Manufacturing Guidelines for Product Design

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Lecture-38
Product Architecture

Namaskar friends, welcome to session 38 of our course on manufacturing guidelines for product design. So currently we are in the last week of our discussion and as you are aware that this is a 8th week course in which we are going to have 40 sessions of half an hour each. In the last week our focus primarily was on the joining strategies. And this week our focus is on summing up what we have already covered and to discuss the topics which are of great relevance in today's scenario.

And in that context if you can remember we have seen in session number 36 and session number 37 the design for environment. The design for environment process, we have seen that what are the steps or the flow chart that we have to follow when we are applying the design for environment concept in our product design approach. In session number 36 we discussed very briefly the concept of design for environment, so by now what I believe that there are other good topics like design for reliability, design for quality, design for safety.

There are number of other important aspects that can be discussed but because of the time constraint and because of the way we have planned our course we have been able to appreciate one important aspect that is design for environment what I will suggest the learners is that if you have really feel motivated or if you have really felt motivated for undergoing such type of courses. You must try to further enhance your knowledge with topics like design for quality topics like design for safety.

Our focus primarily has been on as the name of our course suggest manufacturing guidelines for product design. So we have majorly focused our attention on the manufacturing processes and what are the design guidelines that we must take into account when we are going to design a product. Now today as you can see on your screen our target is product architecture. So, by now

whatever we have covered, we have covered design for primary forming processes such as sand casting, die casting, injection molding, compression molding.

We have seen design for machining, we have seen design for other important processes like joining, we have seen welding, we have seen adhesive joining, we have seen soldering, brazing. Then we have seen for advanced joining processes like vibration, welding we have seen ultrasonic welding, we have seen induction welding. So, basically our primary purpose has been met, our primary purpose was to keep in mind the guidelines the general guidelines that help as to design a product which is easily manufacturable

We want to design our product in such way that we are able to manufacture it in the most simplistic manner. So that was the target now we are closing our course we are at the frag end of our course we are in the 8th week of our discussion. Now to close the discussion we have taken a very important aspect which is very relevant why because when we are designing a product as I have already highlighted in session number 36 that when we are designing a product.

There are 3 important things to ensure the product quality we have to see what type of materials we are choosing?, what type of manufacturing we are choosing for our product the most important that what is the design of our product. So, when we are designing our product we have to finalize the materials we have to finalize the manufacturing route or strategy. So, when we are finalizing the materials and manufacturing that is going to happen for realizing that product.

We have to take into account the impact of this decisions impact of the decisions regarding selection of material, impact of the decisions regarding selection of the manufacturing process on our environment. We must try to select the sustainable materials, we must try to select the green manufacturing strategies. So, that the product we develop is recyclable, is reusable or can be disposed of our discarded into the environment without causing any harm to the mother earth.

So that is a very important decision that we have to take and therefore towards the end of our course after discussing the processes the materials the design strategies like DFM and DFA. We have finally concluded in the 8th week that we must take care of the environment when we are

selecting the materials and manufacturing for our product design. Today we are trying to further sum up our individual discussion.

Because as we have seen that a product is going to be made up of a large number of sub-components or sub-assemblies are modular parts, again I am coming to the example of the camera which is doing this recording. I think some of you will be just having a smile on your face or may be may burst into laughter also that Inderdeep Singh has taken may be 10 times example of the camera why because I am looking into the camera.

And this is the best example that comes to my mind when we are recording this course just Google bigger camera or a recording camera. You will see it is so complex design there are so many modular parts for recording the live session, for recording the lecture or recording the session or recording the discussion that we are doing. So each and every modular part has got come functionality each part is going to perform certain function there is stand.

So, it is the purpose of the stand is to support the camera, now how are this module has to be integrated with the overall product. So, that basically sets up the product architecture, so in product architecture we will try to see that the individual parts that we have manufactured using any of the standard processes that we have already covered. We have already covered sand casting, die casting, injection molding, compression molding then various machining processes can be done.

In many cases we may like to join using adhesive joining, welding, soldering, brazing so many different processes. These are the key words that we have already discussed. So, these processes we can manufacture the individual components. Now how of these individual components will be integrated into a final product that basically has to be decided in the very beginning of the product design process.

So for individual components we can take care of the guidelines that we have already covered and there are number of other guidelines which we know which we have not been able to cover because of the time constraint that we have for individual session. So there are good books

available you can go through the books and further fine tune further tweak, further hone your skills related to the design of a particular product which is going to manufactured by any standard manufacturing process.

So we have just introduced that there are certain set of guidelines for each and every process which must be taken into account when you are designing a product. So, today we will see the product architecture that is combining these individually manufactured parts by different processes into a complete product. So, how the product architecture will take into account or what are the parameters that we need to take into account when we combine these individual parts into a complex assembly.

So, this is given in number of e-resources but we have taken that or we have developed the discussion based on this very good book that we usually follow for product design, product design and development 5th edition by Karl Ulrich and Steven Eppinger. So a very good book on product design and can be taken as a text book also for understanding the course on product design, there other good books like Geoffrey Boothroyd, Product Design for Manufacturing and Assembly. There are number of good books which are available on this topic.

But this discussion has been developed based on the text provided in this book that is Karl Ulrich and Steven Eppinger Product Design and Development.

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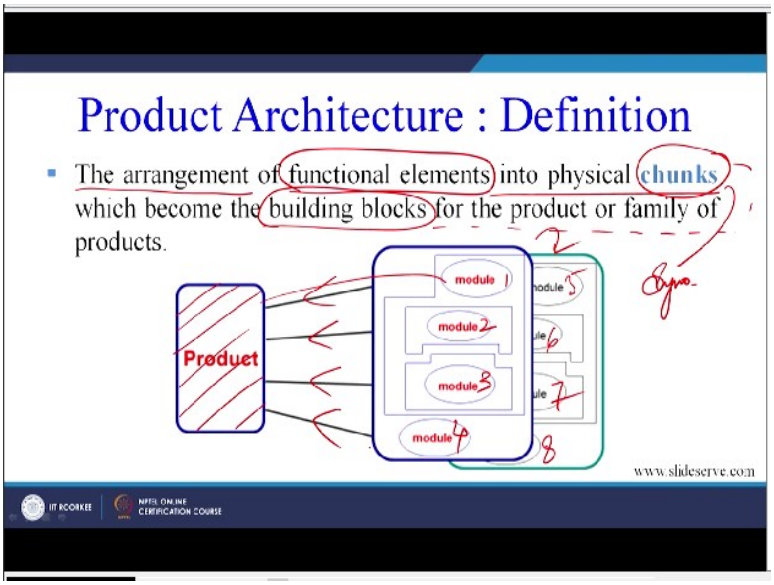

Now let us see the product architecture what is the definition as I have already told and try to explain with the help of the camera the modular parts have been designed. Each modular part has got its own functionality and then this parts have been assembled together to produce the final camera or to assemble the final camera. So the product architecture which means the arrangement of functional elements.

Now you will have different functional elements for example the stand of the camera is one functional element. The lens system is another functional element, the adjustment system is another functional element. So there are different functional elements which are arranged or they are finally brought together interface is developed between the various functional elements and finally these functional elements combined together to give us the product.

So arrangement of functional elements into physical chunks, now what are the chunks and what are the synonyms of chunks that we are going to discuss may be in the subsequent slides which become the building blocks. So one of the may be meaning of chunks is that the chunks become the building blocks for the product or a family of product. So basically it is the explosion of the product into the individual chunks.

And these chunks develop interface among themselves to create the product or a family of products. So, the example is given here this is the may be a black box this is the product that we

are using but this product may be made up of may be module1, module2, module3, module4, so 4 modules may be there can be other modules also which are given here 5, 6, 7, 8. So, a number of modules may combine together to produce the product.

So we have to explode the product into the individual modules and these modules we can manufacture using any of the processes or may be additional processes which we have not been able to cover. And this modules will give us the final product now other terms for chunks as I have already told the synonyms.

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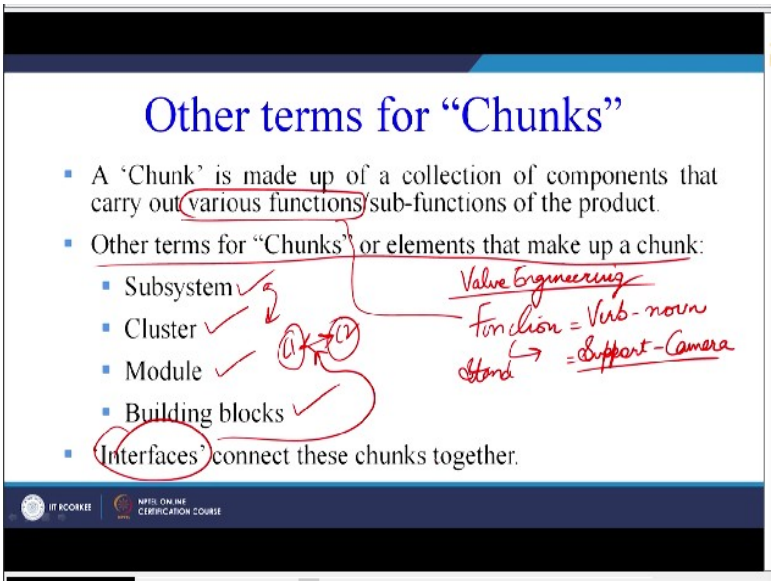

A chunk is made up of a collection of components that carry out various functions. Now the word function here is very important and normally in the course on value engineering we talk about the functional analysis only, so may be if possible we will try to see if we can come up with the course on value engineering may be a small course of 10 hour duration. But here just I would like to introduce that the function is very important here.

Because each and every chunk will create or will establish certain function or will satisfy in order to make it more simpler will definitely satisfy some function. For example if we again take the example of the camera or the video recording camera the function of the stand is to support the camera, so in value engineering normally the function we give by a verb and a noun

definition, for example in this case we can say verb which can be support and the noun can be camera.

So the function of the stand is support the camera, so similarly for different parts or different modules or different chunks we can write the functional definition of each and every chunk that is being combined together to make the product. And even further as for the definition the chunks can further have sub-components which are combining together to produce one chunk or module. So, here we can see the other term for chunks or a elements that make up a chunk or a sub-system.

Sometimes we can call it sub-system or a cluster or a module or a building block and these are interconnected with each other, may be one cluster is interconnected with the another cluster with the help of the interfaces. So these interfaces have to be designed, have to be developed when we are conceptualizing our product that what are going to be the individual building blocks, individual chunks, individual modules, individual sub-systems.

And how these chunks or sub-systems are modules are going to interact with each other and those interfaces have to be developed. So these are interrelated suppose we can say this is cluster C_1, cluster C_2 interfaces connect these clusters together or these chunks together. So, each and every chunk will perform some or certain defined function and each of these will combine together to give us a complete system.

Now system can be a equipment, system can be a machine, system can be a product, so we will see an example are 2 to understand that what are the chunks and how these chunks combine together to give us a product or a machine, a machine can also be a product.

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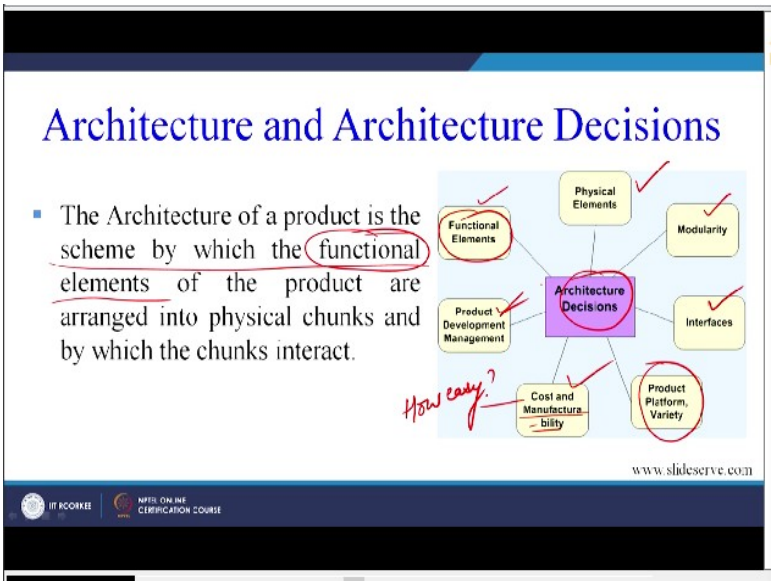

So, the architecture and architectural decisions we can see, the architecture of a product is the scheme by which the functional elements. I think I have explained the word function. The functional element means each and every chunk or a element will perform certain function of the product are arranged into physical chunks and by which the chunks interact. So, this is given, so the architecture decisions that we take what are going to be the physical elements, modularity, interfaces that they suppose in our product architecture we say there are going to be 5 modules.

Now this 5 modules how modules will interact with each other whether the first module will have certain interaction with the 5th module or second or third going to interact with each other. So, those intercalation will be treated at the interfaces then the product platform are variety that but is the product variety that we wish to offer to our customer may be many times you will see a single product has 5 variants or 3 variants.

So in one of the variants 2 of the chunks may be missing and in another variant all 5 chunks or 5 modules may be present. So that is basically the product variety which in which we have to decide when we are fixing up the product architecture why because when we are offering variants to the customer. It must be easy for us to take out a chunk which we are not offering for a particular model to the customer.

So, that those type of decisions also have to be taken at the architectural level only, then most important why the companies are in business cost is a very important parameter manufacturability we have already covered is most important that we have to see that how easy it is to manufacture. So when we are deciding the architecture of our product and the interfaces we have decided we have already decided what are going to be the various modules.

We have to see that whether it is easy to manufacture these modules independently or within a module what are the individuals sub-components that we must make so that the manufacturability becomes easy if our product architecture is very very complex sometimes we may not be able to identify the manufacturing processes which can be use for processing that module. So, those decisions have to be taken at the product architecture level.

Then product development management, functional elements already I have told the functional elements are the most important chunks. So, each of the chunk will be designated for the particular purpose for which the chunk has been listed. So we will see the with the help of an example that how we can divide?, how we can explode?, how we can segregate?, how we can classify the various chunks and the modules for the product.

So, that basically the decisions that have to be taken when we are finalizing the product architecture, modularity, interfaces, functional classification of the module, cost, manufacturability, all these parameters will help us to optimize our product architecture. So, that we are able to produce it in the most efficient effective productive and may be profitable manner. Because the profitable manner is the most important word or the terminology that is important for each and every organization.

That each organization will try to develop a product architecture in such a way or they will be more than happy to manage the point is written here product development management. So the management will definitely try to finalize the product architecture in such a way, so that the product is profitable in the market. So the architecture of a product is the scheme by which the functional elements of the product are arranged into physical chunks and by which the chunks interact.

So, that is basically the architecture and what are the various factors that are going to be influenced by the product architecture is listed in the slide. Now this is a very very important similar diagram we have already seen not the same but the similar we have seen. In the very first session when we started our discussion on this course on manufacturing guidelines for product design. We have seen that product design step by step by step process and we have tried to establish that what is the relevance of this course in the overall product development cycle.

So again we are coming back we started with the similar diagram in our session number 1, in session number 38 again we are coming to the similar diagram only.

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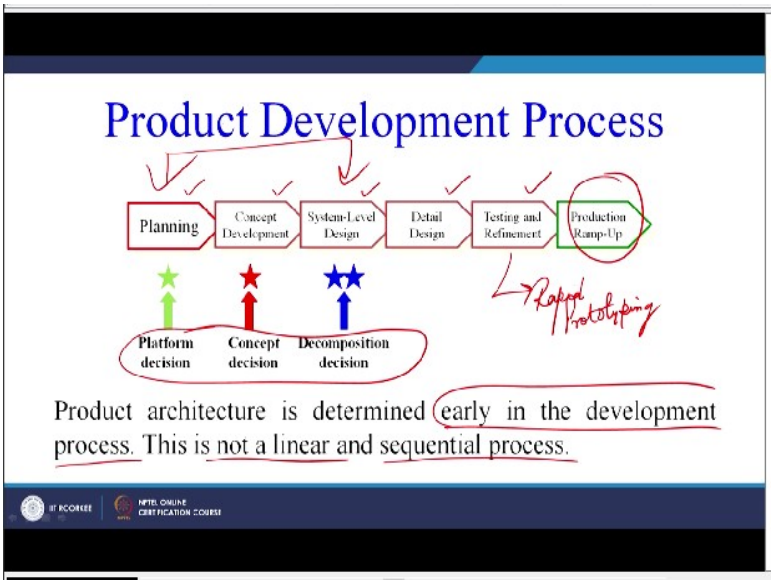

So, we can see that we have to do the planning concept development is done, system level design, system-level design, detailed design, testing and refinement. For testing and refinement we will see another session may be the subsequent where we will see the concept of rapid pro-typing. In our next session we will try to cover this topic because before going for the actual production ramp-up we need to test the model that how it will be manufactured?, how it be look like the various sub-parts will be able to fit into each other or not or what are the assembly issues related to that?, what are the functional issues related to the product.

So, all those things will be checked at the testing and refinement stage. So we will try to see that what are the various decisions and where the product architecture comes in, so the product architecture is determined early in the development process early. So we will try to fix up the architecture in the very beginning stages of our product development process. This is not a linear and sequential process.

So many times there can be movement across it is not linear and sequential may times we will go forward and go back may be depending upon we have decided a particular product architecture. But when we start designing we go to the next stage of detailed designing there may be some issues that may creep up and in that case we need to change our product architecture a bit many times you will see even the product has been lost.

After the launch of the product also the company comes up with the better modified product with the modified architecture why because from based on the customer feedback many times there are improvements that are possible in the product architecture. So, basically as a standard this is the stage which is or these are the steps are the sequence that is followed for developing any product. So we can see that platform decision, concept decision and decomposition decision.

So majorly we will like to finalize our product architecture in the very beginning of our product development process. But that is not final many times we may need changes we nay need to revert back to our initial stages to come up with the modified product with the better architecture. Now different types of product architectures are there modular.

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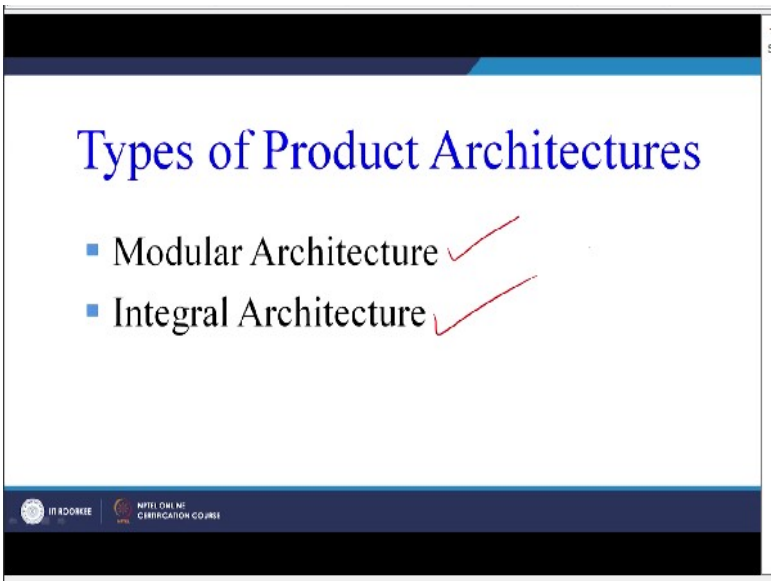

We will try to understand it with the help of an example and integral architecture. So, the modular product architecture you can see an example of Sony Walkman.

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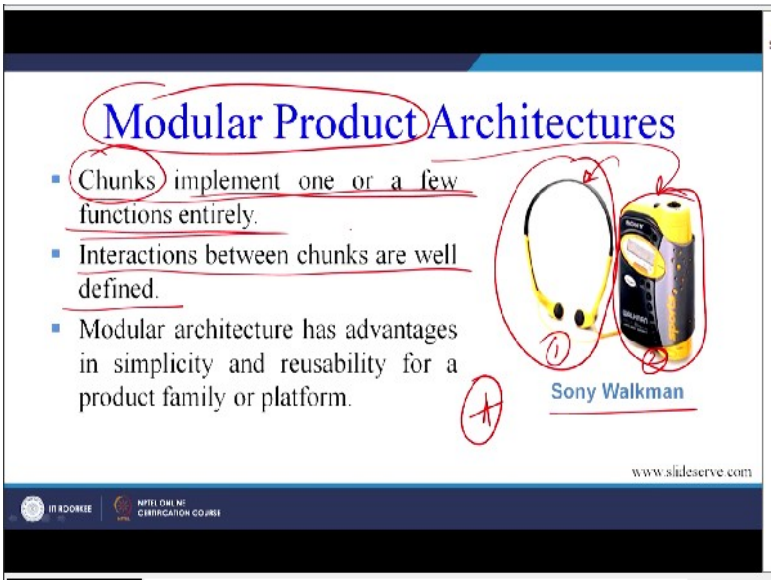

Chunks implement one or a few functions entirely, so the modular product architecture we are talking of the modular product architecture and the example is given here. Interactions between the chunks are very well defined, now we can see may be this part can be one module. And the headphones can be the other modules. So, there are module number1, module number 2. So, we can see the chunks implement one or a few functions in entirety.

So, the 2 are independent we can use may be many cases the headphones with another device also. So, they are independent in the functions and the walkman we can say is the you can say will create music based on the input that we give to the walkman. So, it will create music it is independent of whether we are connecting the headphones with the Walkman or not. So, may be even if do not connect it can give as a music.

So, when we want to here may be in solitude or may be sitting in a room where lot of people are sitting we only want to listen to it. We do not want to others to be disturb, so we can put our headphones on, so both have their independent functions. So which is clearly mentioned here, chunks implement, chunks means the modules implement one or a few functions independently or entirely, interactions between chunks are very well defined.

Modular architecture has advantages in simplicity and reusability for a product family or a platform as I have already explained. They can be reused the modular parts can be reused.

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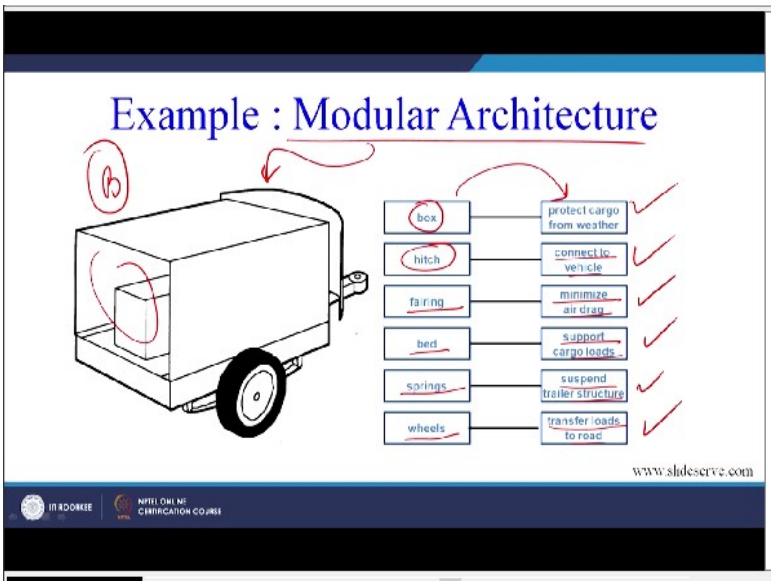

Now this is an example again of a modular architecture, the previous one is again one example, so this is example number1 or we can say example number A. Because 1 and 2 we have already used this is our example number B for the modular architecture. So, we can see here it is box is there what is the function?, function is protect cargo from the weather, so this is the box inside which will protect the material that we are transporting from the weather.

Hitch to connect to the vehicle faring minimize the air drag, bed support the cargo loads. Springs suspend the trailer structure, wheels transfer loads to the road, so here also this is an example of the modular architecture why? because each and every module can be independently performing its function and are not the functions are not too much interacting. So, independently or entirely each and every part is performing its function as is given in the previous slide.

Interactions between the chunks are well defined, chunks implement one or a few functions entirely. So, entirely each and every part is performing the function and the interaction also is very very well defined as is given here.

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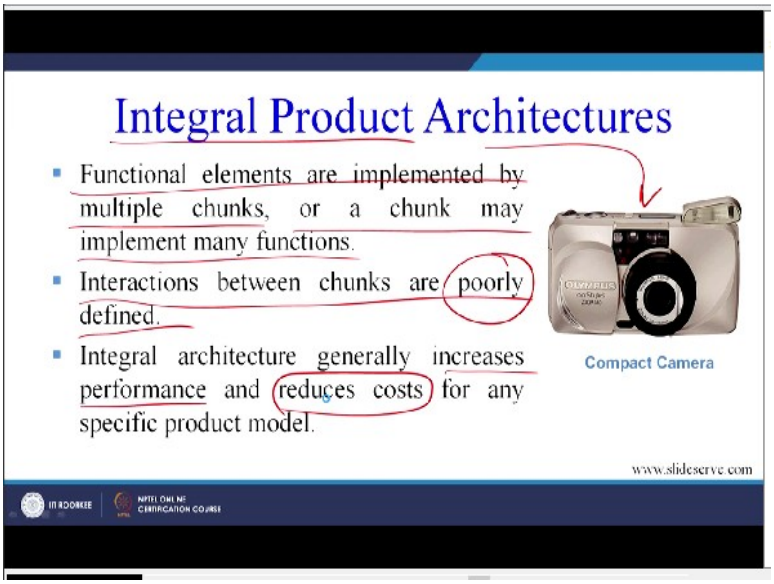

So, this is another example, now the second type of architecture is the integral product architecture. So, here we see the integral product architecture and a camera is shown here, functional elements are implemented by multiple chunks**.** So, there is a maybe 3 or 4 chunks they interact with each other to produce a particular function. So, here we can see in the previous slide functions are independent for the various parts of the products.

So, each and every chunk of the product or each or every module of the product is performing a certain function in entirety. Here each and every function may be combined, for example suppose we want to use of flash. So, when we are using a flash we have to click from the button. And

then integrally there will be some motion of a maybe system through which the flash will be activated.

So, basically there is a interaction between the various chunks. So, functional elements are implemented by multiple chunks or a chunk may implement many functions. So, a chunk may implement many functions, so they which means that when we have identified product is being made out of 3 chunks only 1 chunk may provide different functions. Interaction between the chunks are poorly defined**.**

So, 1 chunk is performing 4 or 5 different functions of the interaction between the chunks is not very well defined maybe we can have a chip which is performing 10 different functions. Now this is a chip which is one chunk of our product but this is performing 10 different functions. So, the interaction between the chunks or may be this chip and there is another chip interaction between the 2 is not very well defined where as both may be performing 5 functions each.

So, the interactions between the chunks are not properly defined or poorly defined. Integral architecture generally increases performance and reduces costs for any specific product level. So, the costs are less because we are identifying that each chunk will perform a large number of functions as well as it increases the performance also. There are advantages of the integral product architecture and therefore we see these days we have very compact products why?.

Because the chunks are multi-functional a single chunk is performing a large number of function. So even you can see an example also in such a way that in integral product approach we have seen an example where we have this type of a trolley system for carrying the cargo, whereas in integral architecture we have very compact product. But it is multi-functional and is performing different functions.

So, therefore the cost wise also we get the effectiveness as well as the performance also is better now step 2 establish the product architecture. So, there are 2 types of approaches we have understood 1 is the modular approach another one is the integral approach. So, let us now to try

to understand step 2 establish that how what are the steps that we have to follow. First is we will try to understand it with the help of a example.

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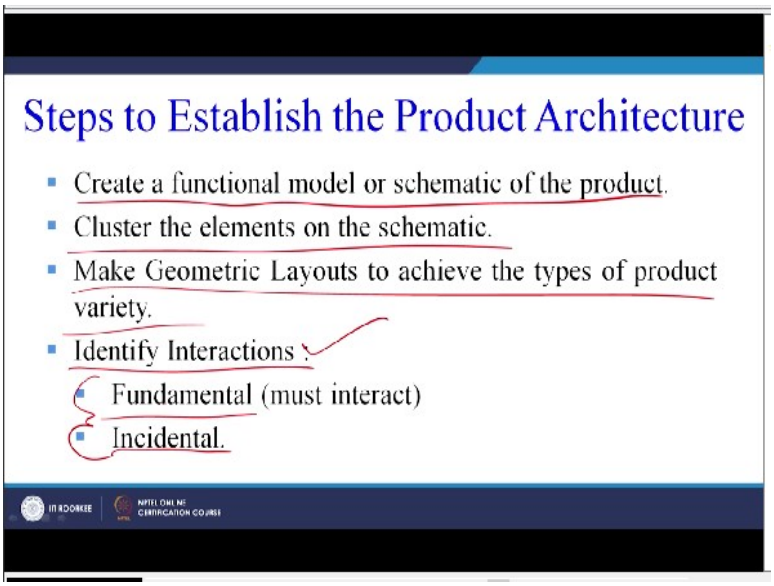

Create a functional model or a schematic of the product, first is schematic how is it will be working. So, we have already seen with the help of an example where a may be a truck is going to carry the cargo. So, how the wagon of the truck will look like the design of the wagon is showing the wheels also, showing the box also, showing the hitch also, so that is basically a schematic model of the product.

So, create a functional modular schematic model of the product, cluster the elements on the schematic. Now we can cluster or we can make the chunks that what are the various chunks in the product on which we are going to focus. Cluster the elements on the schematic make geometric layouts to achieve the types of product variety. Now we have already discussed based on the product variety we can make the geometric layouts, may be many times it may so happen that we may not be able to provide a particular chunk for a specific model of a product.

So, that is these geometric layouts will help us to achieve the types of product variety. Then identify the interactions because each and every chunk is interacting with each other. So, when we identify the interactions there will be fundamental which is must interact, then there will be incidental which may happen from time to time which may not be fundamental may not be

necessary. But may be during the use of the product sometime this type of interaction between the different chunks may take place. So, the interactions we can classify broadly into 2 categories fundamental interactions and the incidental interactions.

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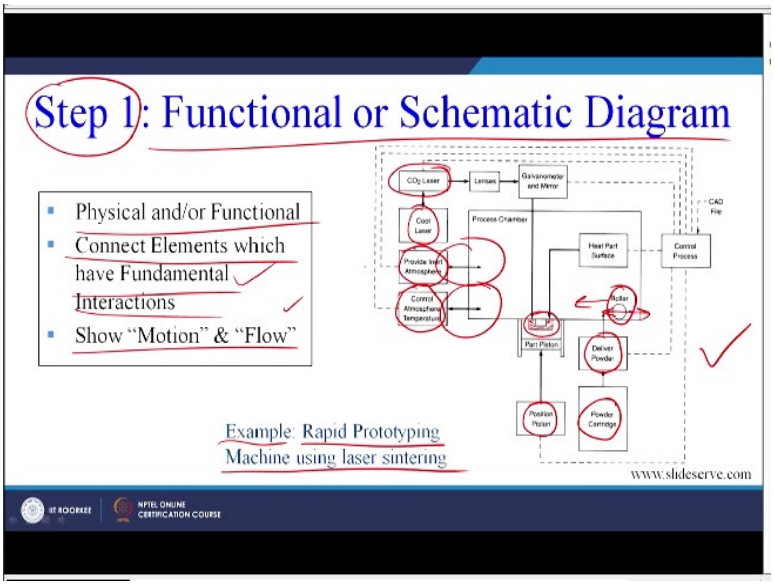

Now this is one example step 1 functional or schematic diagram, so this is basically taken. We can see this is the example of a rapid pro-typing machine using laser sintering. So, basically the powder is taken as a raw material and it is sintered to give a particular shape. Now what is used here lasers are used CO_2 laser is used, then there will be a powder supply because the raw material is in the form of a powder.

So, there is a part piston we are the product will be made this is the position of the piston that where the powder will come and the laser, will CO_2 laser will sinter that powder. Then delivery powder is there heat parts are phases there, there is a laser also cool laser provide inert atmosphere, control atmosphere temperature. So basically there are laser elements can laser control elements.

Then there are powder control elements, how the powder will come?, how the powder will be rolled?, how the laser will be able to sinter the powder?, how the product will get heated up?. How it has to taken out from the build chamber where the product is being made. So, all these

this is the powder cartridge from where the powder will come? This is the delivery of the powder this is the roller which is roll the powder on the build platform.

This is the part piston this is the part which is being made from the powder this is the part which is being made. So basically there are different chunks in this whole process one is related to laser another is related to the powder, another is relate to the platform where the part will be made another is relate to the control processes because we have to move the piston as per the design of the product.

We have to move the laser as per the design of the product, so there has to be overall control of the process. So the basic process is that we have a powder material we have a CO_2 laser which will sinter this powder, the powder will be compacted may be with the roller. And then once it is sintered it will become solid and we will be able to produce a part or a pro-type from the powder which is being sintered by the CO_2 laser.

So that is the process. Now from this process we have to see that how we will establish our product architecture. So the process is known to as the schematic is ready here this is the rapid pro-typing process the concept of rapid prototyping we will cover in the subsequent class may be in session number 39. So, here we see that first step for establishing this product architecture is functional or schematic drawing.

So, this is the schematic drawing which is given here we will see physical or functional parts we will see because each of the part, each of the we can say component or sub-element which is listed the schematic diagram is going to satisfy certain function. So, then connect the elements which have fundamental interactions show motion and flow. So, we can see that here the motion and flow is also shown.

The roller you can see it is shown with the help of the arrows in which direction it will be moving. So, motion and flow also has to be shown, interactions also we can see the interactions are shown here with the help of arrows. So, this is the first stage we are we create a schematic of

the overall product or the system or the machine. And then we try to show the interactions between the various parts are sub-systems of the product.

And try to show the functional and the physical representation of the product, so this is the step 1, in step 2 cluster the elements into chunks.

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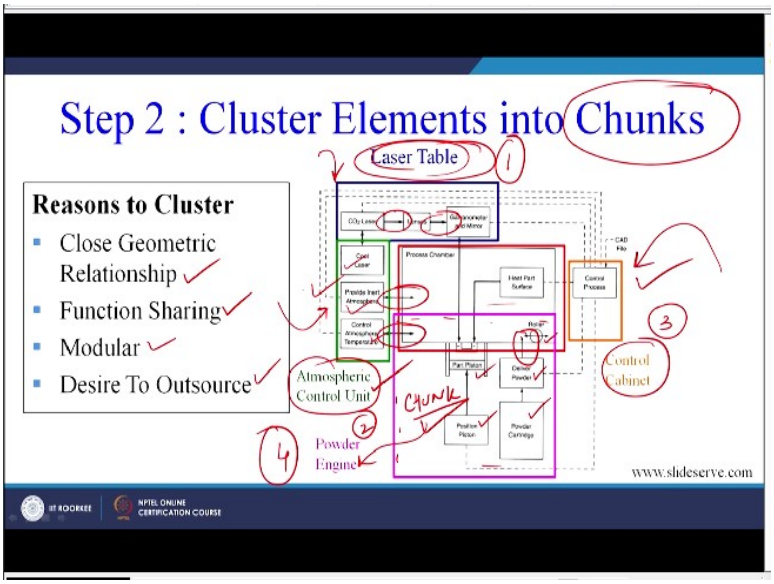

Now here we can see chunks have to be decided, so how what is the reason?. For this clustering or making the chunks then we can see which have the close geometric relationship which are sharing the same function. Because we have seen in the previous slide that we will marked the function for each and every part or the sub-system. So, there may be 3 or 4 sub-system, so there may be 3 or 4 different sub-parts which have the same function.

So, we will make them into a one chunk, so we will try to see here then we will try to because here we are creating them into chunks that will be our modular design for each module we can have a thought process. And see how this design can be improved and finally desire to outsource, many times we may also think that this particular chunk company X has already got the monopoly they have the patent and let us by this complete chunk or this complete module from that organization.

So that we need not spend our time energy and money on doing research in developing this chunks. So that chink can be directly out sourced to a well established organization, so that is a basic purpose of developing the schematic into the individual chunks. Now let us see that what are the chunks one is the laser table, so another one is the atmospheric control unit control the atmosphere temperature provide the inert atmosphere cool the laser.

So, this is a atmospheric control unit one chunk shown by green colour another chunk shown by blue colour here CO_2 laser the lens is the galvanometer and the mirror. So, this is the laser table then there is a control process control cabinet this is the third. So let us say one by one laser table which is a source of energy atmospheric control unit control cabinet and finally the raw material the powder engine.

So, we have to supply the powder this pink colour is the powder engine. So, we can see here where is a position the piston part piston. This is the part which is to be made, so heat part surface, this is the hot part surface here, so roller is there. So all this roller deliver powder, powder cartridge position piston, part piston. This is just one chunk which is related to the powder then this chunk is related to the laser.

This chunk is related to the control, this chunk is related to providing the environment for doing the processing of the powder into the final product. So we have divided the complete schematic into different chunks, now may be our company wants to make rapid pro-typing machine based on the selective laser sintering technology. We may like to buy the co2 laser from other source, so this laser table and laser system we can outsource it to some other company rest all we can try to develop indigenously.

So, that is the you can say advantage of the product architecture that we know that where is our strength? and what all we can get from the industry, so this is the second step, third step is produce the geometric lay out. Now we have to see how physically our product will look like, where the CO_2 laser must fit in, where the table, where the sintering will be done, where that must be fit in, where the control cabinet must be there.

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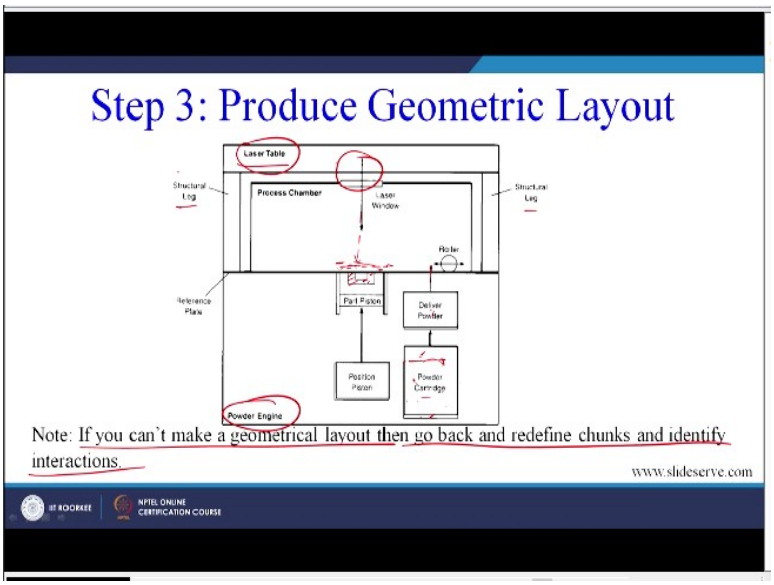

So, note if you cannot make a geometric layout then go back and redefine chunks and identify the interactions. So, if we are not able to because we want our product architecture to be compact it must be aesthetically appealing it must be nice looking we must be able to appreciate by looking at the system that it not only functionally this product is good. But aesthetically also it is very good, so we have to be very judicious in the selection of the geometric layout of our product.

So based on the various chunks we may produce a geometric layout. So, we can see here this is the laser table structural legs on both sides. This is the part piston this is the delivery powder, so basically the powder cartridge, powder is stored here. So, from here delivery powder will come roller will roll the powder, the powder will come here. Then this laser window will fall on this and it will sinter it the movement of this laser from here will be based on the CAD file that is the design of the product and sintering will take place.

And the product will be formed accordingly, so this is the reference plates. So powder engine is here laser table is here, so that is basically the various chunks which we have interacted into now 1. The 4 basic chunks were there, so the control and other parts may be just behind this behind the screen. So, we can see that we have to make a geometric layout how the product will look like based on the architectural chunks that we have decided in the previous slide.

Then identify the interactions, so force is consideration of geometric interfaces to accommodate the flow. So we have to understand that now we have already set geometrically that where which particular chunk has to fit in. Now we have to see how these are going to interact with each other. So, illustrates the possible problems caused by the interactions.

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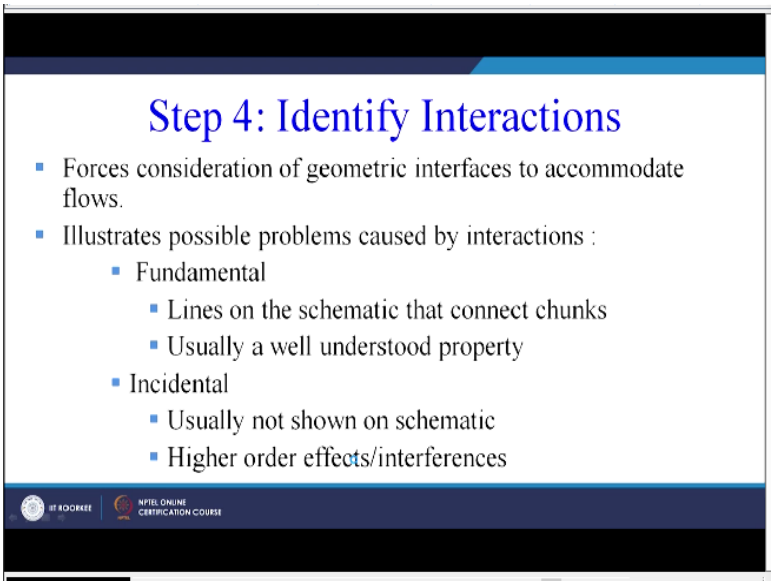

There can be fundamental lines on the schematic that connect the chunks usually a well understood property, incidental can be usually not shown on the schematic higher order effects and interferences, many times it may so happen that in the case that we have taken that the temperature is so high within the build chamber. The powder is being sintered that it has a effect on the efficiency and performance of the environment control unit or the atmosphere unit.

And it may get trip off, so it is not the direct interaction but it may be a incidental or a indirect type of interaction between the 2 broad chunks. One chunk is the may be the powdered delivery part one is the example that we have taken the 4 chunks we have taken one of them was the atmosphere control unit. So, I will go back to the again the slide you can see the atmospheric control unit is 1 chunk.

And the powder is feeding is another chunk, so if there is a problem in the powder feeding chunk it may affect the atmospheric control unit which may not be a planned or a fundamental interaction. We do not expect that there will be much interaction between these 2 chunks. But

because of a problem there can be the interaction between the 2 chunks also which we usually call as the incidental interaction.

So, the fundamental interactions basically are the lines on the schematic that connect the chunks which are easily explained here we can see these are the lines which are showing the fundamental interaction between the various chunks or the various sub-systems. So, here these are the 2 which are showing the interaction between the chunks different chunks and this one is another which is showing the interaction between the powder engine.

And the this one the red portion is our chunk number red one is our atmosphere control unit. So, we can see that there is a interaction between the 2 here direct interaction when we are feeding the powder. But there can be incidental interaction also.

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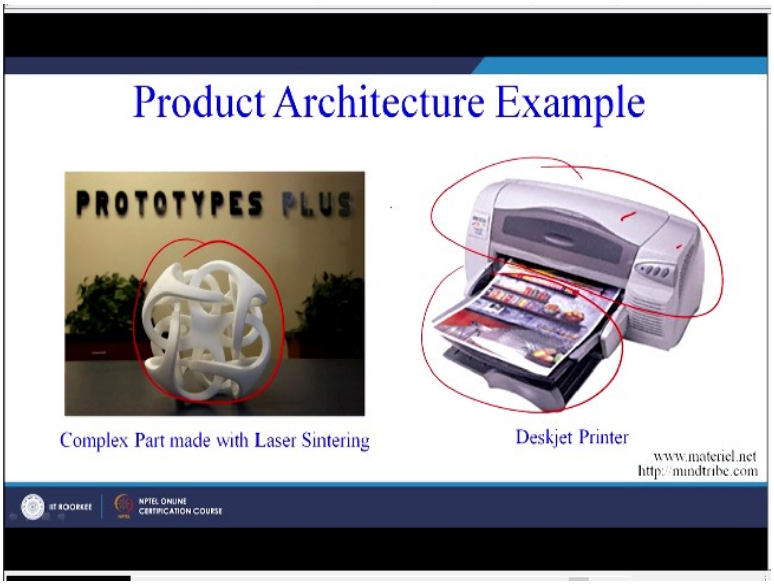

So product architecture this is an example on your screen you can see complex parts made with the laser sintering. This type of complex parts can be very easily made which are very difficult to process using the conventional techniques. This is deskjet printer using the conventional techniques this is the deskjet printer we can see here different it can also be divided into different chunks may be based on the functionality.

We can have the different chunks in this product also, so depending upon the functionality depending upon the geometrical layout depending upon the modularity that we want to put into our product. We can have different layouts of the various chunks within the product and that basically is the objective of defining the product architecture. So, with this we can conclude the today's session the main objective of today's session was to introduce the concept of product architecture that when we are designing a product.

We must be very very careful related to the various chunks or modules that we are going to design which are going to be integrated to make our final product. So, what are the different types of modularity that we can introduce in the product architecture with that we have seen, then we have seen with the step by step approach for the selective laser sintering. How the complete product architecture can be build up.

We can have the different functional chunks and then these functional chunks have to be integrated with each other. We have to produce a geometric layout and if we are not able to produce a geometric layout we have to again think regarding the classification of these chunks. And once all this is ready we will have to understand the fundamental interactions and the incidental interactions between the various chunks.

And once all that is defined we will able to finally prototype our product we will be able to make a prototype and tested for launching it into the market. In our next session we will talk about very briefly about the concept of rapid prototyping. Today we have seen about selective laser sintering which is a very may be important process that is used during rapid prototyping of the product. So with this we can conclude the today's session.
Thank you.