Design Practice
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Lecture – 08
Configurational Design Aspects

Hello and welcome to this course on design practice module 8. We were talking about the product architecture and we described about modular and integral architecture in the last module. In this particular module we will be talking about the configurational design aspects.

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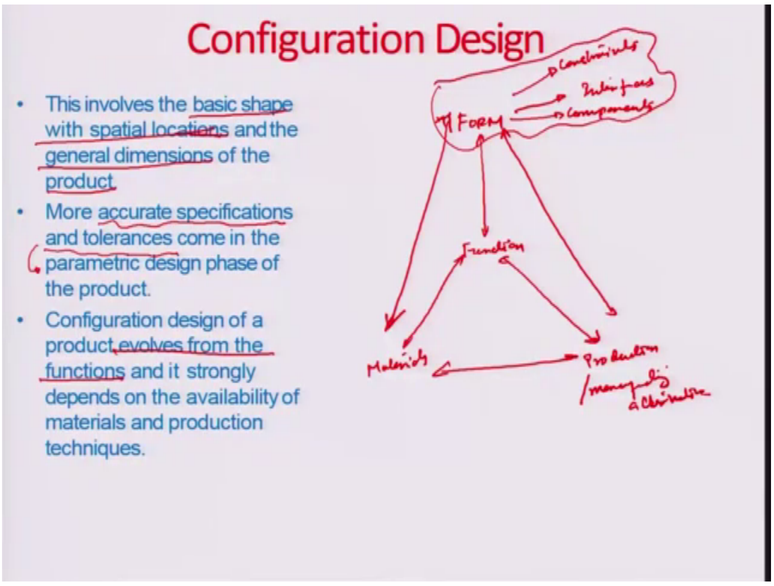

So, what is really meant by Configuration Design? is that you know it is basically sort of a spatial relationship between the various physical components that have been split up in the last step from a basic shape or basic architecture product architecture. So, it involves the basic shape with special locations and also tries to indicate, what are the general dimensions that the product should have; obviously, the configuration design at some point of time would also need to develop accurate specifications or tolerances

But this comes at a later point where we actually talk about the different parameters which are involved in the design ok. So, configuration design essentially evolves from the functions of let us say the different subsystems which are put in place and also in a way to their dependency on the availability of materials and the production processes which are involved to realize them physically.

So, in a way I would rather say that this configuration design is related to the creation of this form of the product which involves again a inter sub domain functional relationship it also involves a lot of logistics related to the availability of the type of materials which are in place.

And also to the production slash manufacturing alternatives which are available for to the designer based on these constraints he emerges the final form of the layout of the product architecture. So obviously, the form has components the form does have also interfaces between these components.

And when we talk about particularly the next step which is the parametric design process these interfaces and the dimensions are tolerances along these interfaces become of immense significance and defining the product architecture. And of course, there are constraints, constraints like physical constraints related to motion related to binding you know between different subsystems at the boundary or the interface.

So, with all this the final form of the product kind of emerges in terms of it is functionality mapped into the different subsystems laid in space parallel to each other in the way that they should be laid out in the product architecture etcetera. So, that is how configuration design would be carried out.

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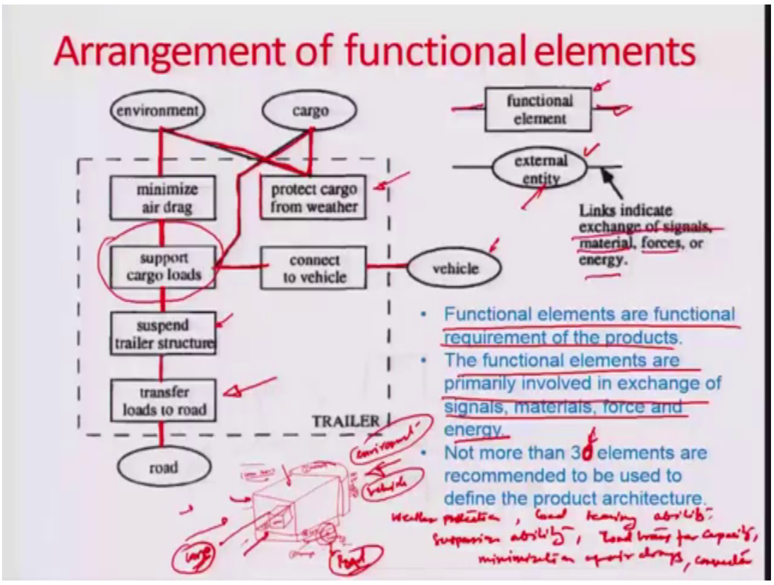

Let us look at an example again when we are talking about the same cargo trolley that we had discussed in the last step. Obviously, there are different components which would create different functionalities if you may remember we had talked about different functions including weather protection, load bearing capacity, or ability, suspension ability, load transfer capacity, and minimization of air drag right.

And in fact, if you may remember we had associated different components like the bed or the upper housing or even the fairing or the hitch or even springs so there is also a connector, connector to the vehicle in terms of these the subsystems which would offer such functionality. So, there were six different subsystems in this whole trolley architecture which would offer 6 different functionalities in the extremely modular, simple modular design of the trolley.

Now if I wanted to connect such functionalities in space with respect to each other in a manner that it would be laid out in the product itself ok. So, that would give you an idea of the functional of the configuration design.

So, how for example, in this particular case there are certain aspects related to this design which talks about interaction with the environment for example, the load bearing capacity of the trolley or the load transfer ability of the trolley is really transferring the load to the road. So, road is one element of the environment through which the system would interact.

Obviously, there is another element of weather or you can say that you know the environment in which the product is being operated through which the product will interact and the third element which is of significance here probably is the cargo because cargo is again externally loaded on to the product. So, it is no longer a part of the system or at least a system level integration between the different subsystems connected together ok.

So, the cargo the environment and the road and also of course, vehicle which would be used as a puller these 4 could be external entities which would in a way interact with this cargo trolley to define it is functionality. So, now, if I wanted to look at how these functionalities would be related we know that when the load transfer issue comes of the wheels the cargo trolley that should have an interaction or a signal flow into the road meaning there by the load is being transferred into the load.

Similarly the suspend trailer structure should in a way be connected through a signal line to the transfer loads to the road because unless the suspension happens there is no way that the load can remain away from the road ok.

And so only if it is way there would be a question of the load being transferred from the wheel into the road similarly the support cargo loads function is again connected through a signal flow to the suspend trailer structure, because ultimately the suspension is needed because there is a requirement of the support ability of the system to the cargo load.

So, it is a way of looking into what is the in space functional relationship or functional line of requirements with respect to each other which will give you an idea of what component to be placed near to what component. So, in terms of functional split up of the whole system you are trying to align all these subsystem level information in a line diagram mode just in a way as a function signal or the function signals flow between the different functionalities of the trolley ok.

So, in this case also there is this minimize of minimization of air drag which in a way is connected to the environment because; obviously, there is an interaction of the environment and so if the air drag is in a way minimized there would be an effect that would be lined up with the cargo loads because if the drag is low then probably lesser amount of force would be needed to transfer the cargo and obviously, the cargo loads in that case would be virtually not felt so much as it were the case when there would be an air drag.

Similarly, if I looked at how the protective cover of the trolley would interact it would basically have a functionality of protection of the cargo from weather again the interaction goes with respect to the environment. And in all these cases the interaction also happens with the cargo because it is a cargo which is to be protected from the environment and both of them are external entities. So, we are connecting these external entities to this functionality here which talks about the protection of the cargo from the weather.

Similarly when we talk about connecting to a vehicle the signal flow of this functionality of connection to a vehicle should go into the vehicle for the vehicle to provide the respective pull to the whole system and in a way the connect to the vehicle should actually take the signal from the support cargo load.

So, that whatever load is being felt here which is also a function of what kind of cargo it is carrying, it would define with along with the minimization of the air drag and the support cargo load functionality. What is the level of signal that should flow between the functionality of connect to the vehicle and the vehicle?

So, this is how you are basically splitting up into functional elements and external entities and with a signal flow diagram trying to ensure that the functional proximity is specially located in a manner so that you know you can define the subsystem level information of components which go into the final design of the trolley ok. So obviously, the functional elements are functional requirements of the product this I think I have already indicated.

There are two different notations used here one is for the external entity which are the circular notations and rectangular notations are for functional elements and the lines here are basically the signals or the links which would indicate the exchange of signals not on the exchange of signals, but exchange even of materials or forces of energy in a way so that you can do the interconnects and the functional elements are primarily involved in exchange of these signals materials forces and energies through these straight lines as has been already defined ok.

And generally when we split up any architecture into let us say a modular form it may be a wise idea do not go more than about 30 elements otherwise the functionalities are simply too complex to be mapped into in terms of subsystems. So, a better idea would be that in case of larger systems you split it up into smaller subsystems and each of these subsystems into several different parts constituting the subsystems where the functionality plot can be made into the subsystems and then the subsystems will be arranged in a manner.

So, that the overall functionality of the whole system can come up from the alignment of different subsystems specially just as I showed in terms of their functionality ah. So, that is how configuration design of an element is done.

So, you are seeing that how we can figure out from philosophical aspect of functionalities. How the components should really connect to each other or interface with each other so that those functionalities can be signal transmitted in ahead and in turn interact with the components of the environment into which such a engineering system is present ok. So, that is how you do configuration design.

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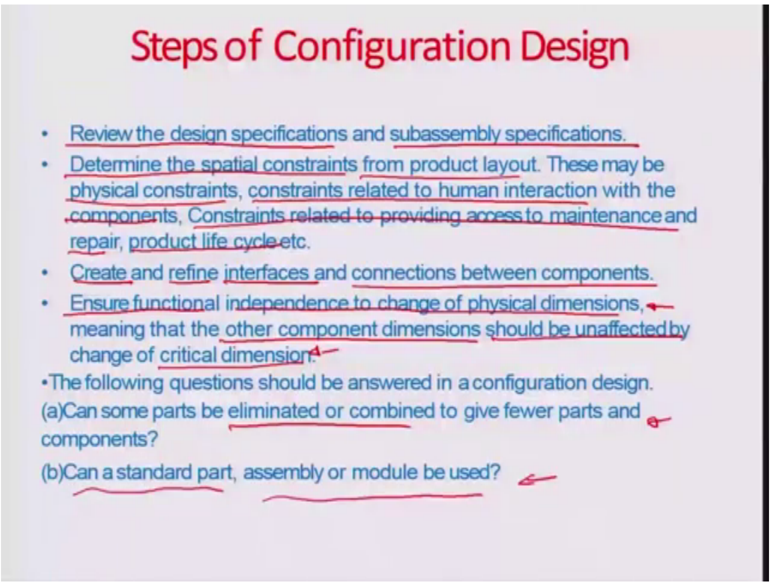

So, the in summary the steps of configuration design are to sort of review the design specifications and the subassembly specifications. Determine what are the spatial constraints particularly from the product layout these may be physical constraints, this may be constraints related to human interaction with the components, or constraints related to providing access to let us say maintainability or repeatability of the product or product lifecycle etcetera.

And then you suitably create or refine in some cases the interfaces between the different product assemblies once the functional planning or functional layout followed by the component layout has been realized and the connections between various components can then be established ok. So, one has to ensure that there is a functional independence to change of the physical dimensions.

For example, if the dimensions are broadened or narrowed there should not be much effect in terms of the functionalities they should remain same. In this particular case for example, if I were to increase or decrease the size of one of the components let us say the weather shield for example, or maybe the. .

So, in a way we are not going to give any or create any issues for the overall functional layout the layout is still going to remain unchanged and the functions of each components are not going to be any different if error is still going to give minimization of the aerodynamic drag or the it is still going to be connected to the vehicle to give the pull or the protection shield of the cargo is still going to be there for doing the cargo protection against weather changes so on so forth. .

So, typically the functional independence should by enlarge be there if there is any change of physical dimension and one has to also try that the component the other component dimensions may not be affected significantly you know if there is a change of a critical dimension of one of the subsystems of a product.

So, once this configuration design is sort of plan one has to ask the following question again and again that out of the layout that has been made is it possible to eliminate or combine two or more such subsystems together to have one system so that you have more you know you have fewer number of parts that you are going to connect eventually.

So, ultimately one has to do a sort of design for manufacturability by modularizing in a manner so that you have more than one components connected together in a single module and there is to be an optimum best of these modules beyond which if any further modularity is introduced it may be expensive in terms of manufacturing assembly etcetera.

So, that right configuration has to be finally, chosen which would be maybe a sort of a combination of more than two subsystem level components ah, but is the optimum best for the overall system as such. So, then also one has to ask a question that can a standard part assembly or module be used for a certain application so on and so forth so that is how you do configuration design.

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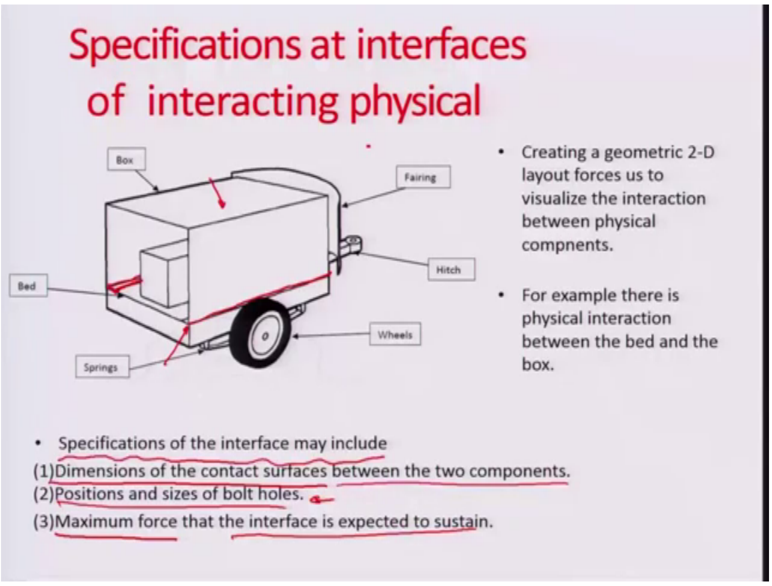

So, one has to also be very careful of the interfaces that is the connects between the various subsystem level information. In this particular case for example, the box is connected to the bed as you can see along this particular line so there is an interface between the box and the bed one has to be careful in designing this interface so that there are so it is very important for defining the final parameters of a product which I will do slightly later after I will have moved with or I have aligned you with what is known as the most modern concurrent engineering approach while doing designing.

So, here the idea is that the specifications of the interface may include probably a degree of overlap this particular sheet metal coming out from the box overhead has a certain amount of extension so that it gives a structural stability to the whole system ok.

So, the dimensions of the contact surfaces at such an interface between the box and the bed let us say in this particular example between two components in general are of critical importance when we try to do the configuration planning or configuration designing.

Also there are very important other information's like the exact positions and sizes of the bolt holes which may be introduced here for holding the box you have to remember that while there is a drag force on one side because of the movement of the hole trolley and there is also a aspect of vibratory load being pushed back from the wheel through the road on to the trolley. There is going to be some kind of interfacial movement or kinematics which is going to take place between the box component and the bed component as in this particular case.

And so you have to design the interface in a manner in the configuration so that it can sustain maximum force that is expected to be sustained at certain interface. So, in that manner the configuration has to be planned if need if need be some structural stiffeners or some other additional you know engineering design improvements we made at the interface at the configuration stage itself so that there are not many problems associated with the component later.

So, once the configuration planning of the product which means in a way a typical layout of the product at the subsystem level is being achieved in terms of it is function map. The next question that is asked is what do you know as you know parametric design where you actually start building up the critical dimensions, the critical tolerances, if there is a need for any particular fit to happen then all those product definitions or basic dimensional definitions of the whole architecture is realized.

But I am go not going to go directly into the parameter design first of all I want to just take you slight detour into another region or another area which is a concurrent philosophy in which designing is practiced out these days in the industry.

So, per say the designer is not a standalone member because he has to work in team with people from the process people from let us say even finance or marketing or sales or after sales. So, it has to be a big team which actually looks at certain design improvement or a change of design or introduction of a new design.

And the whole idea behind this concurrent philosophy is that everybody's input is needed at the very beginning for the design very less iterative and be able to prove to be the best design within a minimum possible time frame.

So, let us look into what is concurrent engineering or what is the approach of concurrent engineering.

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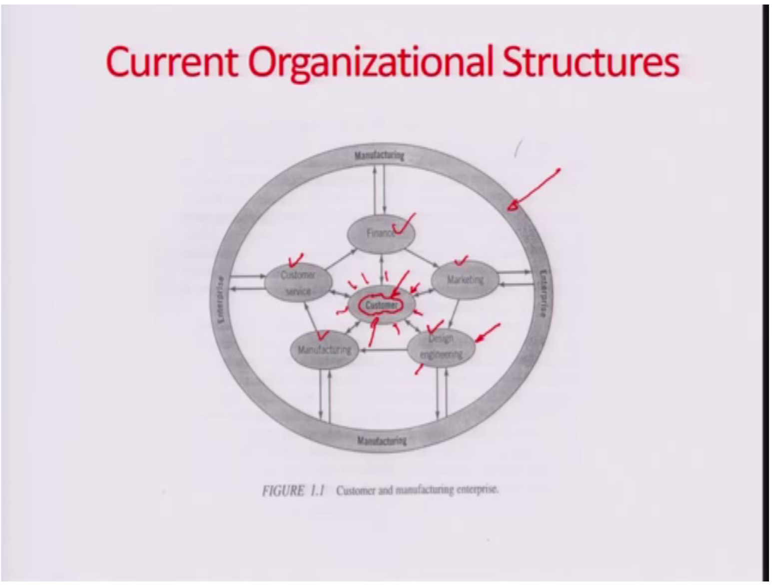

So, the concurrent engineering concept really emerges from the modern day organizational structure which is being represented here which shows that ultimately any manufacturing enterprise where the goal is to produce something of value added component something that formulates a value added component or provides a value to the society it really comprises of a very close level interaction between the various wings associated with this organization this manufacturing organization.

So, there can be a customer service wing, there can be a design engineering and a manufacturing wing, there can be a marketing wing, there can be a finance wing a. So, basically the need is to be able to come very close to what the customer wants and that is the philosophy through which everybody is driven that the customer is really the central focus of such an engineering enterprise.

And when we look at design engineering per say you can see that there is an interaction continuously needed from all the different wings of the organization that are associated directly or indirectly with the organization with the success of the organization with the design in order to have a good work practice in place.

And because of the we can say in increased horizontal level interaction between the various wings associated with an organization most of the modern industries there is a need that design decisions be influenced by almost all from right from the very beginning it.

So, it really creates a high degree of ownership between the various wings of an organization so that the design decision which is the central theme of what needs to be produced which is of value to the society is made in togetherness it is made with collective wisdom of everybody who is a stakeholder in such an organization. So, that is what concurrent engineering philosophy is?

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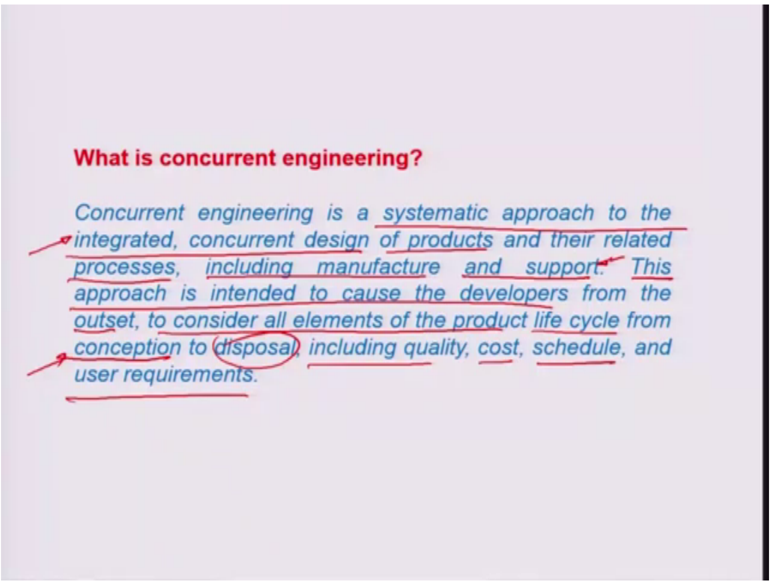

In definition it is a systematic approach to integrated concurrent design of products this is the key word integrated concurrent design. And their related processes including manufacturing, support services, everything which is associated with the product lifecycle from the design phase to the after sale service or even like the recyclability phase of a product.

So, this approach is intended mainly to cause product developers from the outset to consider all elements in the of the product lifecycle particularly from conception of an idea to the disposal of the final product which has met it is lifecycle and gone beyond you know the lifecycle and it is no longer usable ok

So, it includes quality of the product, it includes cost, it includes the schedules for delivery or other user requirements and that is how the product design is being defined concurrently with everybody on board. So, it is a very useful tool people these days in engineering design practice, concurrent engineering philosophy to the core and what I am going to probably outlay in this lecture and also the next lecture is to give you maybe some problem examples of how concurrent engineering is carried out.

The problem example may be very simple related to machining you know or designing a dimension for a machined part, but the underlying logic which is there and which would be spelt out will give you an idea of how optimization can be carried out by inputs from various members or stakeholders on the lifecycle of that engineering product which probably is a machined item or a machined part.

So, although this is a very simple example, but it will give you a philosophical introduction into why concurrent engine in really is needed for the best product designed to roll out of market. So, let us talk about what happened earlier or what used to happen earlier.

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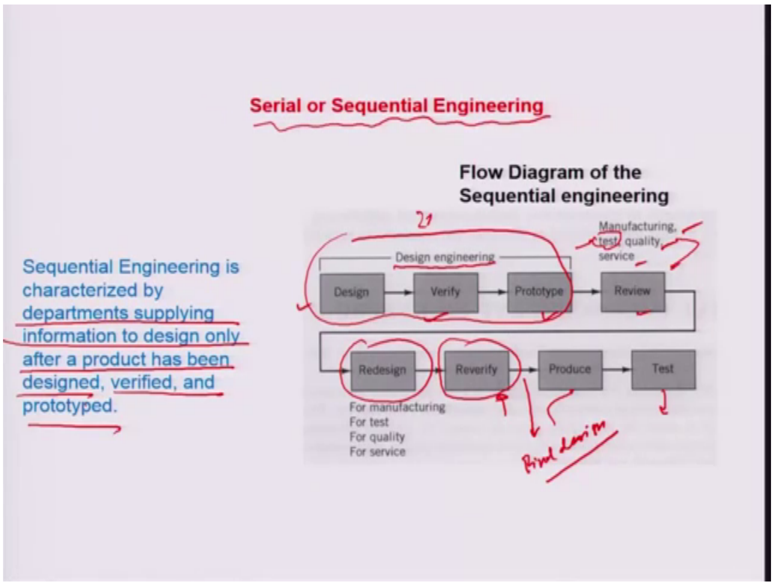

So, there was this serial or sequential engineering design philosophy where it was characterized by departments, supplying, information to design only after the product has been designed verified and prototyped and so therefore, there used to be multiple iterations and there is to be hardly one design which would come off because everybody would be critical about their requirements once the prototyping has been carried out in the prototype and would be probably able to change everything associated with the prototype because of the heaviness of the requirements dictated by you know the manufacturing.

So, the process was really that you design something which is the goal of the design engineering then you verify whether the design is right you know and then you try to prototype and then review the prototype with manufacturing let us say quality or service you know or even some testing of the product or functional testing of the product.

And after this there is one set of review which again probably gets one to redesign again start the whole process again of the design engineering as has been initiated in step one here then again re verify the redesigned item and then finally, iteratively do this many times up till the final design gets produced somewhere here and which is acceptable to all and then you start producing and then test the design after the production has been carried out.

So, the time horizon over which this iterative process would be done because of feedback from all the different sectors associated with the realization of the product from the prototype and that would take immense amount of time and the time horizon will be very large.

So, sequential engineering in a way was very rigorous though it was a lot of extra effort that had to be done in order to roll out something which was very elementary or very simple. So, today's concept of course, as I illustrated earlier is that all functional areas are together they are integrated with the design process as such.

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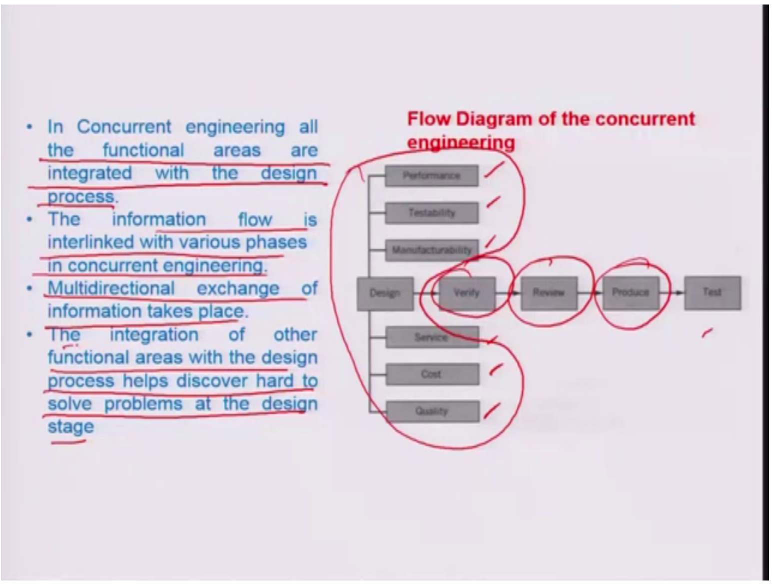

So, when you are designing you are basically taking inputs from the manufacturable or manufacturing site. So, your design should be manufacturable you have good process knowledge or domain knowledge of what processes you have in place for you to be able to design the right kind of product you take inputs from product testing where the functional characterization of the product has been done.

So, if there is something which is wrong in the design which leads to reduced functionality you arrest it at the very beginning so that the final design does not get rolled out. You have interaction with you know the performance coming out of the product, you have interaction with the service the after sales service the overall cost that is the finance and then the quality of the product.

And basically the design which rolls out now is verified it is reviewed and it is directly produced. There is no iterative basis because more or less you know or the iterations I would say is very low in numbers to finalize it because you have all stakeholders participating from day one of the designing process and then you finally test so that is how a sequential concurrent engineering is being carried out.

So, the information flow is interlinked with various phases in contract concurrent engineering. There is in fact, a multidirectional exchange of information which takes place and the integration of other functional areas with the design process helps to discover heart to solve problems at the design stage itself. So, let us actually well just look at an example probably in the next module. So, I like to close this module here ah.

Thank you very much.