get the chair. So, the material is flowing to this particular stakeholder. To whenever you have this kind of a functional modelling you will try to map your trying to map four different things; we are trying to map materials which is flowing, information which is flowing, finance which is flowing and the labour performance which is flowing. Because of this four mappings you will get a whole model of your product service system.

You have to be careful that nobody gives something without getting anything in return. So, I every stakeholder in your system design should have a certain input, and as in return they should give certain kind of an output. So, the input can be any of these it can be materials, it can be information finance and labour performance, and the output that is

going out can also be any one of these four. So, let us take an example to understand this situation more clearly.

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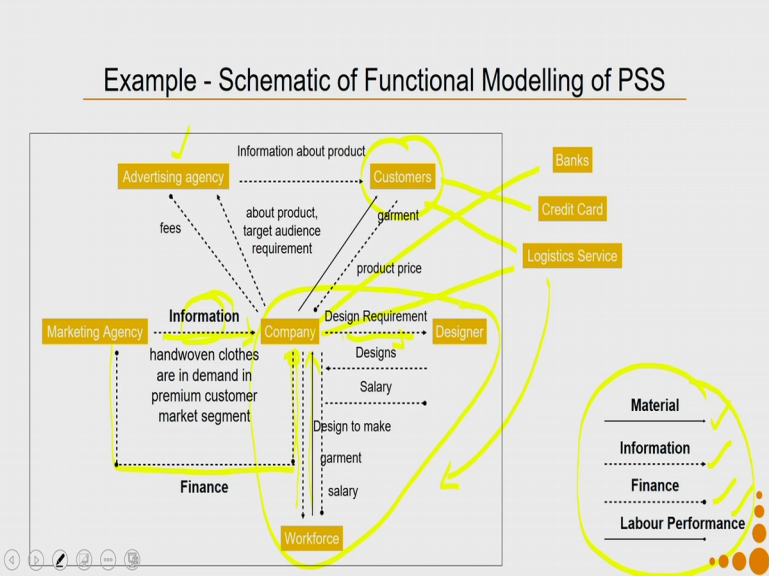

So, whenever you are making schematic of functional modelling of this PSS, what you will do is you will create a legend. The legend will show that materials are depicted by this kind of line and this kind of arrow and so on.

So, say for example, from a marketing agency, our company gets an information. So, this company is into making hand-woven garments. So, from this marketing agency, they get this information that hand-woven cloths are in demand in the premium customer market segment. So, here to make it more clear I have written information over here, but you do not need to write information over here, what you need to say is what information is travelling.

So, from this marketing agency, hand-woven cloths are in high are in demand in premium customer market segment that information is passing to the company. Now as we discussed if there is there cannot be only one way flow so, in return the company pays this marketing agency. So, the direction of arrow tells you which way what is flowing. So, here you can see information is flowing in this direction, because arrow is here and if you see over here the arrow is moving towards this. So, money is flowing towards the marketing agency.

So, with this information the company decides ok, I want to make hand-woven governments for the premium market segment. So, they have to pass on this design requirement to their designer. So, you can see. So, you can make out that this is the information because of the legend. So, this is the. So, design requirement is kind of an information which is passing to the designer. In return designer make some designs and gives to the company. So, again designs are also category of information. As a result of which say the designer is an in house designer they are employed by the company. So, the company gives the designer salary.

Then comes the workforce people who will manufacture to who will do the hand weaving. So, the company gives them a design to make. Now when they have designed to make that is the information which is passing, they will make the garment now when the garment is going to the company it is a material. So, this kind of an arrow. In return for this garment the company will give salary to the workforce, which is the finance. I could have also drawn the labour performance over here, because labour performance direction is from the workforce towards the company.

Who all can be my other stakeholders now this company needs to reach to its bias the premium market segment. Now how will the premium market segment know that this kind of a company exist they have to do some kind of advertising, which can be word of mouth can be through flyers can by enemies. So, let us say there is an advertising agency and there is my final customer. So, my company now has the garment which is the materials. So, it has to flow somewhere.

So, first the company passes on the information to advertising agency about the product, the target audience that they want to reach with that product and the requirements. As a result of which the advertising agency will make some advertising campaign and that information about the product will passed on to the customer. Because of which the customer will want to buy the garment and then company can sell them the garment.

Now, in order to create this advertising campaign, there advertising agency will ask for a fees. So, the come that is the money flow which is happening and how does the company make money? Because of the product price. So, this is the money which the customer is going to now pay to the company. So, this example an example of schematic of the functional modelling of PSS.

Now, for my design purposes I determine that this is my system boundary, who all lies beyond the boundary for my design context is? Say banks, credit card companies, logistics service. So, say for example, till the company makes the money they might need some credit to do the activities like paying the marketing agency, paying the designer, paying the workforce, paying to the advertising agency. So, they might need certain kind of credit from a bank.

So, this system boundary in this system boundary the company interacts with the banks as well. Now the customer while making the purchase they might also use a credit card. In order to reach the product from the company to the customers, I will use a logistics service. So, the company and the customer are connected to each other using the logistics services.

So, all these are a part of the environment from a given context. Say for example, if I change my idea for what kind of PSS I want to design, I might say I want to have a company which also owns its logistics. So, logistics is a separate departments, then this whole thing comes inside the system boundary.

So, depending on what is your design aim at a given point of time, you as a designer have the freedom to decide what you will put in which was stakeholders you will put inside the system and which was stakeholders will put outside the system and like we discussed. So, we will think of what the organisational system in this context. So, all these operations because this is now an organisation. So, all these organisations have to happen because of certain management rules people are going to interact with each other.

I have to also bring certain aspects like that belong to a social system say for example, the advertising agency uses certain parameters from the social systems like, they want to create certain kind of belongingness. So, you all customers who buy products of this particular company you belong to certain group. So, they might also target their advertising campaign thinking around social systems. Because when we are doing all these activities within the company itself, we are also dealing with the sociotechnical system because we will have human elements, we will have different types of machines and we will certain management rules.

So, this gives you a brief idea about what do we mean by systems approach to product service and design; when we will go into discussion on sustainability how to look up on

sustainability. So, you will appreciate this concept more and more; because sustainability is not achievable in a single product. So, your pencil in itself is not a sustainable pencil. So, sustainability is only achieved when different components different entities of a system interact with in each other.

So, the sustainability crops up from the system properties, it is not a property of an individual element and hence in order to achieve sustainability we will have to do system oriented thinking and system oriented design. So, I will see you all during this particular course.

Thank you so much.